ANALYSIS OF PERCEPTION AND ADAPTATION STRATEGIES OF FARMERS TO CLIMATE CHANGE IN IKARA LOCAL GOVERNMENT AREA OF KADUNA STATE, NIGERIA

BY

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DECLARATION

I declare that the work in this Thesis entitled Analysis of perception and adaptation strategies of farmers to climate change in Ikara local government area of Kaduna state, Nigeria has been carried out by me in the Department of Geography. The information derived from the literature has been duly acknowledged in the text and a list of references provided. No part of this thesis was previously presented for another degree or diploma at this or any other institution.

Noelle Ogbenron Ajayi _____ _____

Signature Date

CERTIFICATION

This thesis entitled ANALYSIS OF PERCEPTION AND ADAPTATION STRATEGIES OF FARMERS TO CLIMATE CHANGE IN IKARA LOCAL GOVERNMENT AREA OF KADUNA STATE by Noelle Ogbenron AJAYI meets the regulations governing the award of the degree of Master Degree in Environmental Management of the Ahmadu Bello University, and is approved for its contribution to knowledge and literary presentation.

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DEDICATION

This work is dedicated to my late father, Mr. David FolorunshoAjayi. I know you are proud of the woman I have become.

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ABSTRACT

Climate change is a major environmental threat to the African continent, particularly inthe drier regions. There areseveral studies conducted at regional and national level but a continuous understanding of the knowledge and impact at a local level is required for appropriate interventions. This study therefore seeks to examine farmers' perceptionto climate change,the adaptation strategies employedand theirvulnerability toclimate change in Ikara LGA of Kaduna State. Samples were drawn from all the 10 wards in the study area and 382copies of questionnairewere purposively administered to households and farmers. The result indicated that majority (91.6%) of the respondents are aware of climate change. Respondents view climatechange as a change in weather, mainly in terms of increase in temperature and incessant rainfall. The results also revealed that in the advent of drought in the area, about 22% of the farmers prefer to cultivate milletbecause it is better adapted to dry infertile soils, high temperature, low precipitation and poor water holding capacity than other crops. To cope with the changing climate, about 84%of the farmers in the study area adopted themethod of plantingvariety of crops, 59% plant drought and flood resistant crops, a little over 54% rear heat tolerant animals, close to 68% mulch crops to reduce water loss. The vulnerability index of the respondents in the study area is 0.42 which reflects a moderate vulnerability. The study concluded that, hindrances to coping with the adopted strategies included inadequate amounts of improved seeds, inadequate funds to acquire newtechniques such as irrigation techniques and improved seed varieties, inadequate information on weather incidence, insufficient knowledge on global current adaptation methods andinadequate water for irrigation.This study recommends that, raising awareness and knowledge about early warning of climate change through mass media, improving extension services which would help farmers understand the major impact of climate change and providing programmes that support female farmers. The combination of these would provideglobal best practice adaptation measures to withstand the effects of climate change, thus making farmers less vulnerable.

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CHAPTER ONE: INTRODUCTION

1.1 BACKGROUND TO THE STUDY

The Intergovernmental Panel on Climate Change (IPCC) (2007), views climate change as statistically significant variation in either mean state of the climate or in its variability, persisting for an extended period (typically decades or longer). Climate change maybe due to natural processes, external forces or to persistent anthropogenic changes in the composition of the atmosphere or in land-use. There have been growing awareness that the earth's climate is changing at an alarming rate and the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) affirms that climate change is no longer in doubt but is now unequivocally apparent based on evidence from scientific observations of increases in global average air and ocean temperatures (IPCC, 2007). Although extreme violent weather has occurred throughout history, recent upsurge in climate related hazards is confirming the argument for global warming and climate change (McGuire, Macon and Kilburn, 2002; Odjugo and Ikhuoria, 2003; Nwafor, 2006).

The evolving climate change coupled with increasing temperature has been observed to plunge some localities into experiencing extreme weather conditions (Olaniran, 2002; Ayoade, 2003; Odjugo, 2005). The on-going climate change and its associated global warming are expected to cause distinctive climate patterns in different climatic zones, which will impact negatively on the ecosystem (Mshelia, 2005; Hengeveld, Whitewood, and Fergusson, 2005; Ayuba, Maryah, and Gwary, 2007). That is why Ojo (1991) and Clerk (2002) advised that weather and climate should not be taken for granted in the pursuit of technological development, exploration and processing of environmental resources. The impact of climate change is felt worldwide, but the effects are more varied in countries

based on certain underlying factors. In the Nigerian context, the severe impact of climate change is felt majorly by people whose livelihoods are more intertwined with nature such as farmers, livestock rearers, biomass users among others.

Climate plays an important role in the living and livelihood of man. Hence, changes are perceived by humans based on peculiarity of effects and local level variation. Consequently different communities perceive climate change differently and this should be taken into account for national and regional policy initiatives to either combat or cope with climate change impacts. Hence, the focus of this study is on the perception of farmers.

In the context of climate change, adaptability is often referred to as "adaptive capacity," defined as, "the ability of a system to adjust to climate change (including climate variability and extremes) to moderate potential damages, to take advantage of opportunities, or to cope with the consequences" (McCarthy, Canziani, Leary, Dokken, and White, 2001: p. 21). Scenario based climate change impact assessments increasingly make assumptions about adaptations and invariably treat them as mostly technical adjustments (for example, changing to different crops, adopting efficient irrigation systems, or altering production systems) to the impacts identified.

Coping strategies are those that have evolved over time through farmers' long experience in dealing with the current known and understood natural variation in weather that they expect both within and between seasons, whereas adaptation strategies are longer-term (beyond a single rainfall season) strategies that would be needed to respond to a new set of evolving climatic conditions that they have not previously experienced. Adaptations to climate change are not just discrete technical measures, but are modifications to farm practices with

respect to multiple (climatic and non-climatic) stimuli and conditions. Climate change adaptation refers to adjustments in management strategies to actual or expected climatic conditions or their effects, in order to reduce risks or realize opportunities (Smit, Burton, Klein, and Wandel, 2000). Adaptations usually take different forms, can occur at different scales, and can be undertaken by different agents of a community (e.g farmers, middlemen, large scale organizations, and governments). There is thus a need to continuously assess coping and adaptation ability of farmers, who are stakeholders in the climate change issues toward evolving avenues of mitigating undesirable impacts. This study is a contribution to that process using Ikara local government area of Kaduna state as the locale of investigation.

1.2 STATEMENT OF THE RESEARCH PROBLEM

Available evidences show that climate change is global, likewise its impacts, but the biting effects will be felt more by the developing countries especially those in Africa due to their low level of coping capabilities (Mshelia, 2005; Nwafor, 2007; Jagtap, 2007). Africa is one of the most vulnerable regions to climate change in the world. Previous assessments (Hulme, 1996; IPCC, 1998;) concluded that Africa is particularly vulnerable to the impacts of climate change because of factors such as widespread poverty, recurrent droughts, inequitable land distribution and over dependence on rain-fed agriculture.

Nigeria is one of such developing countries and researchers have shown that Nigeria is already being plagued with diverse ecological problems, which have been directly linked to the on-going climate change (Adebayo, 1997; Odjugo and Ikhuoria, 2003; NEST, 2003;

Chindu and Nyelong, 2005; Odjugo, 2005; Adefolalu, 2007; Ikhile, 2007). These studies focused more on climatic impacts.

The unimpeded increase in greenhouse gas emissions is raising the earth's temperature. The consequences include melting glaciers, more precipitation, more and more extreme weather events, and shifting seasons. The accelerating pace of climate change, combined with increase in global population, threaten food security everywhere. Populations in the developing world, which are already vulnerable and food insecure, are likely to be the most seriously affected. In 2005, nearly half of the economically active population in developing countries 2.5 billion people relied on agriculture for its livelihood.

According to Regmi and Adhikari (2007), climate change is recognized as a threat to communities which depend more on natural resources such as soil, water and biodiversity. As it is, Nigeria remains vulnerable to the economic, ecological and social impacts of climate change since this phenomenon adversely affects various climate-sensitive sectors such as agriculture and water resources. Agriculture remains the backbone of the Nigerian economy providing livelihoods for over 80% of the population, and owing to dependence on nature the livelihood security of farmers should be in consideration. Also, water resources are linked to livelihoods and development through drought and flood disasters. Dinar, Hassan, Kurukulasuriya, Benhin, and Mendelsohn (2006), opined that, many African countries, which have their economies largely based on weather-sensitive agricultural productions systems like Nigeria, are particularly vulnerable to climate change. And this vulnerability has been demonstrated by the devastating effects of recent flooding in the northern and Niger Delta regions of the country and the various prolonged droughts that are currently witnessed in some parts of northern region. Thus, for many poor countries

like Nigeria that are highly vulnerable to effects of climate change, understanding farmers' responses to climatic variation is crucial.

According to Mertz, Mbow, Reenberg, & Diouf, (2009), the study of coping and adaptive resource management strategies is not new, particularly in the drier regions of West Africa, where a poor and vulnerable population has always dealt with a highly fluctuating natural environment. There are diverging opinions on how well rural populations are dealing with their environmental and economic conditions. Recent studies observed that people in dry land are the most ecologically, socially, and politically marginalized groups lagging behind in most economic and health indices and that climate change will be yet another stress factor in a vulnerable system. Moreover, it is argued that the value of local knowledge in climate change studies has received little attention. Using agent-based modelling in a vegetable garden system of South Africa, Bharwani, Bithell, Downing, New, Washington, and Ziervogel, (2005) showed that wealthier households benefit more than the poor from weather forecasts and that, subsistence farmers are the most vulnerable to short-lived droughts even if average rains are good.

Previous studies on the impact of climate change (particularly rainfall and temperature) and climate related adaptation measures on crop yield are not all encompassing. Long term adaptation was observed in Burkina Faso and Niger, where shifts in farming location between sandy dunes and more clayey pedi-plains and piedmonts were related to precipitation patterns (Reenberg, 1994; Reenberg, Nielsen, and Rasmussen, 1998), whereas short term adaptation coping with the 1997 drought in Burkina Faso caused farm households to implement a range of food saving strategies, encourage migration, sell livestock, and even resorting to borrowing and mortgaging of the following year's crops

(Roncoli, Ingram, & Kirshen, 2001). In this case, the ramifications of one year's drought were felt in the following year in terms of lacking seed and labour for cultivation and it sparked interest in drought resistant varieties, but longer term adaptation measures were not assessed (Roncoli *et al*., 2001). In Nigeria, Nabegu (2010) observed that climate change induced geomorphological hazards in Kano and Udeh (2014) assessed farmers' perception and adaptation strategies to climate change in Kano. Also, Abaje, Sawa and Ati (2014) observed climate variability and change, impacts and adaptation strategies in Dutsin-Ma local government area of Katsina State.

From the array of literature available and accessible to the researcher, e.g. (Reenberg, 1994; Reenberg *et al*., 1998; Roncoli *et al*., 2001; Nabegu, 2010; Udeh, 2014; Abaje *et al*., 2014) no study has been conducted on farmers' adaptation to climate change in Ikara local government area (LGA). This leaves a gap to be filled because Ikara LGA is one of the areas in the northern part of Kaduna with a peculiar dry environment and about 80% of the population are rural farmers expected to be most vulnerable to climate change. Consequently, attempt is being made in this study to investigate both long term and short term adaptation strategies being used by farmers towards contributing to knowledge and policy on future adaptation strategies in Ikara LGA and similar areas.

Based on the identified research gap, this study attempts to address the following questions:

i. What are the socio-economic characteristics of households in Ikara LGA?

ii. What is the level of awareness of climate change of farmers?

iii. How do farmers perceive climate change in Ikara LGA?

iv. What have been the adaptation measures to this change?

v. How vulnerable are different households to climate change impacts?

1.3 AIM AND OBJECTIVES OF THE STUDY

The aim of this study is to analyse the perception and adaptation strategies of farmers to climate change in Ikara Local Government Area of Kaduna State and the objectives are to:

i. determine the socio-economic characteristics of households in Ikara LGA.

ii. examine the level of awareness of climate change amongst farmers.

iii. examine farmers' perception of climate change in the Ikara LGA.

iv. characterise the adaptation measures of households to climate change impact.

v. analyse the vulnerability of households to the impact of climate change.

1.4 JUSTIFICATION OF THE STUDY

Agricultural adaptation to climate risks is a relatively new field of inquiry (Wall and Smith, 2005). According to Nelson *et al*., (2009), climate change will cause yield declines for the most important crops in developing countries. Climate change will have varying effects on irrigated yields across regions of the world. Climate change will result in additional price increases for the most important agricultural crops such as rice, wheat, maize, and soybeans.

Indigenous knowledge arises out of continuous experimentation, innovation and adaptation, blending many knowledge systems to solve local problems (United Nations Framework Convention on Climate Change, (UNFCCC) 2006). Without a comprehensive understanding of micro-scale indigenous practice evolving macro scale policy interventions would be elusive.

Climate change is a global phenomenon while adaptation is largely site-specific. A common disadvantage for local coping strategies is that they are often not documented, but rather handed down through oral history and local expertise. As site-specific issues require site specific knowledge, experience has shown that identified adaptation measures do not necessarily translate into changes because there are context-specific social, financial, cultural, psychological and physiological barriers to adaptation (IPCC, 2007). It is very important to clearly understand what is happening at community level, because farmers are the most climate change vulnerable group.

Riebsame (1988) observed, measuring individuals' perceptions and activities can provide insights into how people see and adjust to climate change and variability, and such user-information is relevant when communicating results of climate impact studies and projections of future climate changes to users. Earlier studies have shown that crop yields are very sensitive to rainfall in northern Nigeria due to the erratic nature of rainfall amounts and distribution (Kowal and Kanabe, 1972; Peacock and Heinrich, 1984; Ekpoh, 1999b). Farmers are also increasingly aware of climate change and their particular vulnerability to irregular rainfall. Smallholder farmers in northern Nigeria are highly vulnerable to climate change. Many are developing coping strategies independently. However, there remains a need to provide opportunities for sharing successful adaptation strategies with other farmers

and to combine this with research to lessen the impact of climate change on their livelihoods.

1.5 SCOPE AND LIMITATIONS OF THE STUDY

The spatial scope of this study is the ten wards in Ikara Local Government Area of Kaduna State. The scope of the study in terms of content is to assess farmers' perception and adaptation strategies to climate change in Ikara LGA. The targeted populations are the farming community members in Ikara Local Government Area of Kaduna State.

The temporal scope of the research is based on a growing season in the study area and number of years the respondents who constituted the sample population indicated a change in climatic conditions during their farming activities as included on the questionnaire. The major research variables include climate change and farming activities.

CHAPTER TWO: CONCEPTUAL ISSUES AND LITERATURE REVIEW

2.1. CONCEPTUAL ISSUES

2.1.1 Concept of Climate Change

Climate change is one of the most outstanding challenges facing the global community and as such has been given different definitions by different authors according to their perception and the way it affects them.

Ozor (2009) defined climate change as change in climate over time, whether due to natural variability or as a result of human activity and is widely recognized as the most serious environmental threat facing our planet today. This definition elicits the seriousness of the threat posed by climate change and the urgency of the need for countries to rise up to this urgent clarion call of combating the negative effects of climate change.

Climate cannot be said to be static, but variations are very insignificant that it is only climatologists identify it. Over the years, the change becomes more pronounced and significant. This is as a result of earth's natural variations and man's activities which cause emissions of green house gases thereby increasing global warming. This global warming is what actually induces the change in climate. Over the past 100 years, the earth's average surface temperature has risen by around 0.74°C (Direct Gov., 2010). And if nothing is done, there is going to be more rise in the earth's temperature to the extent that it will be difficult to cope with it. This statement buttresses more the seriousness of the threat pose by climate change to countries that depend mostly on climate-sensitive resources for sustenance of livelihood and overall development.

Eboh, Ojo, Oji, Amakom and Ujah (2004) stated that countries in sub-saharan African, including Nigeria are likely to suffer the most because of their geographical location, low

incomes, low institutional capacity as well as their greater reliance on climate-sensitive renewable natural resources sectors like agriculture. This is further supported by Watson (1997) which stated that African countries are particularly vulnerable to climate change because of their dependency on rain fed agriculture, high levels of poverty, low levels of human and physical capital, inequitable land distribution and poor infrastructure. Adaptation to climate risks in Nigeria is therefore a primary necessity. Government need to integrate climate change issues as well as adaptation strategies into the countries development plan as the climate change risks is not only a challenge to agriculture development (food security) but to the country's general development and livelihood sustenance of the entire citizenry.

Climate change can involve both changes in average conditions and changes in variability, including, for example, extreme weather events. It has become common knowledge that the poor are likely to be hit hardest by climate change, and that capacity to respond to climate change is lowest in developing countries and among the poorest people in those countries. It seems clear that vulnerability to climate change is closely related to poverty, as the poor are least able to respond to climatic stimuli. Furthermore, certain regions of the world are more severely affected by the effects of climate change than others. Generally speaking, vulnerability and adaptation to climate change are urgent issues among many developing countries.

2.1.2 Concept of Perception

Slovic (1987) indicated that individuals form intuitive judgments about potential risk hazards and these judgments are commonly known as one's risk perceptions. According to

Raden-Fessenden and Heath (1987), people base their perceptions upon their personal experiences, knowledge and character. It is reasonable to argue that the first step towards adaptation is the perception of the problem. Farmers' ability to perceive climate change is a key precondition for their choice to adapt. Farmers are also not able to fully take advantage of the technical and economic opportunities around them since adoption only takes place after awareness.

Research on the adaptation of small-scale farmers in Nigeria has often occurred in the absence of knowledge of rural farmers' perception about climate change, its causes and impact, as well as existing adaptation responses. Because prevailing ideas about perception are vague, conducting focused research on effective adaptation practices and formulating appropriate policies and programmes for implementing new practices is difficult.

Human responses to environmental issues have been broadly categorised as cognitive (related to knowledge and understanding), affective (related to feelings, attitudes, and emotions), behavioural (related to changes in behaviour of the viewer), and physiological (biological or physical effects on the observer's body) (Zube, Sell and Taylor, 1982). Perception determines the social mental picture of climate change. But a number of other variables like socio-demographic and socio-economic factors or ideological orientations influence perception and the mental picture of climate change (Sjöberg 1995; Stedman 2004).

Grothmann and Patt (2005) viewed perception as a precondition for adaptation. They examined economical and technical adaptation of US farmers to climate change, and showed that perception was a dominating factor among all other kinds of variables. One

reason why risk perception should be considered as meaningful for adaptation to climate change is the direct correlation with behaviour.

Peters (1997) opined that perception is important because a misconception of a risk has undesirable consequences. Misconceptions can lead to maladaptation, which increase the costs of climate change. Indeed, while a low perception of the risk could lead to an underestimation of a risk, a high perception of a risk could maybe result in exaggerated measures. Both extremes have negative consequences.

A number of factors influence the likelihood that farmers will perceive climate change. Having fertile soil and access to water for irrigation decreases the likelihood that farmers will perceive climate changes, whereas education, experience, and access to extension services increase the likelihood that farmers will perceive climate changes. This suggests that perceptions are not based entirely on actual climate conditions and changes but dependent on other factors as mentioned above (Gbetibouo, 2009).

2.1.3 Concept of Adaptation

In agriculture, adaptation is evolutionary and occurs in the context of climatic, economic, technological, social, and political forces that are difficult to isolate, and most adaptation practices serve multiple purposes (Smit and Skinner 2002). Recent studies have a tendency to focus on financial, technical and institutional criteria in order to evaluate the adaptive capacity (Haddad 2005). According to Falaki, Akangbe and Ayinde (2013), one factor has almost been entirely omitted by a majority of researchers: Perception. How can individuals adequately adapt to climate change if the perception of current and future climate change is not a reality?

Adaptation is an adjustment made to a human, ecological or physical system in response to a perceived vulnerability (US Environmental Protection Agency (EPA), 2008). Adaptation strategies became prominent in literature from the 1990s and is often associated with climate change. IPCC report (2001) states specifically that, adaptation to climate change as adjustment in natural or human systems in response to actual or expected climatic stimuli and their effects which moderates harm or exploits beneficial opportunities. Adaptation will be necessary to address impacts resulting from the warming which is already unavoidable due to past emissions. Adaptation is also important because, setting limits on emissions will not be enough, or happen soon enough, to avoid all impacts of climate change (EPA, 2008).

According to Dixon, Smith and Guill (2003), adaptation refers to adjustments in practices, processes or structures in response to projected or actual changes in climate, with the goal of maintaining the capacity to deal with current and future changes. Adaptation to climate change also refers to activities that reduce the negative impacts of climate change and/or takes advantage of new opportunities that may be presented. It includes activities that are taken before impacts are observed (anticipatory) and after impacts have been felt (reactive).

Eboh (2009) stated that even if efforts to reduce greenhouse gas (GHG) emissions are successful, it is no longer possible to avoid some degree of global warming and climate change. This is supported by Francesco and Philippe (2008) who stated that as a result of greenhouse gases already in the atmosphere from past and current emissions, our planet is already committed to at least as much warming over the 21st century as it has experienced over the 20th century (0.75°C). This implies that in addition to mitigation practices being developed to combat climate change, adaptation to the anticipated climate change is

essential. This fact is also made more explicit in Ozor and Nnaji (2010) which stated that while mitigation is necessary to reduce the rate and magnitude of climate change, adaptation is essential to reduce the damages from climate change that cannot be avoided. Therefore, adaptation is considered an important response option or strategy, along with mitigation (Franhauser, 1996; Smith, Burton, Tol, Kliend and Wandel, 1996; Peilke, 1998; Kane and Shogren, 2000).

According to Ifeanyi-Obi, Etuk and Jike-Wai (2012), there are two basic types of adaptation; planned adaptation and autonomous adaptation. Autonomous adaptation refers to reaction of farmers to changing precipitation patterns, in that he/she changes crops, uses different harvest and planting/sowing dates while planned adaptation measures are conscious policy options or response strategies, often muti-sectorial in nature and aimed at altering the adaptive capacity of the agricultural system of facilitating specific adaptations

Adaptation is an important component of climatic change impact and vulnerability assessment and is one of the policy options in response to climatic change impacts (Smith and Lenhont, 1996; Fankhauser, 1996). Adaptation to climatic change is therefore critical and of concern in developing countries, particularly in Africa where vulnerability is high because ability to adapt is low (Hassan and Nkemechena, 2008). In agriculture, adaptation helps farmers achieve their food, income and livelihood security objectives in the face of changing climatic and socio-economic conditions including climatic variability, extreme weather conditions such as droughts and floods and volatile short term changes in local and large-scale markets (Kandlinkar and Risbey 2000). Farmers can reduce the potential damage by making tactical response to these changes.

2.1.4 Concept of Vulnerability

The word ‘vulnerability’ is usually associated with natural hazards like flood, droughts, and social hazards like poverty etc. Of late it is extensively used in climate change literature to denote the extent of damage a region is expected to be affected by various factors affected by climate change. In the context of climate change there are many studies on vulnerability and its definitions vary according to the perception of the researchers. A brief review of some definitions is given below.

The IPCC Third Assessment Report (TAR) describes vulnerability as the degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the character, magnitude, and rate of climate variation to which a system is exposed, its sensitivity, and its adaptive capacity (IPCC, 2001, p. 995) (IPCC Definition 1). Chamber (1983) observed that vulnerability has two sides. One is an external side of risks, shocks to which an individual or household is subject to climate change and an internal side which is defencelessness, meaning a lack of means to cope without damaging loss.

Blaikie, Cannon, David and Wisner, (1994) defined vulnerability as the characteristics of a person or group in terms of their capacity to anticipate, cope with, resist and recover from the impacts of natural hazards and states that vulnerability can be viewed along a continuum from resilience to susceptibility. According to Adger (1999) vulnerability is the extent to which a natural or social system is susceptible to sustaining damage from climate change. It is generally perceived to be a function of two components. The effect that an event may have on humans, referred to as capacity or social vulnerability and the risk that such an event may occur, often referred to as exposure.

Watson, Zinyowera and Moss, (1996) defined vulnerability as the extent to which climate change may damage or harm a system, depending not only on a system's sensitivity but also on its ability to adapt to new climatic conditions. Kasperson, Kasperson, Turner, Hsieh, and Schiller (2000) defined vulnerability as the degree to which an exposure unit is susceptible to harm due to exposure to a perturbation or stress and the ability or lack of the exposure unit to cope, recover or fundamentally adapt to become a new system or to become extinct.

O'brien and Mileti (1992) examined the vulnerability to climate change and stated that in addition to economic well being and stability, being important in the resilience of populations to environmental shocks, the structure and health of the population may play a key role in determining vulnerability. Age is an important consideration as the elderly and young persons are tends to be inherently more susceptible to environmental risk and hazard exposure. Generally populations with low dependency ratio and in good health are likely to have the widest coping ranges and thus be least vulnerable in the face of hazard exposure.

The adopted definition of perception in this research is that of Raden-Fessenden and Heath (1987), that perception is based on individual personal experiences, knowledge and character. For the purpose of this study, Dixon *et al*., (2003) gives the working definition of adaptation as, adjustments in practices, processes or structures in response to projected or actual changes in climate, with the goal of maintaining the capacity to deal with current and future changes. Adaptation to climate change also refers to activities that reduce the negative impacts of climate change and/or takes advantage of new opportunities that may be presented. It includes activities that are taken before impacts are observed (anticipatory) and after impacts have been felt (reactive). . In terms of vulnerability, it is defined based on

Watson *et al*. (1996) that vulnerability as the extent to which climate change may damage or harm a system, depending not only on a system's sensitivity but also on its ability to adapt to new climatic conditions.

2.2 LITERATURE REVIEW

2.2.1 Climate Change, Agriculture and Food Security

Agriculture is important for food security in two ways: it produces the food people eat; and (perhaps even more important) it provides the primary source of livelihood for 36% of the world's total workforce. In the heavily populated countries of Asia and the Pacific, this share ranges from 40 to 50%, and in sub-Saharan Africa, two-thirds of the working population still make their living from agriculture (International Labour Organisation, 2007). If agricultural production in the low-income developing countries of Asia and Africa is adversely affected by climate change, the livelihoods of large numbers of the rural poor will be put at risk and their vulnerability to food insecurity increased.

According to Food and Agricultural Organisation (FAO) (2008), agriculture, forestry and fisheries are all sensitive to climate. Their production processes are therefore likely to be affected by climate change. In general, impacts are expected to be positive in temperate regions and negative in tropical ones, but there is still uncertainly about how projected changes will play out at the local level, and potential impacts may be altered by the adoption of risk management measures and adaptation strategies that strengthen preparedness and resilience. Climate is a particularly important driver of food system performance at the farm end of the food chain, affecting the quantities and types of food produced and the adequacy of production-related income. Extreme weather events can damage or destroy transport and distribution infrastructure and affect other non-agricultural

parts of the food system adversely. However, the impacts of climate change are likely to trigger adaptive responses that influence the environmental and socio-economic drivers of food system performance in positive as well as negative ways.

Agricultural production and food security in Africa are expected to be placed under considerable additional stress by climate change (FAO 2007, 2010). With about 27% of the population of Africa and 16% of West Africa being undernourished (FAO 2004), hunger is inextricably linked to poverty. Predictions of African food security remain bleak. For instance, it is estimated that crop production (grains, roots and tubers) must increase by 40% and meat products by 58% by 2020 to meet expected demand caused by population growth and increased incomes (Pinstrup- Andersen, Pandhya-Lorch, Rosengrant, 1999).

The IPCC Third Assessment Report (2001) concluded that the poorest countries will be hardest hit, with reductions in crop yields in most tropical and sub-tropical regions due to decreased water availability, and new or changed insect pest incidence. In Africa and Latin America many rain-fed crops are near their maximum temperature tolerance, so that yields are likely to fall sharply for even small climate changes; falls in agricultural productivity of up to 30% over the 21st century are projected. Marine life and the fishing industry will also be severely affected in some places.

Food and Agriculture Organisation (FAO), (2008) opined that, the food security implications of changes in agricultural production patterns and performance are of two kinds:

- Impacts on the production of food will affect food supply at the global and local levels. Globally, higher yields in temperate regions could offset lower yields in

tropical regions. However, in many low-income countries with limited financial capacity to trade and high dependence on their own production to cover food requirements, it may not be possible to offset declines in local supply without increasing reliance on food aid.

- Impacts on all forms of agricultural production will affect livelihoods and access to food. Producer groups that are less able to deal with climate change, such as the rural poor in developing countries, risk having their safety and welfare compromised.

Other food system processes, such as food processing, distribution, acquisition, preparation and consumption, are as important for food security as food and agricultural production are. Technological advances and the development of long-distance marketing chains that move produce and packaged foods throughout the world at high speed and relatively low cost have made overall food system performance far less dependent on climate than it was 200 years ago.

Most agronomists believe that agricultural production will be mostly affected by the severity and pace of climate change, not so much by gradual trends in climate change. If change is gradual, there may be enough time for biota adjustment. Rapid climate change, however, could harm agriculture in many countries, especially those that are already suffering from rather poor soil and climate conditions, because there is less time for optimum natural selection and adoption (Desai and Pujari, 2007).

2.2.2 Evidence of Climatic Variability and Change in the World

The Earth's climate system includes the land surface, atmosphere, oceans, and ice. Many aspects of the global climate are changing rapidly, and the primary drivers of that change

are human in origin. Evidence for changes in the climate system abounds, from the top of the atmosphere to the depths of the oceans. NASA (2013) stated that, the Earth's climate has changed throughout history. Just in the last 650,000 years there have been seven cycles of glacial advance and retreat, with the abrupt end of the last ice age about 7,000 years ago marking the beginning of the modern climate era and of human civilization. Most of these climate changes are attributed to very small variations in Earth's orbit that change the amount of solar energy our planet receives.

According to IPCC (2007), scientific evidence for warming of the climate system is unequivocal. The current warming trend is of particular significance because most of it is very likely human-induced and proceeding at a rate that is unprecedented in the past 1,300 years (Hegerl, 1996). Earth-orbiting satellites and other technological advances have enabled scientists to see the big picture, collecting many different types of information about our planet and its climate on a global scale. Studying these climate data collected over many years reveal the signals of a changing climate.

The following facts about Earth's climate are:

2.2.2.1 *Greenhouse Gases*

The heat-trapping nature of carbon dioxide and other gases was demonstrated in the mid-19th century. Their ability to affect the transfer of infrared energy through the atmosphere is the scientific basis of many instruments flown by NASA. Increased levels of greenhouse gases must cause the Earth to warm in response. Ice cores drawn from Greenland, Antarctica, and tropical mountain glaciers show that the Earth's climate responds to changes in solar output, in the Earth's orbit, and in greenhouse gas levels. They also show that in the past, large changes in climate have happened very quickly, geologically-

speaking: in tens of years, not in millions or even thousands (National Research council (NRC), 2006). Ninety-seven percent of climate scientists agree that climate-warming trends over the past century are very likely due to human activities, and most of the leading scientific organizations worldwide have issued public statements endorsing this position.

2.2.2.2 *Sea Level Rise and Warming Oceans*

Global sea level rose about 17 centimetres (6.7 inches) in the last century. The rate in the last decade, however, is nearly double that of the last century (Church and White 2006). The oceans have absorbed much of this increased heat, with the top 700 meters (about 2,300 feet) of ocean showing warming of 0.302 degrees Fahrenheit since 1969 (Levitus, *et al.*.2009).

2.2.2.3 *Global Temperature Rise*

All three major global surface temperature reconstructions show that Earth has warmed since 1880. Most of this warming has occurred since the 1970s, with the 20 warmest years having occurred since 1981 and with all 10 of the warmest years occurring in the past 12 years (Peterson and Baringer, 2009). Even though the 2000s witnessed a solar output decline resulting in an unusually deep solar minimum in 2007-2009, surface temperatures continue to increase (Allison, and Bindoff, 2009).

2.2.2.4 *Shrinking Ice Sheets*

The Greenland and Antarctic ice sheets have decreased in mass. Data from NASA's Gravity Recovery and Climate Experiment show Greenland lost 150 to 250 cubic kilometres (36 to 60 cubic miles) of ice per year between 2002 and 2006, while Antarctica lost about 152 cubic kilometres (36 cubic miles) of ice between 2002 and 2005.

2.2.2.5 *Declining Arctic Sea Ice*

Both the extent and thickness of Arctic sea ice has declined rapidly over the last several decades (Kwok and Rothrock, 2009).

2.2.2.6 *Glacial Retreat*

Data from the National Snow and Ice Data Centre show that glaciers are retreating almost everywhere around the world including in the Alps, Himalayas, Andes, Rockies, Alaska and Africa.

2.2.2.7 *Extreme Events*

The number of record high temperature events in the United States has been increasing, while the number of record low temperature events has been decreasing, since 1950. The U.S. has also witnessed increasing numbers of intense rainfall events.

2.2.2.8 *Ocean Acidification*

Since the beginning of the Industrial Revolution, the acidity of surface ocean waters has increased by about 30%. This increase is the result of humans emitting more carbon dioxide into the atmosphere and hence more being absorbed into the oceans. The amount of carbon dioxide absorbed by the upper layer of the oceans is increasing by about 2 billion tons per year (Sabine, Feely, Gurber and Key 2004).

2.2.3 Evidence of Climatic Variability and Change in Nigeria

In Nigeria, available meteorological data on surface air temperature for Kano, Calabar and Lagos show evidence of increasing surface air temperatures since 1920 (Federal Ministry of Environment, 2003). Analyses show surface air temperature of about 0.250°C for Calabar and Kano and 0.25-0.50°C for Lagos. Also, there are indications that those other climate variables especially rainfall have declined both in magnitude and temporal distribution. Analysis of monthly rainfall data from 1911 to 1980 reveals a changing pattern in annual

precipitation. The results obtained suggest that, among other things, there appears to be a definite decline in the 1941 – 1980 eras (Federal Ministry of Environment, 2003).

Available individual and collective researches at regional levels show that Nigeria like most parts of the world is experiencing the climate change. Some localities are experiencing extreme weather conditions as a result of increasing temperature and an associated changing climate (Olaniran, 2002; Ayoade, 2003; Odjugo, 2005). Nonetheless, Ayoade (2003) recorded a slight drop in air temperatures within the late 1940s and early 1950s in Nigeria. According to Mabo (2006) and Ikhile (2007), a sharp increase in temperature between 1971 and 2005 could be linked to the effect of climate change and its associated global warming. Temperature anomalies confirm the facts that global warming is unequivocal (IPCC 2007b). According to Odjugo (2010), increasing temperature is already present in Nigeria. Odjugo and Ikhuoria (2003) and Adefolalu (2007) reported that increasing temperature and decreasing rainfall in the semi-arid region of Sokoto, Katsina, Kano, Nguru, and Maiduguri may have resulted in the increasing evapo-transpiration, drought and desertification in Nigeria. Others show evidence of other indicators (Fasona and Omojola 2005; Chindo and Nyelong 2005; Ikhile 2007; Nwafor 2007; Umoh 2007).

Fasona and Omojola (2005), Obioha (2008) and Odjugo (2005, 2009) have observed decreasing rainfall in Nigeria especially in the northern part. The decreasing rainfall, increasing temperature and evapo-transpiration have resulted in either reduction of water levels or total drying up of some rivers and lakes in northern Nigeria, while Lake Chad in Nigeria is reported to be shrinking in size at an alarming rate since the 1970s (Chindo and Nyelong 2005;Odjugo 2007). Nkomo, Nyong and Kulindwa (2006), Molega (2006) and Nnodu, Onwuka and Okoye (2007) confirm the existence of unusual or extreme weather

related events such as erratic rainfall pattern, floods and sea level rise in Nigeria. The increasing rainfall in the coastal cities may have partly been responsible for the increasing floods devastating the coastal cities of Warri, Lagos, Port Harcourt and Calabar as observed by Ogundebi (2004), Ikhile (2007), Nwafor (2007), Umoh (2007) and Odjugo (2010). Jevrejeva, Grinsted, Moore and Holgate (2006) and Rahmstorf *et al*. (2007) suggest that sea levels will rise much higher and faster than previously thought. NEST (2003), Nyelong (2004) and Nwafor (2006) report that, in the coastal region of Nigeria, there is a sea level rise of 0.2m and incursion of salt water into the coastal plain for about 2016-3400 $sqkm^{-1}$.

IPCC (2007b) affirms that Nigeria's entire coastline has been affected by this observed rise. The micro-level research by Duru (2008) on implication of variability in rainfall over Imo State reveals that there is a significant variability in rainfall pattern between 1975 and 2007. Also, rainfall data analysis undertaken by Adejuwon (2002) indicates rainfall decline in several locations in Nigeria thereby authenticating the findings of previous researchers. Several past research studies on climate trends (Aisiokuebo 2000; Gbuyiro 1998; Oladipo 1995; Anyadike 1993; Olaniran and Summer 1989; Clerk 2002; Nkeiruka and Apagu 2005) have also shown significant variation in temperature and other climatic elements. Collectively these illustrations and the various previous research works are indications that there is a significant change in climatic variables indicating change in climate in Nigeria.

2.2.4 Challenges of Rain-fed Agricultural Development in Nigeria

According Nwabiuja (2011), Nigeria has about 79 million hectares of arable land, of which 32 million hectares are cultivated. Nwabiuja (2011) also opined that over 90% of agricultural production is rain-fed and mostly subsistence producers account for 80% of all farm holdings. Both crop and livestock production remains below potentials. Inadequate

access to and low uptake of high quality seeds, low fertiliser use and inefficient production systems lead to this shortfall. Despite a 7% growth rate in agricultural production (2006–2008), Nigeria's food import bill has risen. The growing population is dependent on imported food staples, including rice, wheat and fish.

Rain fed agriculture is the most common practice in Nigeria as more than three quarters of the country's agricultural area is rain fed and subsistence in nature (Nigeria's Country Profile, 2002). However, rain fed agriculture can no longer cope with food demand throughout the year as a result of the growing population coupled with climate change which makes rain fed agriculture unreliable as well as unpredictable and therefore has to be supplemented by irrigation for effective agricultural production to be realized (World Bank, 1995). Nigeria's climate is changing. The Nigerian Meteorological Agency (NIMET) has revealed evidence of dramatic changes in weather patterns over the period from 1941 to 2000.

Climatic changes already have varying, mostly adverse effects on agriculture and food security. Higher temperatures result in decreased agricultural productivity and production, high evaporation rates and reduced soil moisture, lowering of the groundwater table and shrinking of surface water. Heat stress reduces human labour use on farms, lowers labour productivity and leads to rapid deterioration and wastage of farm produce. Changes in the amount of rain, increased rainfall intensity and changes in rainfall patterns lead to reduced production. Changing and erratic rainfall patterns make it difficult for farmers to plan their operations, may reduce the cropping season and can lead to low germination, reduced yield and crop failure. Erratic weather interferes with processing of produce (such as sun-drying of crops and smoking of fish). Increased frequency of major storms causes damage to farm

land, crops and livestock. Major storms can also cause road wash-outs, which make it difficult to access farms and to market products.

FAO (1992) reported that to increase productivity, the use of fertilizers and improved irrigation is viewed as key factors. Efforts are now being geared towards opening up of more hydromorphic land (valley) to complement the rain fed farming (Oluwatosin, 2001), since Nigeria has enormous potentials for higher yields through development of irrigation (Nigeria's Country Profile, 2002). It has been noted that the rapid spread of small scale irrigation will be a key source of agricultural growth and poverty alleviation for small farmers who are otherwise dependent on low and erratic rainfall (World Bank, 1995).

2.2.5 Adaptation and Coping Strategies

Adaptation is a broadly used term, but in some instances it requires that the term is defined and distinguished from the term coping. In their discussion on the issue of adaption, Berkes and Jolly (2001) apply terminology long used in anthropology by McCay (1997) and the development literature Davies (1993), to distinguish between coping mechanisms and adaptation strategies.

Coping responses are the ensemble of short-term responses to potential impacts that can be successfully applied season-to-season or year-to-year as needed to protect a resource, livelihood, etc. Some forms of coping are explicitly anticipatory and take the form of, for example, insurance schemes and emergency preparedness. Adaptive responses refer to the ways individuals, households, and communities change their productive activities and modify their rules and institutions to minimize risk to their resources and livelihoods.

Depending on the frequency, duration, and suddenness in the onset of a stress, and on the resilience of a system, either coping or adaptive responses or both will come into play. With a progression of change in climatic conditions, coping mechanisms may at some point be overwhelmed, and by necessity supplanted by adaptive responses.

Taylor, Harris, and Ehrhart (2010), also stated that the terms adaptation and coping are sometimes used interchangeably. This has led to a lot of confusion. Comparing and contrasting characteristics is one way to understand their similarities and differences. As cited in Taylor *et al*., (2010), Table 2.1 presents CARE's Climate Vulnerability and Capacity Analysis Handbook (2009). This was consolidated from brainstorming sessions with groups of development practitioners in Ghana, Niger and Nepal.

Table 2.1: Characteristic Differences between Coping and Adaptation

Coping	Adaptation
Short-term and immediate	Practices and results are sustained
Oriented towards survival security	Oriented towards longer-term livelihood
Not continuous	A continuous process
Motivated by crisis; reactive	Involves planning
Often degrades the resource base	Uses resources efficiently and sustainably
Prompted by a lack of alternatives	Focused on finding alternatives; Combines old and new strategies and knowledge

Source: Taylor *et al*. (2010).

Table 2.1 shows that this is not just the academic debate about definitions. Our understanding or lack of understanding can have real world implications especially for the poorest individuals, households and communities. In this case, treating the two terms as interchangeable could lead to supporting (or worse still, even promoting) activities or strategies that have worked well enough in the past but, in the context of our changing

climate, could be disastrous. Some may even lead to what is sometimes known as mal-adaptation.

Selling off productive assets like livestock and/or boosting incomes through artisanal charcoal production are two examples of traditional coping mechanisms common across much of semi-arid Africa. But while these strategies may work well enough when drought occurs only once every five or so years, they are a dead-end when it comes to dealing with the contemporary reality of accelerating drought cycles. Knowing the difference between coping and adaptation is essential to identify sustainable solutions to long-term climate change (Taylor *et al*., 2010).

2.2.6 Climate Change and Adaptation Strategies in Nigeria

Adaptation is widely recognised as a vital component of any policy response to climate change because it helps farmers achieve their food, income and livelihood security objectives in the face of changing climatic conditions (Kandlinkar and Risbey, 2000). Studies show that without adaptation, climate change is generally detrimental to the agricultural sector, but with adaptation, vulnerability can be largely reduced (Easterling, Crosson, Rosenberg, McKenny, Katz and Lemon, 1993)

Ifeanyi-Obi, Etuk and Jike-Wai, (2012) concluded that, agriculture is practiced across a broad range of climates and environmental conditions makes it necessary for the country to develop an array of adaptation options that will meet the different conditions of the different ecological locations of the nation. A lot of adaptation options have been tried on

the different areas of agriculture. Some have yielded positive results while the effects of the rest are still being observed.

In livestock management, the common adaptation strategies employed include the following;

i. Modifying the time of grazing
ii. Altering forage and animal species/breeds
iii. Altering the integration within mixed livestock and crop systems including the use of adapted forage crops
iv. Ensuring adequate water supplies
v. Using supplementary feeds and concentrate

While in crop production, a lot of cropping options are also available. These could consist of:

i. Altering of the timing or location of cropping activities
ii. Improved water management through use of technologies to 'harvest' water, conserve soil moisture (for example, through crop residue retention) and use/transport water more effectively
iii. Altering inputs such as crop varieties and species to those with more appropriate thermal time and vernalization
iv. Diversifying livelihood strategy to include income from other farming and non farming activities
v. Improving the effectiveness of pest, disease and weed management practices through wider use of integrated pest and pathogen management, development and

the use of varieties and species resistant to pests and diseases and maintaining or improving quarantine capabilities and monitoring programs

vi. Using climate forecasting tools to reduce production risk.

On the other hand, IPCC (2007) highlighted basic ways in which adaptation strategies could take place. These include;

1. Pastoralist adapt to climate change extremes by making use of emergency fodder, curling of weak livestock for food, and multi-species composition of herds to survive climatic extremes. They also have to move from dry northern areas to the wetter southern areas during drought season in order to survive and sustain their domestic animals.
2. Women plant crops that are more resistant to drought and pests, providing a reserve for extended periods of economic hardships. They also select and save seeds for planting each year. They preserve a variety of seeds that will ensure resistance to the range of conditions that may arise in any given growing season.
3. Other indigenous strategies include controlled bush clearing; using tall grasses for fixing soil nutrients which have been washed away by run-off, erosion control to reduce the effects of run-off; restoring lands by using green manure; constructing store dikes; managing low lying lands and protecting river banks.

These adaptation strategies are in most cases not used in isolation. Farmers can combine two options where necessary in order to achieve the desired result. The fact is that agricultural practices are still climate sensitive and variations in climate may not be avoided in the nearest future. Building up adaptation strategies to cope with the varying climate becomes the most realistic option for farmers to employ in combating climate change risk (Ifeanyi-Obi *et al*., 2012).

2.2.7 Indigenous Knowledge and Climate Adaptation in Nigeria

The importance of indigenous knowledge has been realized in the design and implementation of sustainable development projects, little has been done to incorporate this into formal climate change adaptation strategies. Indigenous knowledge has been defined as institutionalized local knowledge that has been built upon and passed on from one generation to the other by word of mouth (Warren, 1992; Osunade, 1994). It is the basis for local-level decision-making in many rural communities. Indigenous knowledge has value not only for the culture in which it evolves, but also for scientists and planners striving to improve conditions in rural localities (Mundy and Compton, 1991). The knowledge set is influenced by the previous generations' observations and experiment and provides an inherent connection to one's surroundings and environment. Therefore indigenous knowledge is transferable and provides relationships that connect people directly to the environments and the changes that occur within it, including climate change (Woodley, 1991).

Climate change cannot be separated from sustainable development as sustainable development may be the most effective way to frame the mitigation question and a crucial dimension of climate change adaptation and impacts (Cohen, Demeritt, Robinson and Rothman, 1994; Swart, Robinson and Cohen, 2003). Integrating indigenous knowledge into climate change policies can lead to the development of effective adaptation strategies that are cost-effective, participatory and sustainable (Hunn, 1993; Robinson and Herbert 2001). Ajani, Mgbenka and Okeke (2013) opined that, adaptation methods are those strategies that enable the individual or the community to cope with or adjust to the impacts of the climate in the local areas. Such strategies will include the adoption of efficient environmental

resources management practices such as the planting of early maturing crops, adoption of hardy varieties of crops and selective keeping of livestock in areas where rainfall declined. However, incorporating indigenous knowledge into climate change concerns should not be done at the expense of modern/western scientific knowledge. Indigenous knowledge should complement rather than compete with global knowledge systems.

Local farmers in sub-Saharan Africa have been known to conserve carbon (C) in soils through the use of zero tilling practices in cultivation, mulching and other soil management techniques (Schafer, 1989; Osunade, 1994). Natural mulches moderate soil temperatures and extremes, suppress diseases and harmful pests and conserve soil moisture. Before the advent of chemical fertilizers, local farmers largely depended on organic farming, which also is capable of reducing GHG (Green house gases) emissions. It is widely recognized that forests play an important role in the global carbon cycle by sequestering and storing carbon (Karjalainen, Kellomski, and Pussinen, 1994; Stainback and Alavalapati, 2002).

Local farmers are known to have practiced the fallow system of cultivation, which encouraged the development of forests. It may be argued that with the growth in population, lengths of fallow have been reduced to the extent that the practice no longer exists in certain areas. However, one must not forget that the importance of forests have been recognized by traditional institutions to the extent that communal forest reserves were very common in traditional societies. Besides the fact that these well managed forests provided food and timber resources to the community, they also served as carbon sinks (Netting, 1993). Agro forestry is another practice that has been very effective in carbon sequestration. It is a rational land-use planning system that tries to find some balance in the raising of food crops and forests (Adesina, Siyambola, Oketola, Pelemo, Ojo, and

Adegbugbe, 1999). A practice similar to this has been described in south western part of Nigeria to raise shade tolerant crops such as yam and cocoyam in essentially a permanent forest setting (Adesina, 1988). In addition to the fact that agro forestry techniques can be perfected to cope with the new conditions that are anticipated under a drier condition and a higher population density, they lead to an increase in the amount of organic matter in the soil thereby improving agricultural productivity and reducing the pressure exerted on forests.

Local knowledge is vital for preserving bio-diversity, which is considered a very successful adaptation strategy. Through the World Bank, gene banks have been established to preserve genetic information of local varieties or indigenous species. Genetic traits of these species and the knowledge of cultivars may prove instrumental in future breeding programs to introduce resistance against pests or diseases or endurance for harsh climatic conditions. A major criticism of this initiative is that preserving genetic traits without preserving the knowledge of the husbandry may prove futile as the seeds and clones stored in seed banks do not carry the instructions on how to grow them (Warren, 1991). Hence, these gene banks should cooperate with farmers and communities who still cultivate local varieties to preserve such essential knowledge and skills in situ.

Local farmers in sub-Saharan Africa have developed several adaptation measures that have enabled them to reduce vulnerability to climate variability and extremes. One important step in reducing the vulnerability of a climatic hazard is the development of an early warning system for the prediction or forecast of the event (Ajibade and Shokemi 2003). There is a wealth of local knowledge based on predicting weather and climate. A study of weather knowledge in various parts of the sub-Saharan Africa reveals the wealth of

knowledge that farmers possess. These farmers have developed intricate systems of gathering, prediction, interpretation and decision-making in relation to weather. These systems of climate forecasts have been very helpful to the farmers in managing their vulnerability to a very great extent. Farmers are known to make decisions on cropping patterns based on local predictions of climate and decisions on planting dates based on complex cultural models of weather

Smallholder farmers represent an enormous untapped potential for climate mitigation and adaptation. By combining local knowledge with proven technologies, these agricultural systems can become productive, sustainable and resilient to climate shocks but only with policy support.

2.2.8 Climatic Change Prediction in Nigeria: Future Agro-Climatic Scenarios

It is widely known that there has been a detectable rise in global temperature during the last forty years, and that this rise cannot be explained without taking into account the role of human activities (IPCC, 2007, WGI). As discussed in 2.2.3, there is evidence of climate change in Nigeria. But more importantly, the increase in the rate of change is expected to continue potentially resulting, in more rapid changes in climate in the future.

Nigeria's climate is also likely to see growing shifts in temperature, rainfall, storms, and sea levels throughout the twenty-first century. These climatic challenges, if unaddressed, could throw already stressed resources such as land and water into even shorter supply. Moreover, poor responses to resource shortages could have serious negative secondary effects, including more sickness and hunger, fewer jobs, and poor economic growth, which

in turn could open the door to more violence. Understanding Nigeria's future climate depends on better country-specific and local-level analysis.

Predictions so far have relied heavily on models for the world or West Africa. The foremost, the IPCC did identify Nigeria as a climate change hot spot likely to see major shifts in weather in the twenty-first century (Boko *et al*., 2007). Yet, there is a need to examine closer the country's 350,000 square miles, situated in a tropical belt between the 4°N and 14°N, 3°E and 15°E parallels, span six major vegetation zones, from mangrove-saltwater swamp to montane regions to grasslands to desert. Soils and weather patterns vary widely, and altitudes range from 3,000 feet to less than 10 feet above sea level. For this reason, no single generic model or adaptation scheme could reasonably apply to the whole country.

That said, available evidence points to three main types of shifts that could ultimately feed into conflict. First, parts of the country the arid north especially, are facing the one-two punch of more heat and less rain. West Africa's interior, the IPCC predicts, will see 10% less rainfall by 2100. Parts of Nigeria's northern Sahel area (the transition zone between the Sahara desert to the north and the grasslands to the south) get less than 10 inches a year already, a full 25% less than thirty years ago. Temperatures can top 105 degree Fahrenheit and are likely rising. Secondly, many parts of the country will likely experience more severe weather. Data in this area are sparse, but official figures show torrential rains and windstorms becoming harsher and more common across Nigeria. Over the past forty years, for instance, recorded volumes of torrential rains increased 20% across various southern states, some of which already see up to 160 inches of rainfall a year, with wet seasons lasting eight to ten months (Odjugo, 2005). Thirdly, along the southern coastline, sea levels

could rise 1.5 to 3 feet by century's end a further increase over the nearly 1-foot rise observed in the last fifty years (FME, 2009).

The combination of more heat plus less rain raises the spectre of widespread desertification, especially in northern Nigeria. According to some estimates, two-thirds of Bauchi, Borno, Gombe, Jigawa, Kano, Kaduna, Katsina, Kebbi, Sokoto, Yobe, and Zamfara states could turn desert or semi-desert in the twenty-first century. Already the Sahel creeps south by approximately 1,400 square miles a year, swallowing whole villages. Government geological data show a 400% increase in sand dunes over twenty years (FME, 2009). Meanwhile, hydrological modelling indicates that a 1.5-foot sea level rise would submerge more than 11,000 square miles of coastal land. (Onofeghara, 1990) Again, more work on prediction is needed: data for households, communities, and sectors are patchy, and so far a 2009 study by the UK's Department for International Development (DFID) represents the only wide-ranging, serious attempt to model the impacts of climate change on Nigeria's resource base.

Water shortage is also a concern. Usable water is already at a premium for much of Nigeria. Poor management and government supply failures, not limited availability, are likely the biggest causes today. The UN Food and Agriculture Organization rates Nigeria's water use and conservation practices poor by international and African standards, and only 8% of homes nationwide have treated pipe-borne water (FAO, 2009). Yet climatic shifts could also factor into some shortages. More heat plus less rain is already creating drought conditions in parts of northern Nigeria. This is troubling when government data show rural households harvest rain for more than half their total water consumption and northern groundwater tables have dropped sharply over the last half century, owing partly to less rain (National Bureau of Statistics, 2005). In parts of southern Nigeria, flooding caused by

sea level rise is also contaminating freshwater aquifers, rivers, and stock-watering points, leaving them with high salinity and more polluted with sediment and sewage.

UNDP, (2010) observed that poor responses to resource shortages could result in more hunger. Food security is a many-headed issue, shaped by such factors as technology, trade policy, and market performance. Nigeria has not suffered the famine woes of its neighbours Niger or Chad, but its hunger profile is not good and climate change could worsen it. Between 85-90% of Nigerian agriculture is rain-fed, and many crops are sensitive to even tiny shifts in rainfall and temperature. Some experts already link mounting crop failures and declining yields in the northeast to higher temperatures and drought (Sayne, 2011). What little irrigation exists is increasingly stressed. For instance, less rainfall and higher temperatures have helped shrink Lake Chad, once the world's sixth largest lake and the north's biggest irrigation resource, to one-tenth its size a half century ago (Coe and Foley, 2001). The rising sea is also flooding farmland along the southern coast and making soils too salinized for planting. Other reports indicate that more severe rain is causing massive sheet erosion in the sandy soils of the southeast, again resulting in lower yields (NEST, 2008). All of this occurs as production of staples like maize and yam is already stagnant, productivity per hectare is low by commercial standards, and at least four to five million new Nigerians are born each year, placing further stress on food sources (Nkonya, 2010).

Having reviewed available and accessible literature, there is a need for empirical study to validate some of the observations in a local setting. This is the focus of the subsequent chapters using Ikara LGA of Kaduna State.

CHAPTER THREE: STUDY AREA AND METHODOLOGY

3.1 INTRODUCTION

This chapter focuses on the study area and research methodology. Location of the study area, climate, soil and vegetation, geology, population and socio-economic background were discussed in details. Also the methodology of the research comprising types, sources and procedure for data collection analysis were also examined.

3.2 STUDY AREA

3.2.1 Location and Size

Ikara Local Government Area (LGA) is in Kaduna state of Nigeria and is located 30km north-east of the city of Zaria. It lies between latitudes 11°11'N and 11° 32'N and longitudes 8°07'E and 8°40'E. The local government area has an elevation of 676 metres above sea level (Ikara Community Progressive Association, (IKACPA) 2012). The LGA has a population of 194,723 people with a density of 120 persons per square kilometre and a land area of 1,614sqkm with 3% annual population growth (NPC, 2009). Ikara LGA shares its north eastern and eastern border with Kano State and to the north western border is Makarfi LGA, to the south with Kubau LGA and to the south west, is Soba LGA of Kaduna state (IKACPA, 2012). This is shown in Figure 3.1

Ikara LGA is made up of 10 wards namely, Ikara, Jamfalan, Kurmin-kogi, Saulawa, Saya-saya, Pala, Kuya, Rumi, Auchan and Paki. This can be seen in Figure 3.2. The headquarters of the LGA is located in Ikara ward.

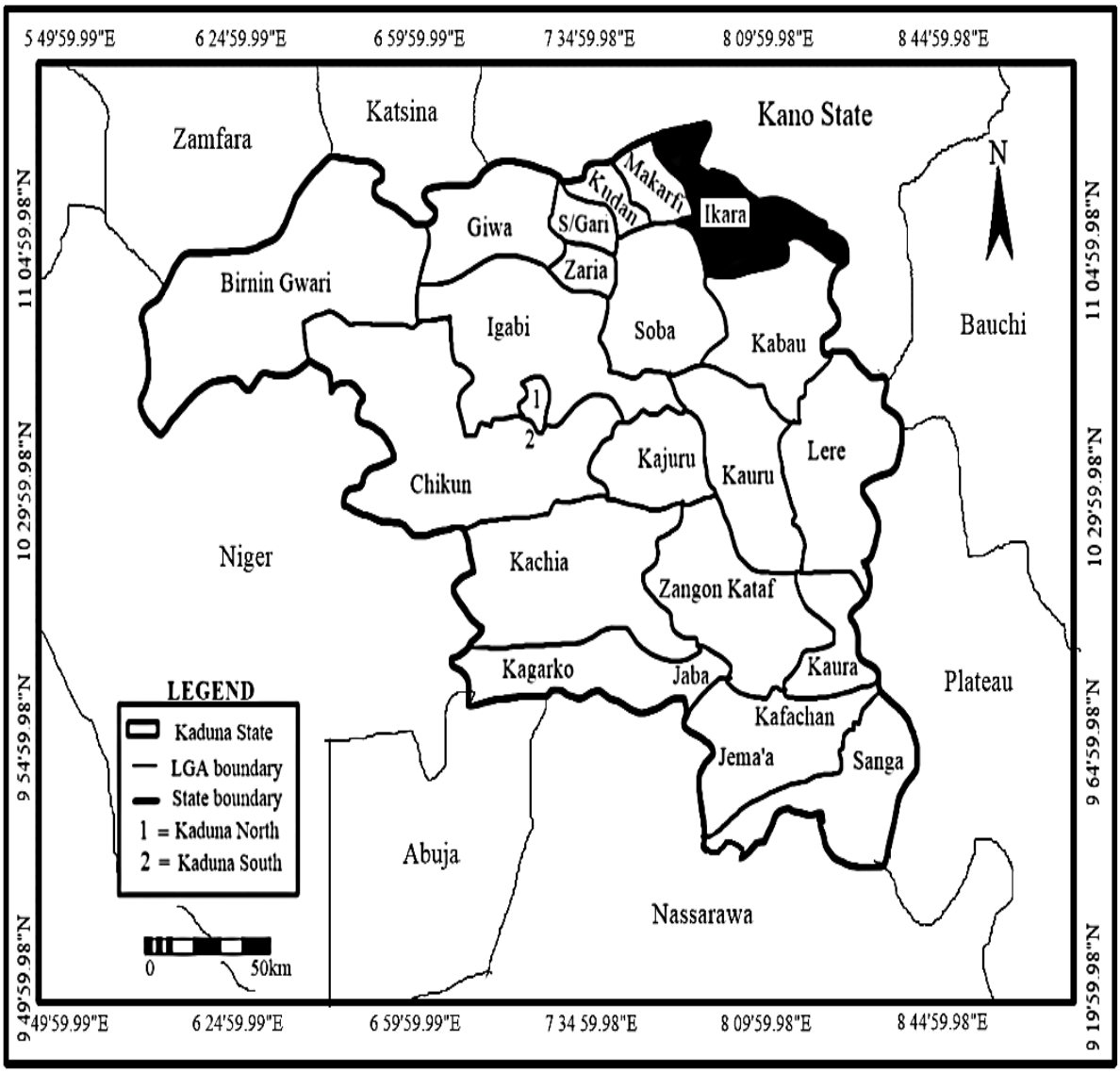


FIG 3.1. IKARA LGA IN KADUNA STATE
Source: Modified from Administrative Map Kaduna state

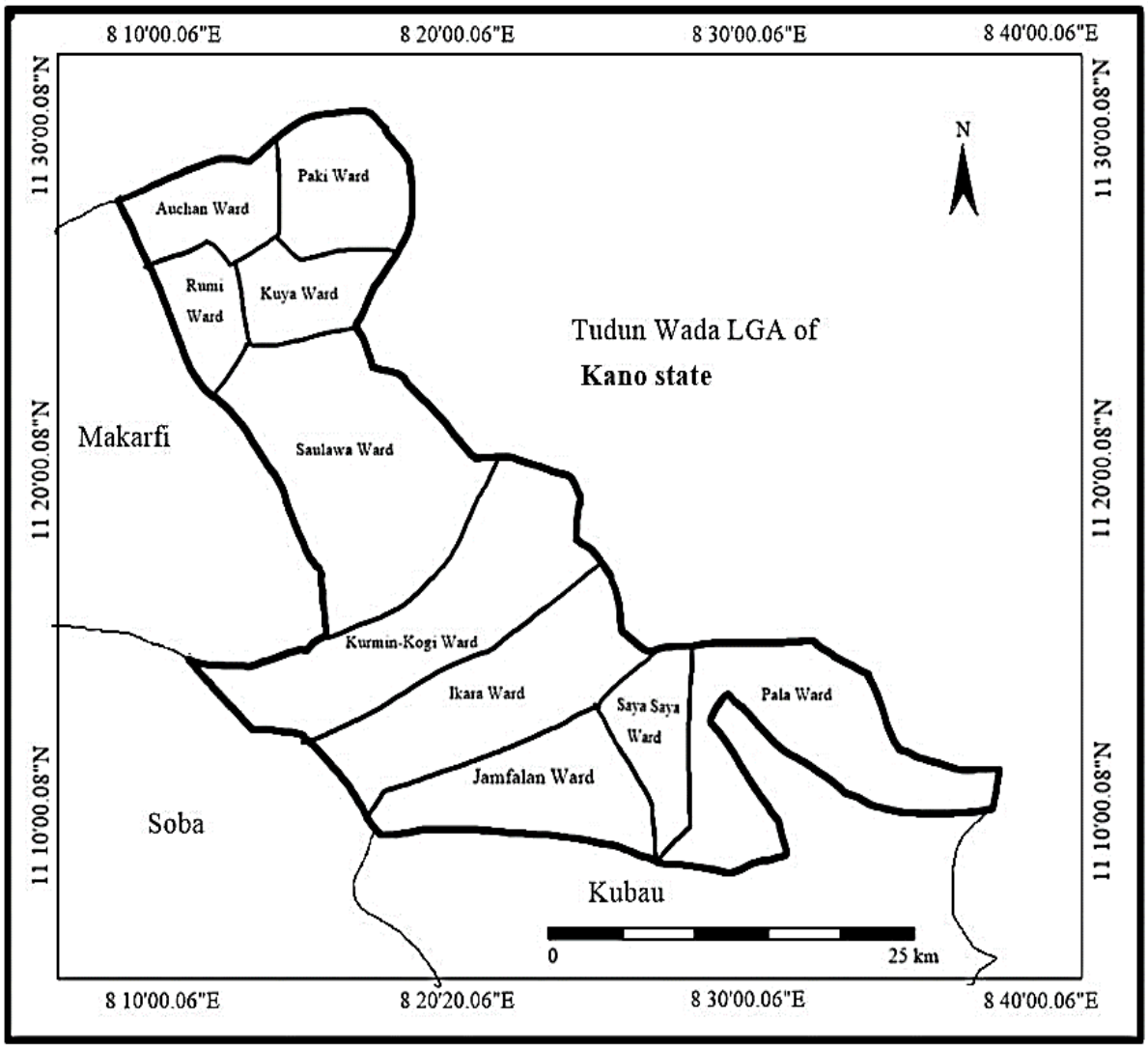


FIG 3.2. WARDS IN IKARA LGA OF KADUNA STATE
Source: Ikara LGA Information Office

3.2.2 Climate

The climate of Ikara is typically wet and dry type. The air mass blowing from the Sahara desert is the north east trade wind that results to harmattan. The other air mass is the

tropical maritime which is monsoonal in character and is composed of moist and relatively cool air. It originates from the south west across the Gulf of Guinea. Ikara and its rural areas fall within the rainfall zone of less than 1200mm. The rainy season starts from the months of March and April with August being the wettest month while, the coolest months are December and January.

The mean annual temperature of the coolest month is about 26°C. The mean temperature of coolest month is about 21°C, while the temperature of the hottest months is 31°C. The climate type is (Aw) (tropical wet and dry climate) under Koppen's climatic classification (IKACKPA, 2012).

3.2.3 Relief and Drainage

Ikara local government is in a gentle undulating plain, an extension of Zaria's close settled zone which is a dissection which developed on the crops tagline complex rocks with plains ranging from 450 to 650 (2200ft) above sea level on the north central plateau (IKACPA, 2012).

In some parts of the city there are rocks outcrops of land resistant granite that have been exposed to agent of erosion through ages. The erosive activities resulted to outcrops rocks forming islebergs and large rocky land covered with literate caps which served as a protective measure against erosion. The example of such can be seen in Dutsen Zaki at the eastern part of Ikara town, Dutsen Lungu and Dutsen Tanki at northern part of the town. Ikara LGA is endowed with mineral deposits such as clay mineral, quarry, granites and gem stones.

3.2.4 Soil and Vegetation

The soil in the study area is predominantly leached ferruginous soil due to downward movement of clay within the profile, a process which leads to the production of sandy soil surface. Iron oxide (Fe_2O) are deposited in the clay rich B horizon in form of mottles or as ferruginous head pans called jurist crust which causes poor internal drainage usually in the B horizon (IKACPA, 2012).

The natural vegetation of Ikara is the Sudan savannah type also called woodland savannah or elephant grass savannah. The indigenous tree species are shea butter, locust bean, mango, isoberlina, neem, baobab, tamarind and various species of acacias (IKACPA, 2012). However, due to human pressure on land resources through various economic activities such as, intensive agriculture, indiscriminate bush burning, firewood making, hunting, intensive grazing among others, the natural vegetation of Ikara is gradually modified from climate climax to plaque climax (IKACPA, 2012).

3.2.5 Historical Growth and Development

The history of Ikara is traced to an era before the tenth century. It has a very large land mass with war like people. The defensive wall that still exist in some parts of the town around police barracks in Jibis known as Ganuwa serves as historical justification of these facts.

The original settlers was said to be the Jukuns from Kwararrafa legendary from Wukari who are known as valiant war lords who conquered the town and named it Ikara which in Jukun's language means "enter this place" or "settle here". A little modification in pronunciation has been made to the name. The Jukuns later was said to have moved to present Tudun Jukun, a suburb in Zaria (IKACPA, 2012).

Ikara was first elevated to the status of district by Emir of Zazzau, Ibrahim Shehu with Sarkin Yakin Zazzau Muhammadu Gida'do as the first district head who was answerable to the Emir. During the reign of General Murtala Ramat Muhammad in 1976 a committee was set up for the creation of state and local government in Nigeria, hence the north central state was recommended as Kaduna state with the capital at Kaduna. This paved way for the creation of the old Ikara local government which comprised of Makarfi, Kubau, Kudan, and Soba local government areas at that time. The new Ikara LGA was created in 1996 when Kubau district was made a LGA (IKACPA, 2012).

3.2.6 Population, Socio-Economic Activities and Land Use

The population of the study area is 194,723 people with 3% annual population growth (National Population Commission, 2009). The major tribes are Hausa and Fulani. The minorities include Yoruba, Igbo, Kataf, Chawai, Karei-karei and other Nigerian tribes. Ikara is an agrarian community. The investment opportunities centred on agricultural production, food processing with the presence of Ikara food processing company. It also includes solid minerals, mining and tourism.

The arts and craft practiced are weaving (raffia and cloth), pottery, blacksmithing, tanning and leather works. Others include, carving (calabash and wood) traditional textile and architecture (IKACPA, 2012). With regards to agriculture, mechanized farming is not common among the farmers as they make use of mostly crude implements. They produce food crops and cash crops alike. Food crops such as maize, rice, sorghum, millet, guinea corn, cowpea, soybeans mostly for their consumption. They regard the following as cash crops; sugar cane, pepper, groundnut and tomatoes because they produce in commercial

quantities to sell for means of money. These crops are taken to the market on market days which holds on Tuesdays and Fridays each week.

The local government area has potentials that would encourage investment. The major tourist attractions are; Ikara Dam in Gimbawa Janfalan ward, Danlawal Hill in Funana ward and Hambawa forest in Saya-saya ward. There are mineral resources that are available to be explored or used for commercial purposes such as potash.

3.2.7 Socio-Cultural Characteristics

The culture of the people in Ikara local government has diversified as the people themselves, but there are similarities in both organization and celebration for example, Sallah seasons are the most highly recognised festivals period in Ikara town, as the people of the town are predominantly Muslims.

Other festivals are Maulud celebration which is done annually. “Hauwan Saurata” is a traditional horse riding performed after turban ceremony. “Hauwan Biki” is another horse riding parade where riders are dressed in royal garments and beautiful horses adorned in traditional attires. This is performed after marriage ceremonies and comprises of different ethnic groups displaying their various cultural characteristics. This is usually done for royal families. The number of ethnic groups is increasing daily due to the peaceful nature and despite few job opportunities; the population is increasing tremendously due to influx of people into the area (IKACPA, 2012).

3.3 RESEARCH METHODOLOGY

3.3.1 Reconnaissance Survey

A reconnaissance survey was conducted in the area to determine the farming and related activities of farmers, the main staple crops and other crops being cultivated currently in the LGA. This assisted the researcher to determine sample size, select the sampling techniques to be employed in selecting sampling units. It also guided the construction of the research instrument for data in terms of questions necessary to satisfy the objectives.

3.3.2 Types of Data Collected

Primary data: These data include information on cropping practices during drought year, staple food crops during drought year and knowledge about climate change. Others are alternative sources of water supply in advent of drought, yield trend and variation in cropping pattern over time, incidence of flood and the consequences. As well as, impact of extreme weather event on health and other socio-economic activities.

Secondary data: These include relevant information from the various departments in Ikara local government council secretariat.

3.3.3 Sources of Data

For this research, the researcher employed the use of questionnaire and interviews to obtain information for the research. The questionnaire contained relevant and well-structured questions aimed at eliciting responses that aid the understanding of the farmers' perception and adaptation strategies and vulnerability to climate change issues in the study area. The questionnaire contained both open and closed ended questions. Also, data about information on the population distribution of the study area was obtained from the National Population Commission (NPC, 2009).

3.3.4 Sampling Technique and Sample Size

A total of ten wards make up the study area. Units of observation were the wards. The Krejcie and Morgan's (1970) method of determining sample size was employed which states that for an area with a population of 75,000 - 999,999, the sample size should be 382. Since the study area falls between this range, the sample size used for this research is 382.

The purposive sampling technique was used for the purpose of selecting respondents. This method is characterized by the use of personal judgment and a deliberate attempt to obtain representative sample by including presumable typical areas or groups in the sample (Abiola, 2007). Due to non availabilitiy of population figures at ward level in the 1991 and 2006 census results, the copies of questionnaire were distributed uniformly among the ten (10) wards in the local government. To determine the actual number of questionnaire administered in each ward, 382 copies of questionnaire were distributed among the 10 wards evenly. Each ward had 38 copies of questionnaire except for Ikara ward which had an addition of 2 making 40 copies of questionnaire being the most populated ward as the local government headquarters.

3.3.5 Techniques of Data Analysis

The data collected from this research was subjected to descriptive statistics and inferential statistics. Descriptive statistics was used to analyse the socio-economic characteristics of respondents and other variables such as volume of harvest, variation in coping strategies, and types of coping strategies. Descriptive statistical methods employed are tables and percentages and bar graphs. Inferential statistics was standard deviation and t-test. T-test was used to test for variability in adaptation strategies over time across the wards of the local government area with respect to changing climate. For vulnerability analysis, climate

change vulnerability index was used as defined by (Kumar, Paul, Krishna, Rao, and Chandra, 2014)

1. To construct an overall index of vulnerability, the following procedure was employed:

$$y_{id} = \left(X_{id} - Min\ X_{id}\right)/\left(Max\ X_{id} - Min\ X_{id}\right)$$

When the values of X_{id} are negatively related to the vulnerability, the standard values would be computed by:

$$y_{id} = \left(Max\ X_{id} - X_{id}\right)/\left(Max\ X_i - Min\ X_{id}\right)$$

Where: $Min\ X_{id}$ and $Max\ X_{id}$ are minimum and maximum of values of risk indicators of wards $(X_{i1}, X_{i2}, \ldots X_m)$ respectively.

X_{id} = value of the risk indicator for ward being calculated for

y_{id} = raw value of risk indicator d for ward i (for values negatively related to vulnerability)

Obviously these standardized indices lie between 0 and 1. The level or stage of development of d^{th} zone is assumed to be a linear sum of y_{id} as

$$\overline{y}_d = \sum_{i=1}^{m} w_i y_{id}$$

where w's $(0 < w < 1$ and $\sum_{i=1}^{n} w_i = 1)$ are the weights determined by

$$w_i = \frac{k}{\sqrt{var\ (y_i)}}$$

$$k = \left[\sum^{n} \frac{1}{\sqrt{var\ (y_i)}} \right]^{-1}$$

$i=1$

The choice of weights in this manner would ensure that large variation in any one of the indicators would not unduly dominate the contribution of the rest of the indicators and distort inter zone comparisons.

2. For classificatory purposes, a simple ranking of the zone indices viz, Yd would be enough. However for a meaningful characterization of the different stages of vulnerability, suitable fractile classification from an assumed distribution is needed. Probability distribution which is widely used is the Beta distribution. This distribution is defined by

$$f(z) = x^{a-1} (1- x)^{b-1} / b (a, b), 0 \leq x \leq 1 \text{ and } a, b > 0.$$

This distribution has two parameters a and b. They can be estimated by using the method given by Iyengar and Sudharshan (1982) (as cited in Kumar *et al*., 2014). The beta distribution is skewed. Let $(0, Z_1)$, (Z_1, Z_2), (Z_2, Z_2), (Z_3, Z_4) and $(Z_4, 1)$ be the linear intervals and each interval has the same probability weight of 20%. These fractile intervals can be used to characterise the various stages of vulnerability.

1. Less vulnerable	if	$0 < y_d < z_1$	(0.0 - 0.2)
2. Moderately vulnerable	if	$z_1 < y_d < z_2$	(0.2 - 0.4)
3. Vulnerable	if	$z_2 < y_d < z_3$	(0.4 - 0.6)
4. Highly vulnerable	if	$z_3 < y_d < z_4$	(0.6 - 0.8)
5. Very highly vulnerable	if	$z_4 < y_d < 1$	(0.8 - 1.0)

CHAPTER FOUR: RESULTS AND DISCUSSION

4.1 INTRODUCTION

This chapter examines the presents the results of the study. In the course of retrieving the questionnaires, only 347 were returned out of 382 initially administered.

4.2 SOCIOECONOMIC AND HOUSEHOLD CHARACTERISTICS OF RESPONDENTS

The socioeconomic characteristics include age, gender, income and other attributes. These are all subsequently examined.

4.2.1 Age of Respondents

Age of respondents was evaluated. The results are shown in table 4.1.

Table 4.1: Age of Respondents

Age Group (Years)	Frequency	Percentage
18-30	111	32.0
31-40	108	31.1
41-50	32	9.2
51-60	77	22.2
>60	19	5.5
Total	**347**	**100**

Source: Field Survey (2014)

As indicated in Table 4.1, majority (72.3%) of the sampled farmers in the study area are within the age bracket of 18-50 years which could be said to be an active age bracket that understand modern adaptive strategies. This result concurs with the study of Ikpe (2014) on adaptation strategies to climate change among grain farmers in Goronyo LGA of Sokoto State which showed that people within the age bracket of 31-50 years are active in farming activities in the area.

According to Adesina and Forson (1995), age plays a major role in agricultural practices and coping strategies to climate change. It is generally agreed that age negatively influences the decision to adopt new strategies. It may be that older farmers are more risk averse and

less likely to be flexible than younger farmers and thus have a lesser likelihood of adopting new technologies. Some scientists say that, age may positively influence the decision to adopt (Mignouna, Manyong, Mutabazi, and Senkondo, 2011). It could also be that older farmers have more experience in farming and are better able to assess the characteristics of the study area and the modern adaptive strategies than younger farmers, and hence a higher probability of adopting the strategies.

4.2.2 Gender of Respondents

The gender distribution of respondents is shown in Fig 4.1. Gender issues in climate change have recently become important because of the social, spatial and economic contexts within which change is perceived and responded.

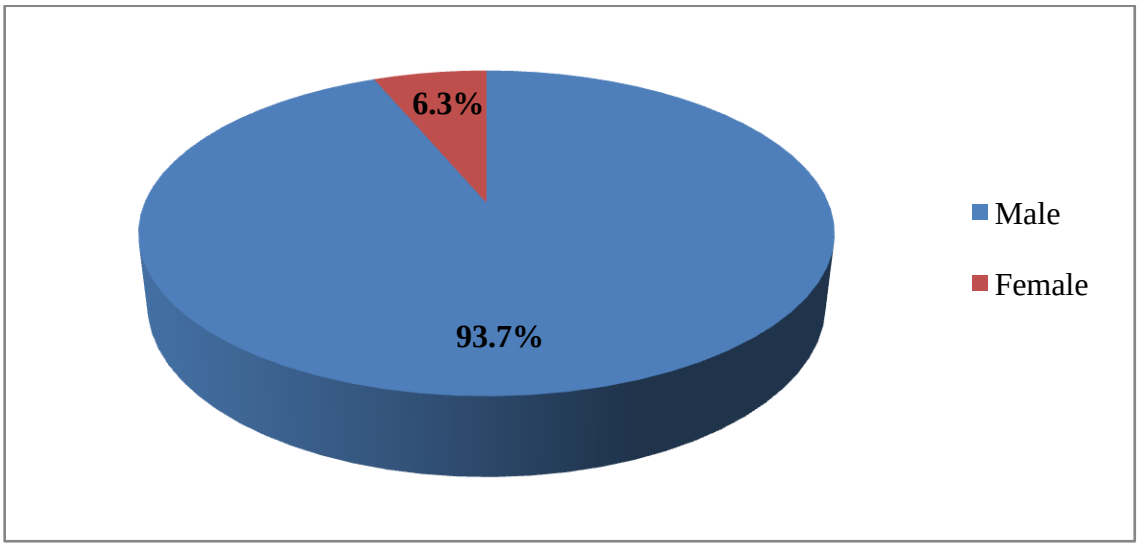


Figure 4.1: Gender of Respondents
Source: Field Survey (2014)

Figure 4.1 shows that about 94% of the respondents are males while, are females are the rest. The result agrees with the findings by Abaje, Sawa and Ati (2014) which shows that the majority of the respondents were males (87%) while only 13% were females. This is in

agreement with other related studies for examples, Ishaya and Abaje (2008); Abraham, Bamidele, Adebola and Kobe (2012) that the agricultural sector and the tedious activities related to climate change adaptation strategies are dominated by males.

The dominance of male farmers is not unconnected with the cultural beliefs or practices prevalent in this part of northern Nigeria limiting women from functioning in outdoor activities. The result of this study corresponds with the findings of (Zonkwa 2012; Ikpe 2014 and Bambale 2014) which all revealed males are the dominant gender involved in farming activities in their respective studies.

4.2.3 Marital Status of Respondents

The marital status of respondents is shown in Figure 4.2.

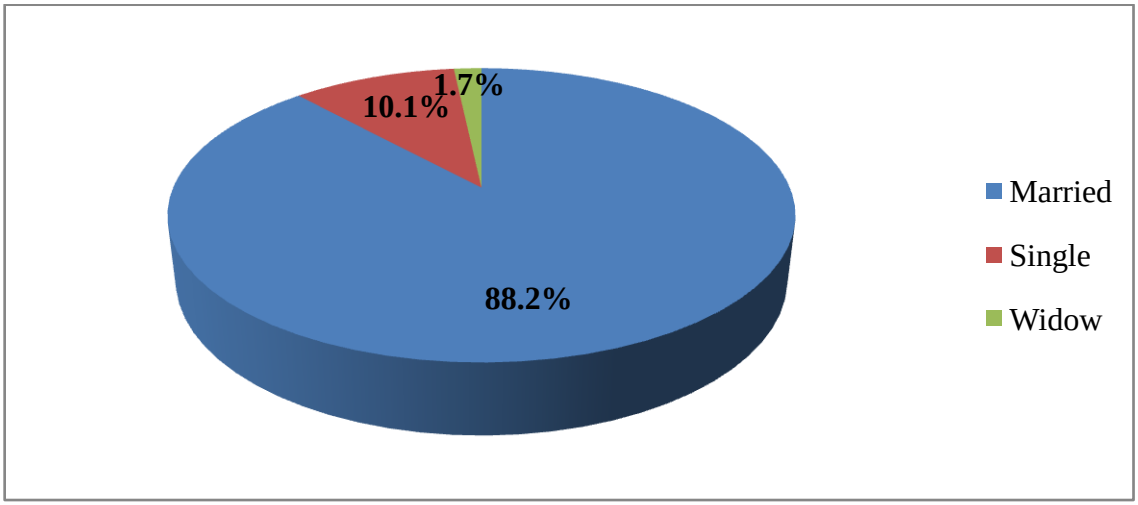


Figure 4.2: Martial Status of Respondents
Source: Field Survey (2014)

Figure 4.2 shows that 88.2% of the respondents are married, 10.1% are single while 1.7% of the farmers are widowed. This may not be unconnected with the fact that marriage is an important aspect of adulthood in most African societies. Thus, individuals who have attained marriageable ages are left alone to fend for themselves outside the comfort of their

parents' care (Bambale, 2014). This result is in line with findings of Abaje *et al*., (2014) that had the majority of the respondents (80.6%) are married.

4.2.4 Household Size

The typical household size obtainable in the LGA is shown in Table 4.2.

Table 4.2 Household size

Household size	Frequency	Percentage
<5	13	3.8
6-10	157	45.2
11-15	113	32.6
16-20	44	12.7
>20	20	5.8
Total	**347**	**100**

Source: Field Survey (2014)

Close to half (45%) of the sampled population had a household size of between 6-10 persons while households with 11-15 persons were also substantial (33%). This implies that on the average, a typical household size is about 11 persons. This result concurs with the finding of Bambale (2014) that, most of the household size ranged between 6-10 persons in the study area. Also this corresponded with findings by Abaje *et al*., (2014) which had a typical household size of 11 persons. This result may not be unconnected with the fact that most African societies place great value on children. To many people, a large household is regarded as an economic and agricultural asset to the society and the nation at large. For this reason, polygamy and early marriages are permitted to facilitate more procreation.

4.2.5 Family Size of the Household

The sizes of family household of respondents were obtained. This was grouped into adults aged 18 years and above for both male and female and persons below 18 years of age both males and females. The results are shown in the Table 4.3, 4.4, 4.5, 4.6.

Table 4.3 shows the number of male adults in each household.

Table 4.3 Male Adults

Number of Male Adult (18 years and above)	**Frequency**	**Percentage**
<3	134	38.6
4-5	167	48.1
>5	46	13.3
Total	**347**	**100**

Source: Field Survey (2014)

The highest number of male adults aged 18 years and above is that between 4-5 persons for almost half of the sampled population (48%) , followed by those with <3 person while only a few are with >5 male adult in the household. This indicates that majority of the farmers have male adult of 18 years and above which adds to the workforce of the family.

Table 4.4 reveals the number of female adults above 18 years within the households of the respondents.

Table 4.4 Female Adults

Female Adults(18years and above)	**Frequency**	**Percentage**

<3	95	27.4
4-5	232	66.9
>5	20	5.7
Total	**347**	**100**

Source: Field Survey (2014)

Respondents with female adults above 18 years are about 67%, 27.4% have <3 of female adult with 18 years and above while 5.7% of respondents have a size of >5 female adult of 18years and above. This result shows that that majority of the households have people in their younger ages.

Table 4.5 shows the number of male children within the households that are less than 18 years.

Table 4.5: Number of Male Children below 18 years

Male children below 18years	**Frequency**	**Percentage**
<3	243	70
4-5	104	30
>5	0	0
Total	**347**	**100**

Source: Field Survey (2014)

About two thirds of the respondent farmers have male children below 18years while a third claimed to have male children with less than 18 years. None of the respondents have male children >5 years in the study area.

Table 4.6 shows number of female children with the households that are less than 18 years.

Table 4.6 Number of Female Children below 18 years

Female children below 18years	Frequency	Percentage
<3	98	28.2
4-5	214	61.8
>5	35	10
Total	**347**	**100**

Source: Field Survey (2014)

About 62% of the sampled farmers have between (4-5) female children below 18years while 28% (<3) have female children that are less than 18 years, while 10% of respondents has >5 female children less than 18 years in their household in the study area.

4.7 Relationship of the Informant to Household Heads

Table 4.7 presents relationship of the informant to the household heads. This becomes necessary because decision on adaptation is usually made at the household level.

Table 4.7: Relationship of the Informant to Household Heads

Relationship of household	Frequency	Percentage
Household head self	260	74.9
Child	87	25.1
Total	**347**	**100**

Source: Field Survey (2014)

About 75% of the sampled farmers had relationship with household head self while 25.1% of them are related as children. Majority of the informants are closely related to household, this implies that, they are adults and would know how their households relate to climate change.

4.2.7 Educational Attainment of Respondents

Figure 4.3 shows the educational attainments of respondents in the LGA.

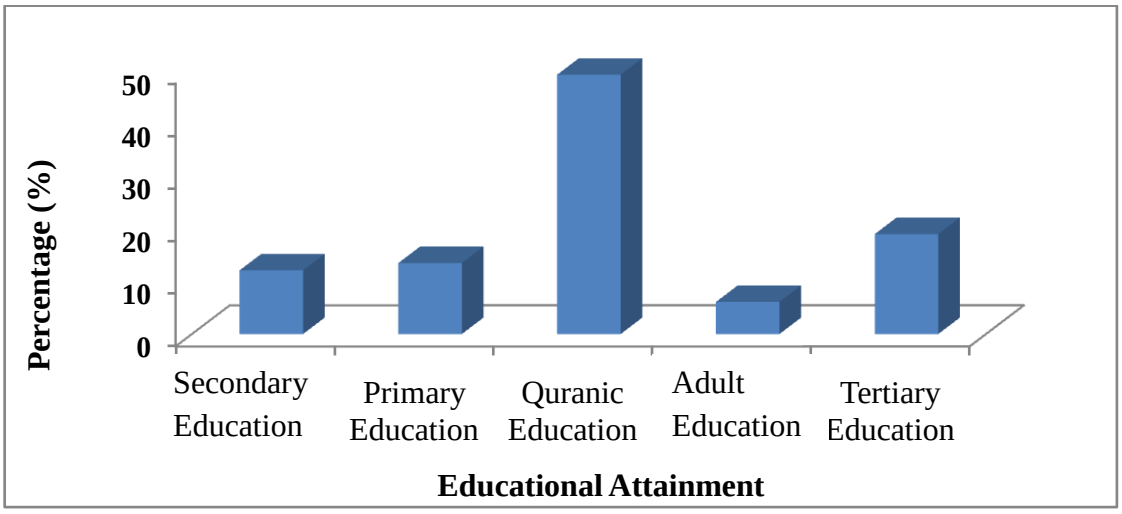


Figure 4.3: Educational Attainment of Respondents
Source: Field Survey (2014)

From the results, about half of the total respondents had Quranic education as their highest education attainment, followed by 12.1% of respondents who attained secondary education as their highest level of qualification, 13.5% of the respondents are primary leavers while a few of the sampled population had adult education as their level of education attainment. A substantial amount of sampled respondents attained tertiary school level of education.

The result shows that a few of the respondents in the study area had attained tertiary education; this may be as the result of numerous tertiary institutions in the Kaduna State. Indeed, education is expected to increase one's ability to receive, decode, and understand information relevant to making innovative decision (Wozniak, 1984). More so, the literacy and numeracy level of the respondents are also vital factors that may determine the understanding and perception of risks associated with climate change.

This result is very closely related to findings by Abaje *et al*., (2014) in Dustin-Ma LGA of Kastina State. Also this result is in line with the finding of Ikpe (2014) on adaptation

strategies to climate change among grain farmers in Goronya LGA of Sokoto State, Nigeria where most of the sampled farmers acquired Quranic education. Formal education is still low among rural households hence their awareness of contemporary climate change issues may be low.

4.2.8 Major Occupation of Respondents

Figure 4.4 shows the major occupation of respondents in the study area.

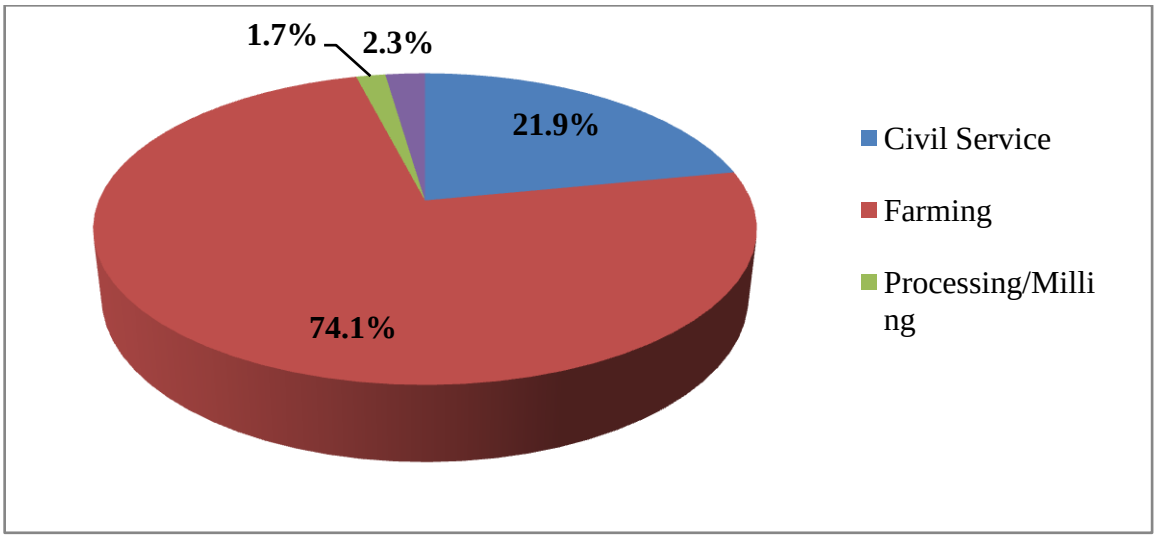


Figure 4.4: Major Occupation of the Household head
Source: Field Survey (2014)

The result clearly reveal that about 75% of the respondents have farming as their major occupation, followed by civil service with about 22% while 2.3 and 1.7% of them engage in trading and processing as their major occupations respectively. This result shows that, farming is the major occupation of the people in the study area. In a general view all of the respondents engage in one form of farming in conjunction with their other jobs as means of livelihood. As a result they may be vulnerable to climate change effects.

4.2.9 Income of Respondents

The Table 4.8 shows the summary of annual income earned by respondents in the study area.

Table 4.8: Income of Respondents

Income per year(Naira)	Frequency	Percentage
<50,000	43	12.4
50,000-100,000	44	12.7
100,000-150,000	108	31.1
150,000-200,000	138	39.8
200,000 Above	14	4.0
Total	**347**	**100**

Source: Field Survey (2014)

The result shows that very few of the respondents (4%) have yearly income of >₦200, 000, while about 40% have a yearly income of between ₦150,000 to ₦200,000. On the average majority of the respondents earn between ₦100,000 and ₦200,000. Income of the farmer can facilitate the ability to choose an adaptive method that is effective to manage climate change. This result also shows clearly that, a lot of respondents in the study area make a meagre amount through the sale of their farm produce. They are quite poor and can rarely afford the essentials needed for comfortable sustenance. As an inference their adaptive capacity may be low when climate change effects manifest.

4.2.10 Crops Cultivated in Order of Importance

The Tables 4.9, 4.10 and 4.11 show the order of crop importance cultivated by the respondents in the study area.

Table 4.9 shows the order of importance of crops cultivated by farmers.

Table 4.9: Crops Grown in First Order of Importance

First order of importance	Frequency	Percentage	Rank
Maize	192	55.3	1st
Rice	66	19.0	2nd
Beans	40	11.5	3rd
Guinea Corn	22	6.3	4th
Soya beans	18	5.2	5th
Okro	9	2.6	6th
Total	**347**	**100**	

Source: Field Survey (2014)

Majority of the respondents (55%) stated that maize is their major crop, while a sustainable number of respondents (19%) stated that rice is their most cultivated crop, 11.5% of the respondents claimed that it is beans while about 6% sorghum is their most cultivated crop. The result shows that only a few of the respondents (5%) prefer to cultivate soya beans and 3% okro. Most of the respondents practice mixed cropping. Mixed cropping is seen by farmers as an insurance against crop failure. It can be deduced that, most farmers preferred cultivating maize. This may be as the result of high yield compared to other crops for its economic and domestic value over other crops.

Table 4.10 shows the second order of important crops cultivated by farmers.

Table 4.10: Crop Grown in Second Order of Importance

Second order of importance	Frequency	Percentage	Rank
Pepper	93	26.8	1st
Tomato	67	19.3	2nd
Millet	46	13.3	3rd

Maize	44	12.7	4th
Cowpea	37	10.7	5th
Onion	16	4.6	6th
Sorghum	13	3.8	7th
Rice	11	3.2	8th
Potato	11	3.2	8th
Okro	9	2.6	10th
Total	**347**	**100**	

Source: Field Survey (2014)

About 27% stated that pepper is their second major crop, close to 19% stated that tomato is their second major crop, close to 13% prefer millet while almost 13% preferred maize as their second major crop. The result also shows that 10.7% of respondents prefer to cultivate cowpea and about 5% cultivate onion as their second major crop. About 4% of the respondents considered sorghum, while only a few of the respondents preferred rice and potato respectively while okro is the least cultivated second major crop.

They employ these second crops in their mixed cropping systems. It is also cultivated when their major crop doesn't do well (fails) because of drought or other unfavourable weather conditions. These crops complement their major farm produce.

Table 4.11 shows the third order of important crops cultivated by respondents.

Table 4.11: Crop Grown in Third Order of Importance

Third order of importance	Frequency	Percentage	Rank
Millet	75	21.6	1st
Pepper	60	17.3	2nd

Soya bean	43	12.4	3rd
Sorghum	40	11.5	4th
Sugar cane	28	8.1	5th
Maize	27	7.8	6th
Onion	27	7.8	6th
Tomatoes	22	6.3	8th
Okro	19	5.5	9th
Potatoes	6	1.7	10th
Total	**347**	**100**	

Source: Field Survey (2014)

About 22% stated that millet is their third major crop, about 17% preferred pepper, 12.4% preferred soya bean and 11.5% preferred sorghum as their third major crop. The result shows that close to 8% of respondents cultivate sugarcane, maize and onion to be their third major crop. About 6% of them preferred tomatoes, 5.5% cultivate okro and close to 2% of the respondents consider potato as their third major crops.

These choices serve to supplement their major crop decisions in advent of crop failure. Since they also engage in mixed farming these crops are incorporated during the planting seasons.

4.2.11 Livestock Reared in Order of Importance

The respondents showed preference for some livestock. The results of are shown in Tables 4.12, 4.13 and 4.14 in order of importance.

Table 4.12 shows the first order of importance of animals reared by farmers.

Table 4.12: Livestock reared in first order of importance

Livestock	Frequency	Percentage	Rank
Sheep	125	36	1st
Cattle	122	35.2	2nd
Goat	55	15.8	3rd
Chicken	32	9.2	4th
Guinea fowl	13	3.8	5th
Total	**347**	**100**	

Source: Field Survey (2014)

About 36% of the respondents stated that sheep is the major livestock reared, close to 35% stated cattle to be their major livestock, about 16% reared goats while close to 10% reared chicken as their major livestock. Only about 4% of prefer to reared guinea fowl as their major livestock.

This result shows that, most of the farmers in the study area rear sheep because of the religious importance attached to it. Also a high concentration of Fulani accounts for the choice of cattle as a livestock in the study area. These are often referred to during crop failure as a result of precarious weather and climate change.

Table 4.13 shows the second order of importance of livestock reared by respondents.

Table 4.13: Livestock reared in second order of importance

Livestock	Frequency	Percentage	Rank
Sheep	131	37.8	1st
Goat	101	29.1	2nd
Cattle	78	22.4	3rd
Chicken	30	8.7	4th
Guinea fowl	7	2.0	5th

Total	**347**	**100**

Source: Field Survey (2014)

About 38% reared sheep as their second major livestock, close to 29% reared goat, 22.4% rear cattle while close to 9% rear chicken as their second major livestock. The result shows that 2.0% of the respondents prefer to rear guinea fowl as their second major livestock. This is in addition to whatever they rear as their major livestock. This is also serves as a means of income in times of crop failure and is therefore an adaptive measure.

Table 4.14 shows the third order of importance of livestock reared by respondents.

Table 4.14: Livestock reared in third order of importance

Livestock	Frequency	Percentage	Rank
Sheep	131	37.8	1st
Goat	101	29.1	2nd
Cattle	78	22.4	3rd
Chicken	30	8.7	4th
Guinea fowl	7	2.0	5th
Total	**347**	**100**	

Source: Field Survey (2014)

About 38% stated that sheep is their third major livestock to rear, close to 29% rear goats, 22.4% rear cattle while 8.7% rear chicken as their third major important livestock. Only

2.0% of the respondents prefer to rear guinea fowl as their third major livestock. This result shows that, most of the farmers in the study area prefer to rear sheep in the three order of importance. The rearing of sheep is basically for religious reasons, the presence of Fulani populations in Ikara amount for the high number of cattle in the study area. Animal husbandary generally provides a means of sustenance in advent of crop failure as a result of unfavourable weather conditions.

4.2.12. Farmers' Organisation Membership Status

Farmers may or may not belong to farmers' organisation. Figure 4.5 shows membership status in a pie chart.

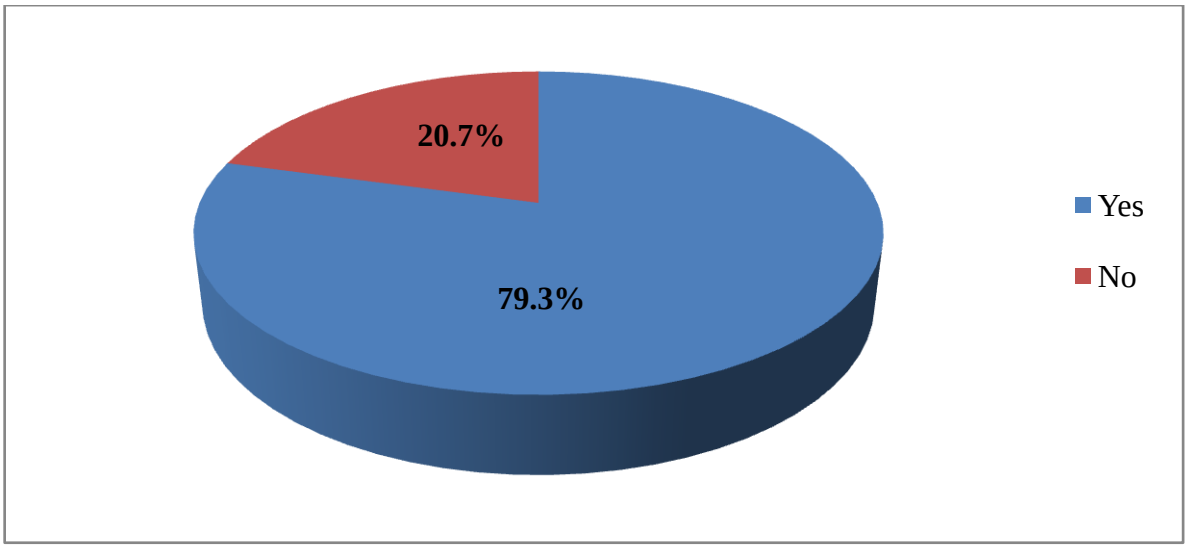


Figure 4.5: Respondents Organization membership Status
Source: Field Survey (2014)

Figure 4.5 shows the organization membership the respondents share in the study area. A large number of the farmers (about 80%) in Ikara LGA, Kaduna State belong to at least one farmer's organization or the other. This implies that, there are farmer's organizations or cooperatives in the study area. The presence of farmer organizations is a means of

providing information on climate change, current adaptive measures and also providing means of farm inputs and other benefits. This could help reduce the vulnerability of respondents to climate change.

4.2.13 Number of organizations

Some of the respondents belong to one organization, some belong to two or more organizations. Table 4.15 shows the number of organizations that the respondents belong to.

Table 4.15 Number of organizations

Number of Organization	Frequency	Percentage
1	72	20.7
>1	275	79.3
Total	**347**	**100**

Source: Field Survey (2014)

A large number of the farmers belong to more than one organization constituting about 80% while a little over 20% of the farmers said that, they belong to only one organization. Belonging to an organization is beneficial because of knowledge on new adaptation methods, availability of inputs and loans, new varieties of seeds etc.

4.2.14 Benefits Derived From Being a Member of an Organization

Figure 4.6 shows the results of respondents view on benefits of belonging to an organization.

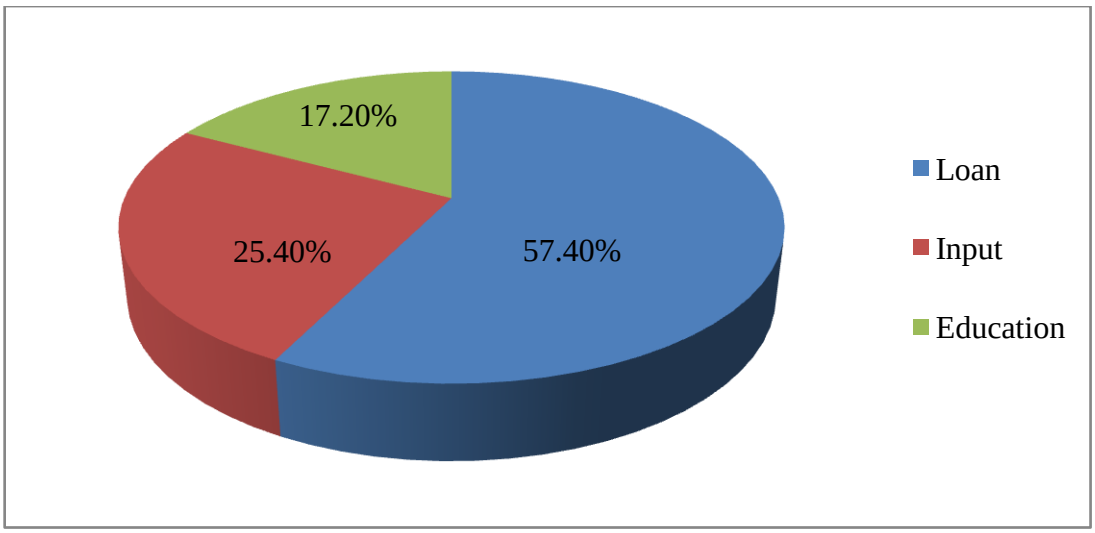


Figure 4.6: Benefits derived from being a member of organisation
Source: Field Survey (2014)

The Figure 4.6 reveals that, close to 60% of the respondents attested that the benefits they derived as member of any farmer organisation is loan, about 25% of them have benefitted from the inputs the organisations provide for their members while little over 17% of them have benefitted through their education scheme

4.2.15 Contact with an Extension Agent

The Table 4.16 shows results of how many of the respondents have had contact with extension agents.

Table 4.16: Contact with Extension Agent

Extension contact	Frequency	Percentage
No contact	28	7.9
Contact	319	92.1
Total	**347**	**100**

Source: Field Survey (2014)

Table 4.16 shows that a large proportion (92%) of the sampled farmers in Ikara LGA attested that, they have come in contact with extension agents in the not too distant past while a little of them claimed otherwise. This shows that, farmers in the Ikara are exposed to information and services provided by extension workers. Though the respondents claimed that the contact isn't regular but this could be responsible for farmers being aware of climate change.

4.2.16 Place of Origin

The Table 4.17 shows results of indigenous and non indigenous respondents in the study area

Table 4.17: Place of Origin

Location	Frequency	Percentage
Settlement in Ikara LGA	244	70.3
Outside Ikara LGA	103	26.7
Total	**347**	**100**

Source: Field Survey (2014)

Table 4.17 clearly shows that out of the respondents, a little over 70% were originally from settlements in Ikara LGA, while the remainder are not native or indigenes of the study area. So, from all indication, majority of the respondents are originally from Ikara LGA hence they have acquired indigenous knowledge on agricultural practices and coping strategies as handed down by previous generations.

4.2.17 Duration of Residency

Years of residency of the respondents was evaluated. This is shown in Table 4.18

Table 4.18: Duration of residency

Duration of residency (Years)	Frequency	Percentage
<10	32	9.2
11-20	77	22.2
21-30	179	51.3
>30	60	17
Total	**347**	**100**

Source: Field Survey (2014)

As shown in Table 4.18, more than half of the respondents have lived in Ikara for between 21-30 years. This also supports the opinion that they were mostly from settlements in Ikara LGA (Table 4.17) and a pointer to their competence in knowledge of evolving changes in climate pattern.

The reason for sampling respondents who must have lived in the area for years was to get information need climate change and the viable adaptation strategies used in the study area. This is in agreement with findings of Gashua (1991) that greater the residential experience of a farmer the higher the chances of knowing the techniques used in adapting to drought. Duration of residency is therefore an advantage for any farmer because he is conversant with the climate of the area and also very experienced with the adaptation mechanisms being employed in his area of residence.

4.3 FARMERS AWARENESS OF CLIMATE CHANGE

4.3.1 Awareness of Climate Change

A precondition of perceptual analysis is awareness of change itself. It is only when change is felt that issues surrounding the changes can be expressed. It is true, that the issue of climate change is no longer news but a reality as the signs are all around humanity today. A

large number of the respondents (> 90%) were aware that climate is changing. This result of the study is slightly lower than the findings of Ikpe (2014) where 98% of the sampled farmers claimed that they are aware of climate change. This is probably because the semi arid nature of Goronyo in Sokoto state makes the people to be more aware than Ikara (Kaduna state) which is more humid.

4.3.2 Sources of Information on Climate Change

Figure 4.7 presents the various sources through which people get awareness about climate change among respondents.

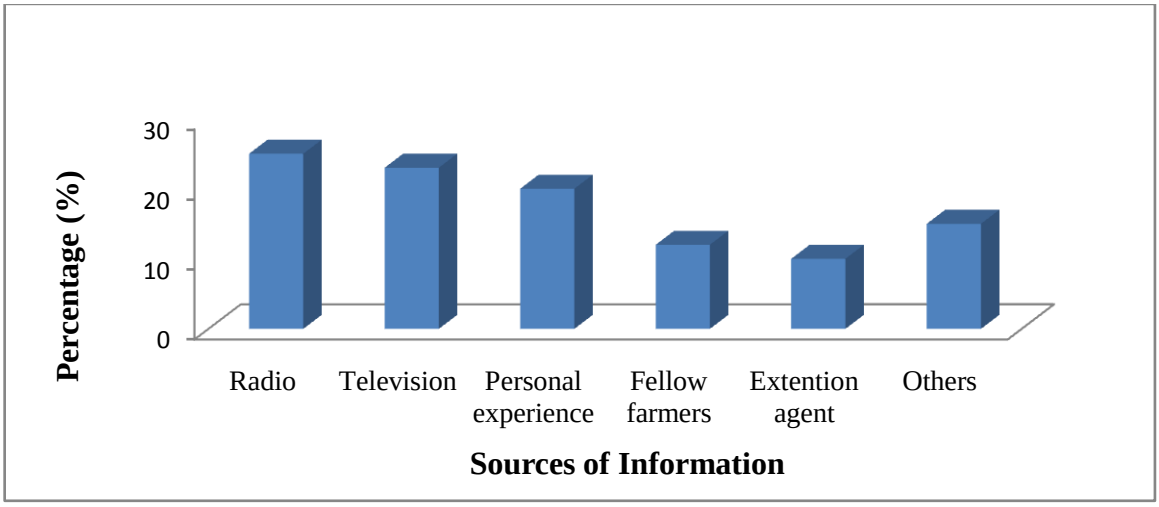


Figure 4.7: Source of awareness on Climate Change
Source: Field Survey (2014)

Figure 4.7 reveals that mass media were the sources of awareness for majority of the respondents as 24.5% got their awareness on climate change from radio; 22.8% from the television. A little over 20% of the respondents claimed that, their awareness of climate change was by their personal experiences. Sources such as extension agents, fellow farmers amongst others were the bases of awareness for the rest population of sampled respondents.

The mass media play an important role in improving the 'disaster reduction consciousnesses' of the general population and disseminating of early warnings. In many

cases, the media is the primary means of communication between policy makers, practitioner and the public. In this regard, the media carry a great responsibility to serve the needs of their audiences, and policy makers and practitioners are tasked with improving ways to formulate messages that are newsworthy and attract the media (United Nations International Strategy for Disaster Reduction (UNISDR), 2007).

4.4 FARMERS PERCEPTION OF CLIMATE CHANGE ISSUES

4.4.1 Farmers' Understanding of the Meaning of Climate Change

Farmers' ability to understand climate change is a key condition for them to adapt to such conditions. From the field survey, it shows that about 85% claimed to understand the meaning of climate change while only a little over 15% stated that, they do not understand the meaning of climate change. This implies that, most respondents in the study have knowledge about climate change.

Basically, those who claim to know the meaning of the term state it to be, "the change of weather condition which is totally different from what they have been experiencing before". Climate change by the respondents is referred to as, increase in temperature (which they call heat) and inconsistent rainfall though heavy, but with long duration of dry spells or persistent drought which affects the growth and yield of crops. They have also characterised it with increased winds too. This increases the rate of evaporation on soil surfaces and evapo-transpiration on farmlands and in rare cases crops may be blown away. Respondents stressed that compared to earlier years (≥ 15 years ago), climate is relatively "bad" and not as constant as it used to be before which favoured agricultural production.

This is in line with findings by Ogalleh, Vogl, Eitzinger and Hauser (2012) who conducted study in Kenya. Respondents of the district claimed that previous climates as the time of settlement 20 years ago was good as against current climate reported to be bad. They termed the ability of farmers to value their climate as, "good", "constant", "bad" or "very bad" which is an indicator of the depth of their local knowledge or perception.

4.4.2 Duration of Notice of Change in Climate

The table 4.19 shows the period for which the respondents seemed to have started noticing change in climate of the study area.

Table 4.19: Duration of notice of climate change

Duration of climate change(Years)	Frequency	Percentage
2009-2014	117	33.7
2004-2009	132	38
1999-2004	73	21.1
Before 1999	25	7.2
Total	**347**	**100**

Source: Field Survey (2014)

A high number of the respondents, (about 38%) said that, it was between 2004 to 2009 they noticed changes in climate, close to 34% of them said the notice the changes in the last five years (2009-2014), about 21% of the farmers confirmed that, they have noticed changes in climate within 11-15 years while a little over 7% believe that changes have been observable even before 1999 which was 15years ago. This shows that climate change began to occur well above 15 years ago but it wasn't noticed by all farmers. This might have an effect in their ability to adapt to climate change thus making them somewhat vulnerable.

4.4.3 Farmers Perception on Climate Change

The Table 4.20 presents how climate change is perceived by respondents in the study area. This reveals their symmetry or otherwise with conventional indicators of measuring the perception of climate change.

Table 4.20 Farmers Perception on Climate Change

S/N	Perceptual Indicator	Agree N (%)	Disagree N (%)	Indifferent N (%)	Strongly Agree N (%)	Strongly Disagree N (%)
1	The green environment in this village is reducing	151(43.5)	28(8.1)	34(9.8)	123(35.5)	11(3.2)
2	The dryness in the environment is more	104(30)	38(11)	101(29.1)	99(28.5)	5(1.4)
3	Temperature is rising	102(29.4)	70(20.2)	21(6.1)	107(30.8)	47(13.5)
4	Yearly rainfall begins early	113(32.6)	58(16.7)	41(11.8)	75(21.6)	60(17.3)
5	Yearly rainfall begins late	107(30.8)	50(14.4)	77(22.2)	100(28.8)	13(3.8)
6	Yearly rainfall ends early	64(18.4)	79(22.8)	120(34.6)	44(12.7)	40(11.5)
7	Yearly rainfall ends late	129(37.2)	55(15.9)	78(22.5)	75(21.6)	10(2.9)
8	Total rainfall is decreasing every year	159(45.8)	24(6.9)	21(6.1)	139(39.2)	7(2.0)
9	The weather is becoming drier every year	105(30.3)	45(13)	85(24.5)	108(31.1)	4(1.2)
10	Total rainfall is increasing every year	157(45.2)	28(8.1)	52(15)	105(30.3)	5(1.4)
11	The weather is becoming wetter every year	116(34.4)	32(9.2)	24(6.9)	163(47)	12(3.5)
12	Climate change has led to increased crop pest infestation and diseases	127(36.6)	69(19.9)	22(6.3)	85(24.5)	44(12.7)
13	There is a gradual reduction of vegetation cover	194(55.9)	19(5.5)	20(5.8)	107(30.8)	7(2.0)
14	There is a gradual drying of water resources	152(43.8)	25(7.2)	17(4.9)	145(41.8)	8(2.3)
15	The cost of food crops are increasing because of climate change	156(45)	21(6.1)	36(10.4)	119(34.3)	15(4.3)
16	Choice of crops has changed with climate change (rainfall regimes)	96(27.7)	75(21.6)	15(4.3)	84(24.2)	77(22.2)
17	Crop yields have decreased with climate change	94(27.1)	79(22.8)	24(6.9)	83(23.9)	67(19.3)
18	Livestock numbers have decreased due to decrease in available pasture	172(49.6)	30(8.7)	17(5.0)	119(34.3)	9(2.6)
19	Climate change has led to the change in livelihood system	117(33.7)	28(8.1)	87(25.1)	104(30)	11(3.2)
20	There has been increase incidences of floods during the rainy season	143(41.2)	21(6.1)	12(3.5)	153(44.1)	18(5.2)
21	There have been increase incidences of drought during the rainy season	116(33.4)	42(12.1)	67(19.3)	112(32.3)	10(2.9)
22	Length of drought period during the	105(30.3)	66(19.0)	24(6.9)	109(31.4)	43(12.4)

	rainy season is long					
23	There is awareness on climate change	210(60.5)	36(10.4)	11(3.2)	68(19.6)	22(6.3)

Source: Field Survey (2014)

Table 4.20 shows that about 44% of respondents agree that, the green environment in the LGA is reducing, a little over 35% of the sampled farmers strongly agreed. This result concurred with findings of Bambale (2014) and Ikpe (2014) in their studies in Kastina state and Sokoto state respectively.

Also 30% agreed while a little over 29% strongly agreed respectively to changing climate. The cumulative percentages correspond to the findings of Bambale which showed that, about 66% of the farmers in Katsina believed that the climatic environment is changing. This is also in line with the results by Farauta, Egbule, Agwu, Idrisa and Onyekuru (2012), which showed that 79% also affirmed that they had knowledge of the changing climate. This knowledge can be deduced from observation and awareness is a necessary step in adapting to the changing climate.

The result also revealed that, close to 31% of the respondents strongly agree that, temperature is rising and a little over 29% of the sampled farmers agree with the above statement. The finding is in line with that of Ikpe (2014) whereby 55.8% of grain farmers in Goronyo (Sokoto State) attested that temperature is rising. This agreed with the work of Ishaya and Abaje (2008) in which 73% of the respondents were on the opinion that temperature has been increasing over the past few decades. This is also in agreement with the study of Oladipo (2011) that the country has been experiencing temperature increase of about 0.2 °C – 0.3 °C per decade in all its ecological zones.

As shown in table 4.20, a little over 30% of the total responses agreed that, the weather is becoming drier every year, 108 respondents representing 31.1% also strongly agree .Only

13% and 1.2% of the total respondents disagreed and strongly disagreed respectively. The finding is parallel to the findings of (Zonkwa, 2012, Bambale, 2014, Ikpe, 2014,) where most of the sampled farmers averred that the weather is becoming drier every year. This is as a result of increase in temperature and increase in evapo-transpiration in northern Nigeria.

On the statement about total amount of rainfall on increase every year, close to 46% farmers agreed that the annual rainfall is on increase, about 39% strongly agree with the statement while 2% strongly disagree with assertion that total rainfall is on increase. This is line with findings by several researchers. For examples Ati, Iguisi, and Afolayan (2007); Ati, Stigter, Iguisi, and Afolayan (2009); Odekunle, Andrew, and Aremu (2008); Abaje, Ati and Iguisi (2012); Abaje, Ati, Iguisi and Jidauna (2013) using recorded rainfall data observed that this zone is now experiencing wetter conditions in recent years.

The perception of the respondents on the issue whether climate change has led to increased in crop infestation and disease reveal that, 36.6% agree with the above statement and 24.5% strongly agree that increased in infestation and disease is because of climate change. The result concurred with finding of Bambale (2014) which showed that 48.5% of the sampled farmers agreed that infestation and disease is as the result of climate change. This again is line with the findings by Zonkwa (2012) which showed 49.5% agreeing to the above statement.

Futhermore, over half of the respondents (55.9%) agree that, there is gradual reduction in vegetation cover, close to 31% strongly agree that, there is reduction in vegetal cover while 2% strongly disagree. This is in variance with findings by Nicholson (2001) who carried

out studies in Sudan and reported no evidence of widespread removal of vegetation cover in the villages. However, the study revealed that vegetation changes was as a result of drought and noted that there was full recovery of the land as soon as drought ended.

It is also noted that, close to 44% and 42% of the respondents agree and strongly agree respectively that there is gradual drying of water sources in the study area. While 7.2% disagree with the assertion and a little over 2% strongly disagree. This observation can be based on observations of decreasing rainfall, increasing temperature which results in decreased agricultural productivity and production, high evaporation rates and reduced soil moisture, lowering of the groundwater table and shrinking of surface water.

From the collated data shown in the table 4.20, majority of the respondents (45%) attested that the prices of food crops are higher as a result of climate change. This followed by 34.5% of them that also strongly agreed that the high cost of food crops is because of climate change while About 7% of them disagree with the declaration and a little over 2% of the sampled farmers strongly disagree with the statement. Drought and flooding in recent years have resulted in serious farm losses. This in result has led to high cost of food items especially when these climatic conditions occur.

The result also revealed that, close to 28% of the respondents agree that the choice of crop to farm has changed as a result of climate change, 21.6% disagree that changes in the choice of crop to farm is not as the result of change in climate, while about 24% strongly agree that changes in choice of crop is as the result of climate change but only 4.3% strongly disagree with the statement. From the table 4.13 again, about 34% of respondents agree that, as the result of climate change, there is change in the livelihood system of

farmers in the study area, while 30% of them strongly agreed that there is change in the livelihood system of the farmers. The community's exposure to climate change has led to indirect changes in water, air, food quality and quantity, agriculture and livelihoods. These direct and indirect exposures can cause death, disability and hardship in the study area. The results of the respondents is in line with the report of the IPCC (2007b) that increases in climate extremes (e.g., storms, floods, temperature, droughts) associated with climate variability and change would cause deaths and injuries, population displacement, and adverse effects on food production, freshwater availability and quality, and would increase the risks of infectious disease, particularly in low-income regions. The result is also in good agreement with the findings by Bambale (2014) in which 46.8% of the sampled farmers Katsina state agreed that climate change brought change in livelihood of the farmers.

Result from the table also show that a little over 27% of the respondents agree that there is decrease in crop yields and close to 24% out of them strongly agree that there is decrease in crop yields as a result of climate change. This result agreed with IPCC (2001) which stated that climate change in the form of higher temperature, reduced rainfall and increase rainfall variability reduces crop yield and threatens food security in low income and agriculture based economics. It is also noted from the table that, almost half of the respondents (49.6%) agree that there is decrease in the number of livestock reared in the study area, while 8.7% disagree with the claim. Inference can be made from this observation because farmers often sell their livestock to compensate for crop losses due to climate change or augment poor yields from crop production during drought.

On the assertion that, there is an increase incidence of floods during rainy season in the area, about 41% of the respondents agree to that. Also, a little over 44% of them strongly

agree that there are increase cases of flood in the study area during rainy season while 5.2% strongly disagree. This is line with findings by Abaje, Sawa and Ati (2014) in Dutsin-Ma LGA of Katsina state that 83% of the people perceived that flood occurrences are increasing. Records have shown that this extreme weather event (flood) is becoming an annual occurrence in the northern parts of the country leading to loss of lives and property.

From the data shown in Table 4.20, about one third of the respondents (33.4%) agree that there have been increased incidence of drought during rainy season and a little over 19% strongly agree to this assertion. Only about 12% and close to 3% disagree and strongly disagree with the statement that there has been increased incidence of drought during rainy season. The finding is in line with Zonkwa (2012) and Bambale (2014) where 53.1% and 57% of the sampled farmers agreed that, there is increased of drought during rainy season. But this is also in variance with most of the recent researches related to drought occurrences in the northern parts of the country using recorded climatic data. For examples, Ati *et al*., (2007); Ati *et al*., (2009); Odekunle *et al*., (2008); Abaje *et al*., (2012); Abaje *et al*., (2013) observed that drought occurrences in this zone is decreasing in recent years.

On the perception of whether there is serious awareness on climate change in the study area, a little over 60% of them agree that, there is serious awareness on climate change, while about 20% strongly agree to this. Only a little over 6% strongly disagree to this assertion. This is in line with findings by Farauta *et al*., (2012) about 84% of the respondents noted that they were aware of climate change.

4.5 ADAPTATION STRATEGIES TO CLIMATE CHANGE

4.5.1 Adaptation Strategies Adopted by Respondents

Respondents claimed to have variety adaptive strategies to withstand climate change. Results are depicted in Table 4.21.

Table 4.21: Farmers' adaptation strategies

Adaptation Strategies	Frequency	Percentage **
Planting of different varieties of crops	290	83.6
Planting of drought tolerant crops	203	58.5
Planting of flood resistant/tolerant crop	174	50.1
Planting of disease resistant/tolerant crop	216	62.3
Changing the extent of input into crop production	206	59.4
Changing the breed of livestock	188	54.2
Mulching of crops to reduce water loss	235	67.7
Planting of different crops (Mixed cropping)	245	70.6
Decreased use of chemical fertilizer	210	60.5
Increase in use of Organic Manure	238	68.6
Agricultural Insurance of Entreprise	196	56.5
Migration	204	58.8
No adaptation method	57	16.57

** Respondents provided multiple responses

Source: Field Survey (2014)

Table 4.21 shows that, close to 84% of the respondents argued that cultivating varieties of crops is the method employed for adapting to climate change, 58.5% practice adaptation by planting drought and tolerant crops, another 50% of the respondents indicated that planting of flood resistant and tolerant crops, 53% of the respondents employed the method of planting resistant and tolerant crops, a little over 62% adapted by cultivating of disease resistant and tolerant crop while almost 60% of the respondents adapted by changing the extent of input into crop production.

Table 4.21 also depicts that, over 54% have adapted to climate change by changing the breed of livestock. About 68% of the respondents, practice mulching of crops to reduce water loss, close to 71% practice mixed cropping/planting of different crops, 68.6% of the respondents increased the use of organic manure as an adaptation strategies. Furthermore, about 61% of the respondents practice adaptation by decreasing the use of chemical fertilizer while more than half of the respondents (57%) claim that, relying on agricultural insurance could be a very effective way of adapting to climate change.

It can also be noted that about 59% of the respondents claim that migration is the best means to adapt to climate change while almost 17% of them said that they do not adopt any method as a means of adapting to climate change. Most of the respondents combine two or more options to adapt. This is in line with findings by Ifeanyi-Obi *et al*., (2012) who stated that, adaptation options/strategies must not be used in isolation. Farmers combine two options where necessary in order to achieve the desired result.

4.5.2 Perceived Hindrances to Adaptation Strategies

Respondents are of the opinion that several factors hindered their ability to employ efficient adaptation strategies to combat effects of climate change in the study area. This is shown in Figure 4.8.

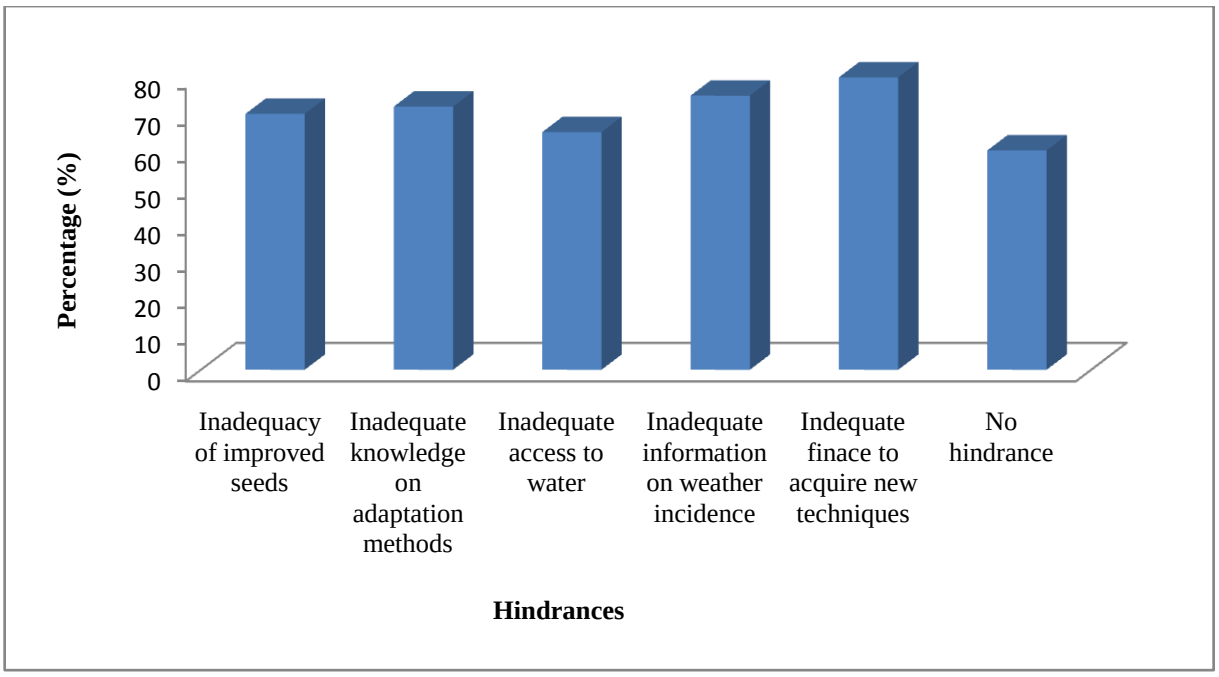


Figure 4.8: Perceived hindrances to adaptation strategies.
Source: Field Survey (2014)

A large number of the respondents in Ikara LGA argued that lack of money to acquire new techniques as a hindrance to employing adaptation strategies (75.8%); 73.8% confirmed that lack of information on weather incidence as a hindrance to adaptation; a little over 65% are of the opinion that inadequate knowledge on adaption methods is a hindrance; 64% of the respondents held to the view that inadequacy of improved seeds as a hindrance to adaptation, close to 58% claimed that lack of access to water for irrigation is a hindrance while about 45% held to the opinion that there is no hindrance to adaptation to climate change. This is in line with findings by Gbetibouo, (2009) who opined that, a number of factors influence the likelihood that farmers will perceive climate change.

Having fertile soil and access to water for irrigation decreases the likelihood that farmers will perceive climate changes, whereas education, experience, and access to extension services increase the likelihood that farmers will perceive climate changes. This suggests

that perceptions are not based entirely on actual climate conditions and changes but dependent on other factors as mentioned above. The result varies slightly from findings by Mustapha, Sanda and Shehu (2012), who stated that 46.3% argued that lack of current knowledge on adaptation measure is a challenge while 5% confirmed that lack of irrigation water and inadequate finance/credit is an impediment to modern technology/innovation adoption, 27.5% held to the view that poor extension services is responsible and 16.3% blamed lack of climate information to be the constraint of adaptation.

4.5.3 Alternative Sources of Water during Drought

In the study area there have been episodes of drought and dry spells during the rainy season. Figure 4.9 presents the options employed by farmers in such situations.

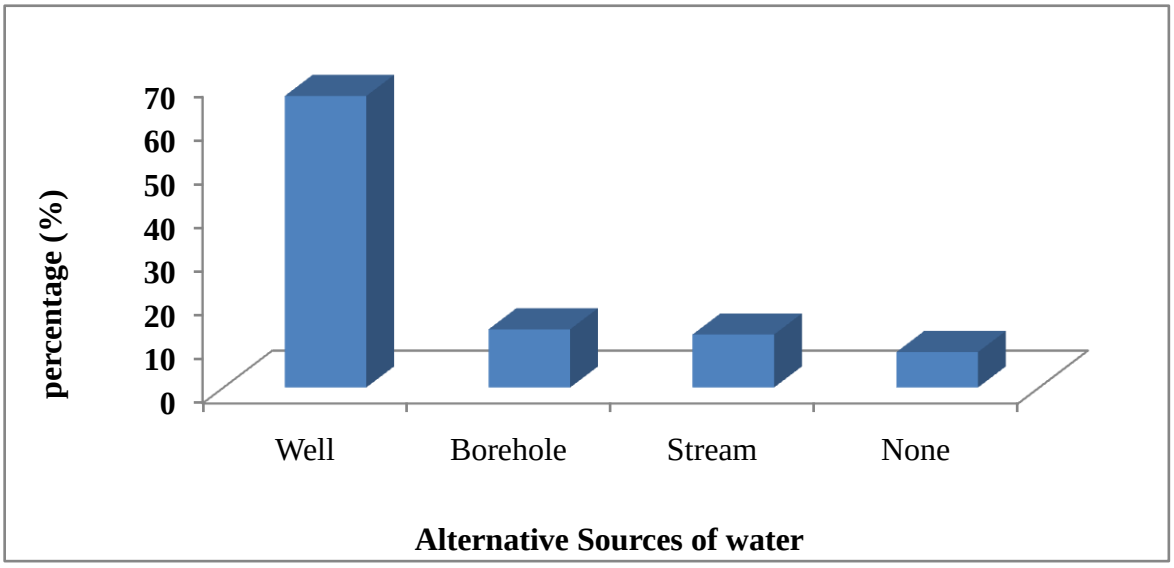


Figure 4.9: Alternative sources of waters in advent of drought
Source: Field Survey (2014)

Figure 4.9 shows alternative sources of water use by respondents. Most of them use well water during drought which accounted for 66.6%, a little over 13% claimed to use borehole water during drought while close to 12% used stream water during the drought period. Only

a few of the respondents (8.1%) did not provide answers on the sources of water during the period. This implies that, farmers in the study look for other sources of water during drought period. They basically employ these methods with use of water pumps, to get the water to their farmlands.

4.5.4 Alternative Crops Grown During Drought

Respondents indicated that they cultivated various crops asides their major crops in cases of drought or dry spells to help them survive the change in the climatic conditions. The results of these findings are shown in Table 4.22

Table 4.22: Alternative crops grown during drought

Alternative crops	Frequency	Percentage
Millet	130	37.5
Tomatoes	71	20.5
Onions	60	17.3
Pepper	42	12.1
Sorghum	28	8.1
Spinach	9	2.6
None	7	2
Total	347	100

Source: Field Survey (2014)

Table 4.15 shows alternative crops grown in the advent of drought in the study area, over one third of the respondents (33%) cultivate millet, about 21% grow tomatoes, a little over 17% grow onions while close to 12% cultivate pepper. From the table the results show that, about 8% cultivate sorghum while, almost 3% propagate spinach and 2% do not cultivate any crop. This shows that farmers in the area cultivate crops with short life span in cases of drought. Most of them choose to cultivate millet as a staple crop because it is drought

resistant crop and has economic and domestic value over sorghum and maize which are also staple crops. Onions and tomatoes are preferred too because they are cultivated for commercial purposes in dry weather or irrigation farming. These crops compensate for losses that might have occurred as a result of drought during rainy season. According to respondents, consistent drought was majorly observed in the last 10 years (since 2004) in the study area and has been occurring persistently over the years at an increased rate. The incidence also produces army worm which is a major pest that attacks maize crop which is a staple crop. Hence, the need for alternative crops during drought.

4.6 VULNERABILITY ASSESSMENT

Scale of vulnerability index was based on the Kumar, Paul, Krishna, Rao, and Chandra (2014) classification of vulnerability index (Appendix 2).

4.6.1 Vulnerability Assessment Based on Gender

The Table 4.23 shows vulnerability to climate change among farmers in Ikara LGA.

Table 4.23: Vulnerability Assessment based on Gender

Sample	Vulnerability index	Vulnerability Status
All sample	**0.42**	**Moderate**
Gender		
Male	0.03	Low
Female	0.40	Moderate

Source : Field Survey (2014)

Scale of vulnerability index was based on the Kumar *et al*., (2014) classification of vulnerability index (Appendix 2). This assessment was based on gender. Female respondents in the study area appear to be more vulnerable to the impact of climate change than their male counterparts because the vulnerability index for female respondents is closer to 1 than the male respondents. This is in line with findings by DFID (2009) in Nigeria, women, young, children and the elderly will be most vulnerable to climate change.

This is because in rural areas they are less exposed to information on adaptation strategies and less economically empowered to adopt such methods. In other words female literacy rates are generally lower in areas like this because of early marriages and poor attention to girl child education in northern Nigeria.

The vulnerability index among the respondents in the study area is 0.42 indicating moderate vulnerability. A vulnerability index value is typically an average of the summation of raw values of the factors used in decision making. It is a quantifiable measure of the drought and index values used in assessing every agricultural or seasonal year (Keyantash and Dracup, 2002). According to IPCC (2001b), Nigeria as a developing country is particularly vulnerable because a large share of her economy is dependent on climate and sensitive natural resources. Thus, Boko *et al*., (2007) consider Nigeria as one of the countries expected to be worst affected. According to Okali (2004), Nigeria's vulnerability to climate change comes both from being located in the tropics, and from various socioeconomic, demographic, and policy trends limiting its capacity to adapt to change.

On the other hand, considering the household head educational qualification, it can be observed that, quite a number of the respondents have some level of education. A high value of this variable implies more literates in the region and so they will have more awareness to cope with climate change. Therefore this accounts for the moderate (intermediate) vulnerability index of the study area. The vulnerability index is lower than expected since adult literacy rate has negative functional relationship with vulnerability. In other words, the higher the literacy rate the lower the vulnerability.

4.6.2 Vulnerability Assessment of Wards in the LGA

The computed overall vulnerability index for the study area was determined. This is shown in Table 4.24 indicating the vulnerability status and rank for each ward. This result is also depicted catographically in Figure 4.10 amongst the wards in Ikara.

Table 4.24: Vulnerability assessment to Climate Change among respondents in Ikara LGA of Kaduna State.

Wards	Vulnerability index	Vulnerability Status	Rank
Kuya	0.46	Moderately vulnerable	1
Rumi	0.45	Moderately vulnerable	2
Saya Saya	0.44	Moderately vulnerable	3
Saulawa	0.44	Moderately vulnerable	3
Funana	0.44	Moderately vulnerable	3
Paki	0.43	Moderately vulnerable	6
Auchan	0.43	Moderately vulnerable	6
K/kogi	0.39	Less vulnerable	8
Jamfalan	0.38	Less vulnerable	9
Ikara	0.37	Less vulnerable	10
Total	**0.42**	**Moderately vulnerable**	

Source: Field Survey (2014)

From Table 4.24, the vulnerability index of wards in Ikara LGA can be observed. This classification is based on study and classification by Kumar *et al*., (2014). The vulnerability index so computed lies between 0 and 1, with 1 indicating maximum vulnerability and 0 indicating no vulnerability at all. The entire study area is said to be moderately vulnerable to the impact of climate change. The most vulnerable ward is Kuya and Ikara ward is the least vulnerable.

Several factors could be responsible for this index. Ikara is the headquarters of the LGA. Therefore the ward has the privilege of having more schools including private schools, hospitals, agricultural bank and several other amenities. A lot of educated household heads or respondents were from this ward. The Agricultural Officer who is the head of

Agricultural Division also resides in the local government headquarters. The impact of the officer and this department as a whole can be felt through distribution of climate coping resources like, fertilisers, improved seed varieties and other agricultural inputs to farmers within his proximity. This could be a reason for Ikara having a lower vulnerability index.

In Figure 10 (map showing vulnerability), the neighbouring wards Jamfalan and Kurmin Kogi also have a relatively low vulnerability index. This is also attributable to the influx and overflow of education and the beneficial impact of the local government council. The remaining wards have a higher vulnerability index and are characterised by less

infrastructure (which are also climate change mitigating opportunities) like schools, good road network and health facilities. This finding mirrors the Third Assessment Report of IPCC (2001) that, the poorest countries are more vulnerable to the risk of climate change. The vulnerability index values of other wards are quite similar because their level of development is largely the same.

CHAPTER FIVE: SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 INTRODUCTION

This chapter presents the summary of this study, conclusions derived from the findings and recommendations based on farmers' perception and adaptation strategies to climate change in Ikara LGA of Kaduna State, Nigeria.

5.2 SUMMARY

The study provides insight on the farmers' perception and adaptation strategies to climate change in Ikara LGA of Kaduna State. This study was achieved through set of objectives which are to examine farmers' perception of climate change in the study area, examine vulnerability and characterize the coping measure of households to climate change. A total of ten wards in LGA were sampled and well structured questionnaire were used on 382 respondents while purposive sampling method was used to administered questionnaire.

The study revealed that 92% of farmers are aware of climate change, 75% claimed to understand the meaning of climate change. From the study, it was observed that there has been increase in the incidence of drought during rainy season (66%), increase in pest crop infestation and disease as a result of climate change (61%) and there has been increase in the total amount of rainfall (75%). Also, in the study area there has been rise in temperature (60%) and rainfall is now coming early in the recent years (54%) which are evidences of climate change.

The study also showed that respondents with access to climate change information and extension services are likely to perceive changes in the climate of the area because extension services provide information about weather and climate. Inadequate access to information on weather incidence (73.8%), inadequate improved seed varieties (64%), lack of water for irrigation (58.2%) and no access to loan (75.8%) are hindrances farmers experience adapting to climate change. On the vulnerability assessment of respondents to

the impact of climate change in the study area is moderate (0.42) vulnerability index. Kuya ward is the least vulnerable amongst the 10 wards of the LGA while women with an index of 0.42 are more vulnerable than men (0.3).

The study confirms that the main adaptation strategies of farmers in Ikara include planting of varieties of crops (maize, millet, sorghum, cowpea) (83.6%), mulching of crops to reduce water loss (67.7%), increase in the use of organic manure (68.6%) and rearing of heat tolerant livestock (54.2%). It also includes planting of disease resistant and tolerant crops (62.3%), planting of drought tolerant crops (58.5%), planting of flood resistant and tolerant crops (50.1%), migration (58.8%) and agriculture insurance of enterprise and planting of resistant and tolerant crops (56.5%). The study also showed the change in the type of crops cultivated by respondents in order of preference because some noticeable change in climatic condition.

5.3 CONCLUSION

Based on the objectives of this study it was concluded that, farmers observed elements of climate change in the study area. Respondents refer to the change in climate currently experienced as, “bad” compared to what was experienced 15 years ago or more in the study area. This finding is similar to the Kenyan study conducted by Ogalleh *et al*., (2012). Also respondents have observed increased temperature, incessant rainfall, dry spells during rainy season etc.

Vulnerability impact assessment conducted reveals that farmers are moderately vulnerable to the impact of climate change. Female respondents are more vulnerable than their male

counterparts. Given that the study area is a rural area and level of development is low, which makes the community quite vulnerable to the impact of climate change.

Various adaptive measures are being employed by the farmers. These include planting of drought tolerant crops, mulching of crops to reduce water loss, increase in the use of organic manure and planting of different varieties of crops amongst others.

The problems of climate change are already evident. Therefore all should be done to properly address this issue for self sufficiency in food production and for export, thereby enhancing virile economy.

5.4 RECOMMENDATIONS

Following the findings and conclusions made from the study, the following recommendations are made:

1. More emphasis on dissemination of climate change issues through the mass media is highly needed. Government should broadcast programmes to enlighten farmers on adaptation strategies to reduce factors that aggravate climate change and as well as showcase successful adaptation techniques adopted elsewhere that have local relevance.
2. Also there is need for extension agents, policy makers and researchers to try and get farmers to effectively adapt to climate change. This can be achieved by providing free extension advice; information on early warning signals and improved farmer education to create proper awareness on climate change and effective adaptation processes that can be employed by farmers.

3. There is need for Ikara local government council to partner with multilateral and international agencies to build capacities of farmers in relevant areas so as to strengthen the farmers' ability to develop and implement adaptation strategies and plans that would reduce her vulnerability to the impacts of climate change. Some of these areas include, providing financial resources which will increase their ability to adopt crop, water and soil management strategies in response to climate change.

4. Also there is a need for international agencies, researchers and extension agents to provide programmes such as female cooperative groups that support female farmers from being extremely vulnerable to climate change. By so doing, it will go a long way in improving the standard of living of households in the Ikara LGA.

5.5 CONTRIBUTION TO KNOWLEDGE

The primary aim of the researcher in this study is to examine the perception and adaptation of farmers to climate change in Ikara LGA and to characterize their vulnerability. So far no study of this kind has been conducted in the study area.

In this study, the researcher has discovered that over 90% of farmers in Ikara LGA are aware that climate is changing and respondents perceive the change in climate to have worsened as compared to the climate of 15 years ago or more in the study area. Farmers use combinations of two or more adaptation methods to counter the effects of climate change. As a result of this, households in the community have a vulnerability index of 0.42s, with females being more vulnerable than their male counterparts.

REFERENCES

Abaje, I. B., Ati, O. F., & Iguisi, E. O. (2012). Changing climatic scenarios and strategies for drought adaptation and mitigation in the Sudano-Sahelian Ecological Zone of

Nigeria. In M. A. Iliya & I. M. Dankani (Eds.), *Climate change and sustainable development in Nigeria* (pp. 99-121). Ibadan: Crown F. Publishers.

Abaje, I. B., Ati, O. F., Iguisi, E. O., & Jidauna, G. G. (2013). Droughts in the Sudano-Sahelian Ecological Zone of Nigeria: Implications for Agriculture and Water Resources Development. *Global Journal of Human Social Science (B): Geography, Geo-Sciences & Environmental, 13*(2), 1-10.

Abaje, I. B., Sawa, B. A., & Ati, O. F. (2014). Climate Variability and Change, Impacts and Adaptation Strategies in Dutsin-Ma Local Government Area of Katsina State, Nigeria. *Journal of Geography and Geology*, *6*(2), 103-112.

Abiola, O. (2007). *Procedures in Educational Research*, Kaduna: Kingon Nigeria Limited.

Abraham, F., Bamidele, F. S., Adebola, A. J., & Kobe, I. H. (2012). Climate change mitigating activities and determinants in the rural guinea savannah of Nigeria. *Sustainable Agriculture Research, 1*(2), 170-177.

Adebayo, W. O. (1997) Heat Island and Oasis effect of vegetative canopies: A Micro-meteorological investigation. *International Journal of Urban and Regional Affairs, 1(2), 35-39.*

Adefalolu, D. O. (2007, June). *Climate change and economic sustainability in Nigeria.* Paper presented at the International Conference on Climate Change and Economic Sustainability held at Nnamdi Azikiwe University, Enugu, Nigeria.

Adejuwon, S. A. (2002, February). *Global warming and climate change: The global efforts towards reversing the trend.* Paper presented at a workshop on Climate Change held at University of Ibadan.

Adesina, A. A., & Forson, J. B. (1995) Farmers' perception and adoption of new generation Technology: Evidence from analysis in Burkina Faso and Guinea. *West Africa. Agricultural economics, 13, 1-9.*

Adesina, F. A. (1988). *Developing stable agroforestry systems in the tropics: an example of local agroforestry techniques from south western Nigeria*. Discussion Papers in Geography 37, Department of Geography, University of Salford, United Kingdom.

Adesina, F. O., Siyambola, W. O., Oketola, F. O., Pelemo, D. A., Ojo, L. O., & Adegbugbe A. O. (1999). Potentials of agroforestry for climate change mitigation in Nigeria: Some preliminary estimates. *Global Ecology and Biogeography*, *8*, 163–173.

Adger, W. N. (1999). Social vulnerability to climate change and extremes in coastal Vietnam. *World Development*, *2*, 249-269.

Aisiokuebo, I. N. (2000). *Temperature Humidity Trends in Nigeria.* Unpublished Master's thesis, University of Lagos.

Ajani, E. N., Mgbenka, R. N., & Okeke, M. N. (2013). Use of Indigenous Knowledge as a Strategy for Climate Change Adaptation among Farmers in sub-Saharan Africa:

Implications for Policy. *Asian Journal of Agricultural Extension, Economics & Sociology 2*(1), 23-40. Article no. AJAEES.2013.003. Retrieved from http://www.sciencedomain.org.

Ajibade, L. T., & Shokemi O. O. (2003). Indigenous approaches to weather forecasting in Asa LGA, Kwara State, Nigeria. *Indilinga African Journal of Indigenous Knowlegde System, 2*, 37-44.

Allison, I., & Bindoff, N. L. (2009). *The Copenhagen diagnosis: updating the world on the latest climate science.* Sydney: UNSW Climate Change Research Centre.

Antle, J. M. (2010). Adaptation of agriculture and the food system to climate change: Policy issues. *Resources for the Future, 1*, 10-03.

Anyadike, R. N. C. (1993). Seasonal and annual rainfall variation over Nigeria. *International Journal on Climate, 13,* 567 – 580.

Anyanwale, K. C. (2007). *Climate Dynamics of the Tropics* (KAP: Dordrecht), 488, cited in Olusegun, C.F., & Adeyewa, Z.A. (2013). Spatial and Temporal Variation of Normalised difference vegetation index and rainfall in North east arid zone of Nigeria. *Atmospheric and Climate Science, 3*(4), *2013, 412-426. doi: 10.4236/acs.2013.34043.*

Ati, O. F., Iguisi, E. O., & Afolayan, J. O. (2007). Are we experiencing drier conditions in the sudano-sahelian zone of Nigeria? *Journal of Applied Science Research, 3*(12), 1746-1751.

Ati, O. F., Stigter, C. J., Iguisi, E. O., & Afolayan, J. O. (2009). Profile of rainfall change and variability in the northern Nigeria, 1953-2002. *Research Journal of Environmental and Earth Sciences, 1*(2), 58-63.

Ayoade, J. O. (2003). *Climate Change*. Ibadan: Vantage Publishers.

Ayuba, H. K., Maryah, U. M., & Gwary, D. M. (2007). Climate change impact on plant species composition in six semi-arid rangelands of Northern Nigeria. *Nigerian Geographical Journal, 5*(1), 35-42.

Bambale, U. S. (2014*). Farmer's adaptation strategies to drought in Katsina and its Environs.* Unpublished Masters Thesis, Department of Geography, Ahmadu Bello University, Zaria.

Berkes, F., & Jolly, D. (2001). Adapting to climate change: Social-ecological resilience in a Canadian We stern Arctic Community. *Conservation Ecology*, 5(2):18. Retrieved from http://www.consecol.org/vol5/iss2/art18. Accessed 12th September, 2013

Bharwani, S., Bithell, M., Downing, T. E., New, M., Washington, R., & Ziervogel, G. (2005). Multi-agent modelling of climate outlooks and food security on a community garden scheme in Limpopo, South Africa. *Philosophical Transactions of The Royal Society of London Series B-Biological Sciences, 360*, 2183–2194.

Blaikie, P., Cannon, T., David, I., & Wisner, B. (1994). *At Risk: Natural hazards, people's vulnerability, and disasters.* London: Routledge.

Boko, M., Niang, I., Nyong, A., Vogel, C., Githeko, A., Medan, M., & Yanda P. (2007). Climate change 2007 - Impacts, adaptation and vulnerability in Africa. In: M. L. Parry, O. F. Canziani, J. P. Palutikof, P. J. van der Linden, & C. E. Hanson (Eds.): *Contribution of working group II to the fourth assessment report of the intergovernmental panel on climate change.*(pp. 433-467). Cambridge: Cambridge University Press.

CARE (2009). Climate Vulnerability and Capacity Analysis Handbook: retrieved from http://www.careclimatechange.org/cvca/

Chamber, R. (1983). *Rural development: Putting the last first*. Essex: Longman.

Chindo, A., & Nyelong, P. N. (2005). Lake Chad: From megalake to minilake, *Arid Wetld Bull, 6*, 24-27.

Church, J. A., & White N. J. (2006). A 20th century acceleration in global sea level rise, *Geophysical Research Letters, 33*, L01602. doi:10.1029/2005GL024826.

Clerk, C. R. (2002). Climate change or climate fluctuation? *Journal of Arid Environments, 1*(1): 18-33.

Coe, M., & Foley, J. A. (2001). Human and natural impacts on the water resources of the Lake Chad Basin. *Journal of Geophysical Research 106*, 3349–56.

Cohen, S., Demeritt, J., Robinson, J., & Rothman, D. (1998). Climate change and sustainable development: Towards dialogue. *Global Environmental Change*, *8*(4), 341–371.

Nigeria's Country Profile. (2002). [pdf]. *Retrived from www.icid.org/vnigeria.*

Davies, S. (1993). Are coping strategies a cop out? *Institute for Development Studies Bulletin*, *24*, pp. 60–72.

Department for International Development. (2009). *Impact of climate change on Nigeria's economy*. Scotland.

Desai, B. K., and Pujari, B. T. (2007). *Sustainable Agriculture: A Vision for Future*. New Delhi: New India Publishing.

Dinar, A., Hassan, R., Kurukulasuriya, P., Benhin, J., & Mendelsohn, R. (2006). *The policy nexus between agriculture and climate change in Africa. A synthesis of the investigation under the GEF/WB Project: Regional climate, water and agriculture: Impacts on and adaptation of agro-ecological systems in Africa.* CEEPA Discussion Paper No. 39. Centre for Environmental Economics and Policy in Africa, University of Pretoria.

Directgov. (2010). *Causes of climate change*. Retrived from http://www.direct.gov.uk/en/environmentandgreeneerliving/thewiderenvironment.

Dixon, R. K., Smith, J. & Guill, S. (2003). Life on the edge: Vulnerability and adaptation of African ecosystems to global climate change. *Mitigation and Adaptation Strategies for Global Change, 8*(2), 93-113.

Duru, A. J. (2008). *The Implications of Variability in Rainfall Over Imo State on the little Dry Season (1975 – 2007).* Unpublished Bachelor's thesis, Imo state University, Owerri.

Easterling, W. E., Crosson, P. R., Rosenberg N. J., McKenny, M. S., Katz, L. A., & Lemon, K. M. (1993). Agricultural Impacts of and Responses to Climate Change in Missouri-Iowa-Nebraska-Kansas (MINK) region. In; N. J. Rosenberg. *Towards an intergrated Impact Assessment of Climate Change. The MINK study (pp.*23-62) Dordrecht: Kluwer Academic Publishers.

Eboh, E. C. (2009). Implications of climate change for economic growth and sustainable development in Nigeria. *Enugu forum policy paper 10, (*9-12).

Eboh, E. C., Oji, O. G., Oji, O. K., Amakom, U. S., & Ujah, O. C. (2004). Towards the ECOWAS common agricultural policy framework: Nigeria case study and regional analysis. Report submitted to Associaltion for International Resources and Development (AIRD), Cambridge, USA, for USAID/WEST AFRICA. (pp. 3-7)

Ekpoh, I. J. (1999). Estimating the sensitivity of crop yields to potential climate change in North-Western Nigeria. *Global Journal of Pure and Applied Sciences, 5*(3), 303-308.

Falaki, A. A., Akangbe, J. A., & Ayinde, O. E. (2013). Analysis of climate change and rural farmers' perception in North Central Nigeria. Journal of Human Ecology, 43(2), 133-140

Fankhauser, S. (1996). The potential costs of climate change adaptation. In: J. B. Smith, N. Bhatt, G. Menzhulin, M. Benieff, M. Budyko, and M, Campos. (Eds.), *Adapting to climate change: An international perspective* (pp. 80-96). New York: Springer.

Farauta, B. K., Egbule, C. L., Agwu, A. E., Idrisa, Y. L., & Onyekuru, N. A. (2012). Farmer's adaptation initiatives to the impact of climate change on agriculture in Northern Nigeria. *Journal of Agricultural Extension, 16* (1), 132-144. Retrieved from http://dx.doi.org/10.4314/jae.v16i1.13.

Fasona, M. J., & Omojola, A. S. (2005). *Climate change, human security and communal clashes in Nigeria*. Paper prepared for an International workshop on Human Security and Climate Change in Asker, Oslo. Retrieved from http://www.researchgate.net/publication/216411288.

Federal Ministry of Environment. (2003). *National Communication on Climate Change,* Final Draft. Abuja: Special climate change unit. Retrieved from http://www.unfccc.int/nigerianeeds/pdf.

Federal Ministry of Environment. (2009). *Nigeria and Climate Change: Road to Cop15*.Abuja. Retrieved from http://mrl.uk.com/nigeriaatcancun/pdf.

Food and Agricultural Organisation. (1992). *The state of food and agriculture*. FAO Agriculture series 89/91 CJPNIR45SR. FAO, Rome: Author. Retrieved from http://www.fao.org/docrep/003/t0800e/t0800e.pdf.

Food and Agriculture Organisation. (2004). *State of food insecurity in the world*. Rome: Author.

Food and Agriculture Organisation. (2007). *Climate change and food security: a framework for action*. FAO Interdepartmental Working Group on Climate Change, Rome: Author.

Food and Agricultural Organisation. (2008). *Climate Change and Food Security: A Framework Document.* Report of the FAO Interdepartmental Working Group on Climate Change. Rome: Author. Retrieved from ftp://ftp.fao.org/docrep/fao/010/k2595e/k2595e00.pdf.

Food and Agriculture Organization (2009). Nigeria's Water Profile. United Nations. National Bureau of Statistics, 2009. Abuja. Author.

Food and Agriculture Organisation. (2010). *Climate change implications for food security and natural resources management in Africa*. Twenty-sixth regional conference for Africa [on-line], Rome: Author. Retrieved from http://www.fao.org/docrep/ meeting/018/k7542e.pdf.

Francesco, T., Philippe, L. (2008). *Evaluation of the livestock sector's contribution to the EU greenhouse gas emissions* (GGELS). Final report. European commission, joint research centre.

Franhauser, S. (1996). The potential cost of climate change adaptation. In N. Smith, M. Bhatti, G. Mezilin, M. Benoiff, M. Budykos-Compos, B. Jallow, & F. Ridsberman (Eds), *Adapting to Climate Change: An International Perspective*. (pp 80- 96). New York: Springer–Verlag.

Gashua, M. A. (1991). *An evaluation of indigenous techniques of coping with drought in Bade Local Government Area of Borno State.* Unpublished Masters thesis, Department of Geography, Ahmadu Bello Univeristy, Zaria.

Gbetibouo, G. A. (2009). *Understanding farmers perceptions and adaptations to climate change and variability: The case of the Limpopo Basin, South Africa* (IFPRI discussion paper No. 00849) retrieved from http://www.ifpri.org/pubs/dp/IFPRIDP00849.pdf.

Gbuyiro, S. O. (1998). *On rainfall variability, ENSO and its relationship with Nigerian rainfall*. Unpublished Master's thesis, University of Lagos, Nigeria.

Grothmann, T., and Patt, A. (2005). Adaptive capacity and human cognition: The process of individual adaptation to climate change. *Global Environmental Change,* 15(3), 199-213.

Haddad, B. (2005). Ranking the adaptive capacity of nations to climate change when socio-political goals are explicit. *Global Environmental Change*, 15, 165-176.

Hassan, R., & Nhemachenam C. (2008). Determinant of climate adaptation strategies of African farmers: Multinominal choice analysis. *African Journal of Agricultural and Resources Economics* 2(1), 83-104.

Hegerl, G. C. (1996). Detecting Greenhouse-Gas-Induced Climate Change with an Optimal Fingerprint Method, *Journal of Climate*, 5(9), 2281-2306.

Hengeveld, H., Whitewood, B., & Fergusson, A. (2005). An introduction to climate change: A Canadian perspective. *Environment Canada*, 7-27.

Hulme, M. (Ed.). 1996. *Climate Change in Southern Africa: An Exploration of Some Potential Impacts and Implications in the SADC Region.* East Anglia: Climatic Research Unit.

Hunn, E. (1993). What is traditional ecological knowledge? In: N. Williams, & G. Baines (Eds.), *Traditional ecological knowledge: Wisdom for sustainable development. Centre for Resource and Environmental Studies*. (pp. 3–15). Canberra: Australia National university press,

Ifeanyi-Obi C. C., Etuk U. R.. & Jike-Wai O. (2012). Climate change, effects and adaptation strategies; implication for agricultural Extension system in Nigeria. *Greener Journal of Agricultural Sciences*. *2*(2), pp. 053-060.

IKACPA (2012). Ikara Community Progressive Association Handbook on Ikara, Information and Protocol unit, Ikara L.G.A. secretariat, Ikara, Kaduna.

Ikhile C. I. (2007). *Impacts of climate variability and change on the hydrology and water resources of the Benin-Owena River Basin.* Unpublished PhD. thesis, Department of Geography and Regional Planning, University of Benin, Benin City.

Ikpe, E. (2014). *Adaptation strategies to climate change among grain farmers in Goronyo Local Government Area of Sokoto state.* Unpublished Master's thesis, department of Geography, Ahmadu Bello University, Zaria.

International Labour Organisation. **(**2007). Employment by sector. In *Key indicators of the labour market (KILM),* Chapter 4. *5th edition*. Retrieved from www.ilo.org/public/english/employment/str.at/kilm/download/kilm04.pdf

Intergovernmental Panel on Climate Change (IPCC). (2007). *Impact, Adaptation and Vulnerability*. Contribution of Working Group 1 of the Intergovernmental Panel on Climate Change to the Third Assessment Report of IPCC. Cambridge: Cambridge University Press.

Intergovernmental Panel on Climate Change (IPCC). (2007b). *Climate Change 2007- The Physical Science Basis*. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge: Cambridge University Press.

Intergovernmental Panel on Climate Change IPCC. (2007). *Climate Change 2007: Impacts, Vulnerability and Adaptation*. Geneva: WMO

Ishaya, S., & Abaje, I. B. (2008). Indigenous people's perception on climate change and adaptation strategies in Jema'a Local Government Area of Kaduna State, Nigeria. *Journal of Geography and Regional Planning, 1*(8), 138-143.

Jagtap, S. (2007). *Managing vulnerability to extreme weather and climate events: Implications for agriculture and food security in Africa*. Paper presented at the International Conference on the impacts of extreme weather and climate on socio-economic development in Africa held at Federal University of Technology, Akure, Nigeria. pp 1-15.

Jevrejeva, S., Grinsted, A., Moore, J. C., and Holgate, S. (2006). Non-linear trends and multi-year cycle in sea level records. *Journal of Geophysical Resource*, 111, 2005 JCOO3229.

Kandlinkar, M., & Risbey, J. (2000). Agricultural Impacts of Climate Change: if adaptation is the answer, what is the question? *Climatic Change.45*, 529-539.

Kane, S. M. & Shogren, J. (2000). Linking adaptation and mitigation. *Climate Change Policy, 45*(1), 75 -102.

Karjalainen, T., Kellomski, S., & Pussinen A. (1994). Role of wood-based products in absorbing atmospheric carbon. *Silva Fennica*. *28*(2), 67–80.

Kasperson, J. X., Kasperson, R. E., Turner, B. L., Hsieh, W., & Schiller, A. (2000). *Vulnerability to Global Environmental Change*: *The Human Dimensions of Global Environmental Change.* Cambridge: MIT Press.

Kenyantash, J., Dracup, J. A. (2002). The qualification of drought: An evaluation of drought indices. *Bulletin of the American Meteorological Society 83,* 1167-1180.

Kowal, J. M. & Kanabe, D. T. (1972). *An Agroclimatic Atlas of the Northern States of Nigeria.* Zaria: Ahmadu Bello University Press.

Krejcie, R. V., & Morgan, D. W. (1970). Determining sample size for research activities in educational psychological measurement. *Journal of Education and Psychology, 30*, 607-610.

Kumar, P. N. S., Paul, K. S. R., Krishna, R. K., Rao, D. V. S., & Chandra, S. R. M. (2014). Assessment of vulnerability and impact of climate change on crop production in Krishna river basin of Andhra Pradesh: *International Journal of Current Agricultural Research, 3,*(2), 062-066.

Kwok, R., and Rothrock, D. A. (2009). Decline in Arctic sea ice thickness from submarine and ICESAT records: 1958-2008, *Geophysical Research Letters*, 36, L15501.

Levitus, S., Antonov, J. I., Boyer, T. P., Locarnini, R. A., Garcia H. E., Mishonov, A. V., & Baranova O. K. (2009). Global ocean heat content 1955–2008 in light of recently revealed instrumentation problems. *Geophysical Research Letters* 36, L07608.

Mabo, C. B. (2006). Temperature variation in northern Nigeria between 1970 and 2000. *Journal of Energy and Environment*, *19*(1), 80-88.

McCarthy, J. J., Canziani, O. F., Leary, N. A., Dokken, D. J., & White, K. S. (2001). *Climate Change 2001: Impacts, Adaptation, and Vulnerability*. Contribution of Working Group II to the Third Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge: Cambridge University Press.

McCay, B. J. (1997). Systems ecology, people ecology and anthropology of fishing communities. *Human Ecology*, *6*, 397–422.

McGuire, B., Macon, I., & Kilburn, C. (2002). Natural hazards and environmental change. London: Arnold.

Mertz, O., Mbow, C., Reenberg, A. Diouf, A. (2009). Farmer's perception of climate change and agricultural adaptation strategies in rural Sahel. *Journal of Mangaement, 43*(5), 804-816. doi: 10.1007/s00267-008-9197-0.

Mignouna, D. B., Manyong, V. M., Mutabazi, K. D. S., & Senkondo, E. M. (2011). Determinants of adopting imazapyr-resistant maize for Striga control in Western Kenya: A double-hurdle approach. *Journal of Development and Agricultural Economics 3*(11), 572-580. Retrieved from http://www.academicjournals.org/JDAE

Molega, A. U. (2006). Rainfall anomalies in Nigeria. *Journal Arid Environment, 5*(1), 1-8.

Mshelia, A. D. (2005). Adaptation strategies to climate change. *Journal of Energy and Environment*. *18*(3), 74-81.

Mustapha, S. B., Sanda, A. H., and Shehu, H. (2012). Farmers' Perception of Climate Change in Central Agricultural Zone of Borno State, Nigeria. *Journal of Environment and Earth Science*. *2*(11), 21-27.

Mundy P., and Compton L. (1991). Indigenous communication and indigenous knowledge. *Development Communication Report*, *74* (3), 1–3.

Nabegu, A., B. (2010). An analysis of municipal solid waste in Kano Metropolis, Nigeria. *Journal of Human Ecology, 31*(2), 111-119.

NASA's Jet Propulsion Laboratory. (2013). Global warming or Global climate change? Retrieved July 21, 2013 from https://sealevel.jpl.nasa.gov/overview/overviewclimate/overviewclimatewarmingorchange/htm.

National Bureau of Statistics. (2005). *Social Statistics in Nigeria.* Part III: health, employment, public safety, population and vital. Abuja: [Author].

National Population Commission bulletin (2009).

National Research Council (NRC). (2006). *Surface temperature reconstructions for the last 2,000 years*. Washington, DC: National Academy Press.

Nelson, G. C., Rosegrant, M. W., Koo, J., Robertson, R., Sulser, T., Zhu, T., ... Lee, D. (2009). *Climate change impact on agriculture and cost of adaptation.* Food policy report Washington DC: IFPRI

Netting, R. McC. (1993). *Smallholders, Householders*. Stanford: Stanford University Press.

Nhemachenam C., & Hassan R. (2007). Micro-level Analysis of farmers' adaptation to climate change in southern Africa. IFPRI Discussion paper No.00714. International Food Policy Research Institute, Washington D.C.

Nicholson, S. E. (2001). Climatic and environmental change in Africa during the last two centuries. *Climate Researcg*, *17*, 123-144.

Nigerian Environmental Study Team (NEST). (2003). *Climate Change in Nigeria: A Communication Guide for Reporters and Educators.* Ibadan: Author.

Nigerian Environmental Study/Action Team. (2008). *Facts on climate change in Nigeria No. 4: Repercussions for Agriculture, Food Security, Land Degradation, Forestry and Biodiversity.* Abuja: Author.

Nkeiruka, E. N., & Apagu, B. (2005). Rainfall anomaly for environmental application in Maiduguri, Nigeria. *Global Journal of Environmental Science, 4*(2), 155-159.

Nkomo, J. C., Nyong, A. O., & Kulindwa, K. (2006). The impacts of climate change in Africa. *Final Draft submitted to the Stern Review on The Economics of Climate Change.* Retrieved July 12, 2013 from http://www.researchgate.net/publication/253698396.

Nkonya, E. (2010). Increasing agricultural productivity and profitability in Nigeria. International Food Policy Research Institute Brief No. 19 IFPRI. Washington, DC.

Nnodu, V. C., Onwuka, S. V., & Okoye, C. V. (2007). *Climatic variability and its impact on runoff in South-eastern Nigeria*. Paper presented at the International Conference on Climate Change and Economic Sustainability held at Nnamdi Azikiwe University, Awka, Nigeria.

Nwafor, J. C. (2006). Environmental Impact Assessment for Sustainable Development: The Nigerian Perspective, Enugu. *Environmental and Development Policy Centre for Africa*, pp. 372-385.

Nwafor, J. C. (2007). *Global Climate Change: The driver of multiple causes of flood intensity in Sub-Saharan Africa*. Paper presented in the International Conference on

Climate Change and Economic Sustainability in Nnamdi Azikiwe University, Enugu, Nigeria.

Nwajiuba, C. (2011). Nigeria's Agriculture and Food Security Challenges. *Journal of Agriculture and Food Security,* pp 45-53.

Nyelong, P. N. (2004). Global Warming and Global Waters. *Journal of Energy and Environment, 17*(1), 79-90.

O'brien, P., & Mileti, D. (1992). Citizen participation in emergency response following the Loma Prieta Earthquake. *International Journal of Mass Emergencies and Disasters 10*, 71-89.

Obioha, E. E. (2008). Climate change, population drift and violent conflict over land resources in northeastern Nigeria. *Journal of Humam Ecology, 23*(4), 311-324.

Odekunle, T. O., Andrew, O., & Aremu, S. O. (2008). Towards a wetter Sudano-Sahelian ecological zone in twenty-first century Nigeria. *Weather, 63*(3), 66-70. Retrieved from http://dx.doi.org/10.1002/wea.172

Odjugo, P. (2005). An analysis of rainfall Pattern in Nigeria. *Global Journal of Environmental Science 4*(2), 139–45.

Odjugo, P. A .O. (2005). An analysis of rainfall pattern in Nigeria. *Global Journal of Environmental Science*, *4*(2), 139-145.

Odjugo, P. A. O. (2007). The impact of climate change on water resources: Global and regional analysis. *Indonesia Journal of Geography*, *39*(1), 23-41.

Odjugo, P. A. O. (2009). Quantifying the cost of climate change impact in Nigeria: Emphasis on wind and rainstorm. *Journal of Human Ecology*, *28*(2), 93-101.

Odjugo, P. A. O. (2010). Regional evidence of climate change in Nigeria, *Journal of Geography and Regional Planning*, *3*(6), 142-150.

Odjugo, P. A. O., & Ikhuoria, A. I. (2003). The impact of climate change and anthropogenic factors on desertification in the semi-arid region of Nigeria. *Global Journal of Environmental Science*, *2*(2), 118-126.

Ogalleh, S. A., Vogl, C. R., Eitzinger, J., & Hauser, M. (2012). Local Perceptions and Responses to Climate Change and Variability: The Case of Laikipia District, Kenya. *Sustainability*. 4, 3302-3325. doi 10.3390/su4123302.

Ogundebi, A. O. (2004). Socio-economic impacts of flooding in Lagos State. *Environ Impact Anal, 12*(1), 16-30.

Ojo, O. (1991). Overcoming hunger: The challenges in meteorological hazards. In: E. E. Ekuwem (Eds.). *Meteorological hazards and development* (pp. 22-36). Lagos: Kola Okanlawom Press.

Okali, D. (2004). Nigeria Climate Change: A guide for policy Makers. Ibadan: NEST.

Oladipo. E. O. (2011). The challenge of climate change for Nigeria: an overview. In: E. O. Iguisi, O. F. Ati, R. O. Yusuf & A. E. Ubogu (Eds.) *climate Change Impacts: Risks and Opportunities*, Lead Presenter 2 (pp 22-44). Proceedings of the International Conference of the Nigeria Meteorological Society held at NEARLS Conference Hall, Ahmadu Bello University, Zaria-Nigeria, 13th to 17th Novermeber, 2011.

Oladipo, E. O. (1995). Some statistical characteristics of drought area variations in the Savanna region of Nigeria. *Theoretical* and Applied Climatology, *50*, 147 – 155.

Olaniran, O. J. (2002). Rainfall anomalies in Nigeria: The contemporary understanding. *Paper presented at* 55th *Inaugural Lecture*, University of Ilorin, Ilorin.

Olaniran, O. J., and Summer G. N. (1989). A study of climatic variability in Nigeria based on the onset, retreat and length of the rainy season. *International Journal of Climatology, 9*: 253 – 269.

Oluwatosin, G. A. (2001). *Land management practices under fadama system*. Paper presented at a workshop on Fadama agriculture held at Institute of Agricultural Research and Training, Moor Plantation, Ibadan, Nigeria pp 1-2.

Onofeghara, F. A. (1990). Nigerian Wetlands: An overview In: T. V. I. Akpata & D. U. U. Okali. *Nigeria Wetlands* (Eds.). Port Harcourt: UNESCO/MAB.

Onyenechere, E. C. (2010). Climate change and spatial planning concerns in Nigeria: Remedial measures for more effective response. *Journal of Human Ecology, 32* (3): 137-148.

Osunade, M. A. (1994). Indigenous climate knowledge and agricultural practices in Southwestern Nigeria. *Malays Journal of Tropical Geography,1*, 21–28.

Ozor, N. (2009). *Understanding climate change: Implications for Nigerian Agriculture, policy and Extension*. Paper presented at the National Conference on Climate Change and the Nigeria Environment. Organized by the Department of geography, University of Nigeria, Nsukka.

Ozor, N., & Nnaji, C. (2010). The Role of extension in agricultural adaptation to climate change in Enugu State, Nigeria. *Journal of Agricultural extension and Rural Development 3*(3), 42-50.

Peacock, N., & Hemrich, J. (1984). Light and temperature responses in sorghum. In S. M. Virmani, M. V. K. Sivakumar & V. Kumble. *Agrometeorology of sorghum and millet in the semi-arid tropics* (40). India: ICRISAT. Retrieve from http://oar.icrisat.org/802/1/RA_00064.pdf.

Peters, G. (1997). Risk analysis. *Technology, Law and Insurance, 2*, 97-110.

Peterson, T. C., & Baringer, M. O. (Eds.). (2009). *State of the Climate in 2008*. Special Supplement to the Bulletin of the American Meteorological Society, 90(8), August 2009, pp. S17-S18.

Pinstrup-Andersen P., Pandhya-Lorch R., & Rosengrant M. W. (1999*). World food prospects: critical issues for the early 21st Century. 2020 vision food policy report*. Washington: International Food Policy Research Institute.

Raden-Fessenden, F., & Heath, J. (1987). Providing risk information in communities: Factors influencing what is heard and accepted. *Science, Technology and Human Values*, *12*(3-4), 94-101.

Rahmstorf, S., Cazenave, A., Church, J. A., Hansen, J. E., Keelings, R. F., Parker, D. E., and Somerville, R. C. J. (2007). Recent Climate Change Observations compared to projections. Science doi: 10.1126/science.1136843.

Reenberg, A. (1994). Land-use dynamics in the Sahelian zone in eastern Niger-monitoring change in cultivation strategies in drought prone areas. *Journal of Arid Environments* 27, 179–192.

Reenberg, A., Nielsen, T. L., & Rasmussen, K. (1998). Field expansion and reallocation in the Sahel—land use pattern dynamics in a fluctuating biophysical and socio-economic environment. *Global Environmental Change* 8, 309–327.

Regmi, R. B., & Adhikari, A. (2007). *Climate change and human development - risk and vulnerability in a warming world*. Occassional Paper, Human Development Report Office (HDR). New York: UNDP.

Riebsame, W. E. (1988). *Assessing the social implications of climatic fluctuations: a guide to climate impact studies*. Dept. of Geography, University of Colorado, Boulder.

Robinson, J., & Herbert, D. (2001). Integrating climate change and sustainable development, *International Journal of Global Environmental Issues*, *1*(2), 130–148.

Roncoli, C., Ingram, K., & Kirshen, P. (2001). The costs and risks of coping with drought: livelihood impacts and farmers' responses in Burkina Faso. *Climate Research, 19*, 119–132.

Sabine, C. L., Feely, R. A., Gurber, N., & Key, R. M. (2004). The Oceanic Sink for Anthropogenic CO2. Science, *305*, 367-371.

Sayne, A., (2010). *Climate Change Adaptation and Conflict in Nigeria*. United States Institute of Peace Special Report. Washington: United States Institute of Peace.

Schafer, J. (1989). Utilizing indigenous agricultural knowledge in the planning of agricultural research projects designed to aid small-scale farmers. In: D. M. Warren, L. J. Slikkerveer, S. O. Titilola (Eds.), *Indigenous knowledge systems: Implications for agriculture and international development. Studies in Technology and Social Change* No. 11, Technology and Social Change Program, Iowa State University, Ames, Iowa.

Sjöberg, L. (1995). *Explaining Risk Perception: An Empirical and Quantitative Evaluation of Cultural Theory.* Risk Research Reports. Center for Risk Research, Stockholm School of Economics.

Slovic, P. (1987). Perception of Risk. *Science, 236*, 280-285.

Smit B., & Skinner M. (2002). Adaptation options in agriculture to climate change: A typology. *Mitigation and Adaptation Strategies for Global Change*, *7*, 85-114.

Smith, B., Burton L., Tol, R., Kliend J. T., *and* Wandel, J. (2000). Anatomy of adaptation to climate change and variability. *Climate Change*, *45*, 223 -251.

Smith, J. B., & Lenhont, S. (1996). Climate change adaptation policy options. *Climate Research, 6*,193-201.

Stainback G. A., & Alavalapati J. (2002). Economic analysis of slash pine forest carbon sequestration in the Southern US. *Journal for Economics*, *8*, 105–117.

Stedman, R. (2004). Risk and climate change: Perceptions of key policy actors in Canada. *Risk Analysis*, *24,* 1395-1406.

Swart, R., Robinson, J., & Cohen, S. (2003). Climate change and sustainable development: Expanding the options. *Climate Policy*, 19–40.

Taylor, A., Harris, K., & Ehrhart, C. (2010). Adaptation Key Terms. *Tiempo*, 77, 10-13. Retrieved July 12, 2013 from http://www.tiempocyberclimate.org/portal/archive/pdf/tiempo77low.pdf.

Udeh, L. E. (2014) *Assessment of Farmers' Perception and Adaptation Strategies to Climate Change in Kano State, Nigeria*. Unpublished Doctor of Philosophy Dissertation, Department of Geography, Ahamdu Bello University, Zaria.

Umoh, E. (2007). Flooding problems in Rivers State. *Journal of Environmental Science, 4*(2), 44-60.

The United States Environmental Protection Agency (2008) Final Report on the Environment (ROE), retrieved from: July 12, 2013 from http://www.epa.gov/ncea/roe.

United Nation Development Programme. (2010). *Nigeria Country Report: Millennium Development Goals.* Abuja: Author.

United Nations Framework Convention on Climate Change. (2006). Climate change: Impacts, Vulnerabilities and Adaptation in Developing Countries. Author. Retrieved June 12, 2013 from http://unfccc.int/resource/docs/publications/impacts.pdf.

United Nations International Strategy for Disaster Reduction (2007). Retrieved June 12th, 2013 from http://www.unisdr.org/files/1130_GlobalReview2007chapter3.pdf

Wall, E., & Smit, B. (2005). Climate Change Adaptation in Light of Sustainable Agriculture. *Journal of Sustainable Agriculture, 27*(1), 113-123.

Warren, D. M. (1991). *Using indigenous knowledge in agricultural development*. World Bank Discussion Paper No.127, the World Bank, Washington, DC.

Warren, D. M. (1992). *Strengthening Indigenous Nigerian Organizations and Associations for Rural Development: The case of Ara Community*. Occasional Paper No.1, African Resource Centre for Indigenous Knowledge, Ibadan.

Watson, R. T., Zinyowera M. C., & Moss, R. H. (1996). *Climate Change 1995: Impacts, Adaptations and Mitigation of Climate Change: Scientific-Technical Analysis*. Cambridge: Cambridge University Press.

Woodley, E. (1991). Indigenous ecological knowledge systems and development. *Agricultural and Human Values, 8*,173–178.

World Bank. (1995) Impact evaluation report on Nigeria, Kano and Sokoto Agricultural Development Projects. Retrieved from *http://inweb18worldbank.Org/oed/oeddoclib.nsf*

Wozniak, G. D. (1984). The adoption of interrelated innovation: A human capital approach. *The review of Economics and Economics, 66*, 70-79.

Zonkwa, K. (2012). *Perception and adaptation strategies to climate change among indigenous farmers in Zongon Kataf Local Government of Kaduna state*. Unpublished Master's thesis submitted to the department of Geography, Ahmadu Bello Univeristy, Zaria.

Zube, E. H., Sell, J. L., & Taylor, J. G. (1982). Landscape perception: Research, application, and theory. *Landscape Planning, 9*, 1-33.

APPENDIX 1

DEPARTMENT OF GEOGRAPHY

FACULTY OF SCIENCE

AHAMDU BELLO UNIVERSITY, ZARIA.

RESEARCH QUESTIONNAIRE

Dear respondent,

I am an M.sc. student of Geography Department, Ahmadu Bello University Zaria undertaking a research titled "Farmers Perception of Climate change and Adaptation Practices in Ikara Local Government Area of Kaduna State. Your co-operation in completing this questionnaire will be appreciated. All information supplied would be treated confidentially and strictly for the purpose of this study. Thank you immensely.

Please answer the following questions sincerely

Geographical Location

State	LGA	Community/ Village	Ward

Section A: Household characteristics

1. Age : ≤30 ( ) 31-40 ( ) 41-50 ( ) 51-60 ( ) ≥61 ( )
2. Gender: Male [ ] Female [ ]
3. Marital status : Married [ ] Single [ ] Widow [ ] Separated [ ] Divorced [ ]
4. Household size? _____
5. Family size of the main Household:

Number of Adults (18yrs and above		Number of Children (below 18)	
Male	Female	Male	Female

6. Relationship of informant to household head: 1. Household head self; 2. Child; 3. Spouse; 4. Others (specify)……

7. Educational attainment of household head
   a. No formal education ( ) b. Quranic education ( )
   c. Adult education ( ) d. Primary education ( )
   e. Secondary education ( ) f. Tertiary education ( )
8. Major Occupation and Income/year of household head (₦)_____:
   Farming ( )
   Civil Service ( )
   Trading ( )
   Processing/Milling ( )
   Others (Specify) _____
9. Other Occupation Income/year (₦) _____
10. Three major crops grown in order of importance 1st .... 2nd ..... 3rd .....
11. Three major livestock reared in order of importance 1st ..... 2nd ..... 3rd. .....
12. Membership of farmer organization. Yes ( ) No ( )
13. If yes, Number of groups ( )
14. What benefit do you derived from being a member of the group(s)?
    a. Loan [ ]
    b. Inputs [ ]
    c. Education [ ]
    d. Others (Specify) __
15. Contact with extension agent
    (a)Frequent (once or more in a month.....
    (b) Infrequent (once or less greater than a month….....
    (c)Not at all ....
16. Are you originally from this village town? Yes ( ) No ( )
17. How long have you lived in this village/ town?

A. Perception and understanding of climate change issues

18. Have you heard about climate change? Yes ( ) No ( )
19. How did you become aware of climate change (a.) Extension agent .... (b) Radio ..... (c) Television .... (d) personal experience ..... (e) fellow farmers ..... (f) others ..... specify
20. Do you understand what is meant by climate change? Yes ( ) No ( )

21. What is climate change in your own word ----------

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22. Have you observed any changes in climate in your area? Yes ( ) No ( )
23. How many years ago have you noticed changes in the climate? ..... years ago

Kindly use the options below to answer the following questions according to your level of agreement or disagreement.

A. Strongly Agree (SA) B. Agree (A) C. I don't know (I)

D. Disagree (D) E. Strongly Disagree (SD)

QUESTION **SA, A, I, D, SD**

24. The green environment in this village is reducing ( )
25. The dryness in the environment is more ( )
26. Yearly rainfall begins early ( )
27. Yearly rainfall begins late ( )
28. Yearly rainfall ends early ( )
29. Yearly rainfall ends late ( )
30. Total rainfall is decreasing every year ( )
31. The weather is becoming drier every year ( )
32. Total rainfall is increasing every year ( )
33. The weather is becoming wetter every year ( )
34. Climate change has led to pest crop infestation and disease ( )
35. There is a gradual reduction of vegetation cover ( )
36. There is a gradual drying of water sources (rivers, streams, lakes, fadama lands, wells( )
37. The cost of food crops are increasing because of climate change ( )
38. Choice of crops has changed with climate change (rainfall regimes) ( )
39. Crop yields have decreased with climate change ( )
40. Livestock numbers have decreased due to decreased pasture ( )
41. Climate change has led to the change of livelihood system ( )
42. There has been increase incidences of floods during the rainy season ( )
43. There have been increase incidences of drought during the rainy season ( )
44. Length of drought period during the rainy season is longer ( )
45. There is awareness on climate change Yes ( ) No ( )

B. Adaptation and coping practices

46. What strategies are you employing in adapting to climate change?

a) Planting of different varieties of crops (multi-crop agriculture) ( ) b) Planting of drought tolerant crops ( ) c) Planting of flood resistant/tolerant crop or variety ( ) d) Planting of disease resistant/tolerant crop or variety ( ) e) Changing the extent of input into crop production ( ) f) Rearing of heat tolerant livestock ( ) g) Mulching of crops to reduce water loss ( )

h) Planting of different crops (Mixed cropping) i) Changing to irrigation fadama farming ( ) j) Decreased use of chemical fertilizer ( ) k) Increase in use of organic manure ( ) l) Agricultural insurance of enterprise (crop, livestock.) m) Migration (CI RANI) ( ) n) No adaptation method used ( )

47. What are the perceived hindrances to adaptation of modern techniques in adapting to climate change?

a. Inadequacy of improved seeds ( ) b. Inadequate knowledge on adaptation methods ( )

c. Lack of access water to irrigation ( ) d. Lack of information on weather incidence ( )

e. Lack of money to acquire new techniques ( ) f. There is no hindrance to adaptation ( )

48. During drought what alternative sources of water supply is being used?

49. In cases of drought what alternative crops are being used?

C. Vulnerability Assessment

50. Who are the people affected by climate change a. farmers ( ) b. artisans ( ) c. civil servants d. livestock keepers ( ) e. biomass resource users ( )

51. The threat of climate change is more felt on

a. Health ( ) b. Food supply ( ) c. Fuel wood availability ( )
d. Business ( ) e. Instigating disaster f. Biodiversity quality and sustainability ( )

52. The incidence of climate change will affect the sustainability of our environment?

Yes ( ) No ( )

53. What are the reasons for your vulnerability?

a. Low income ( ) b. Poor agricultural land ( ) c. Inadequate knowledge ( )

54. What individual attributes predisposes you with the inability to cope with climate change impact?

a. Gender ( ) b. Age ( ) c. Disability ( )

APPENDIX 2

Ratings of Perception by Farmers

Very bad- Intense sun's heat, high temperatures, erratic/unpredictable rainfalls, poor crop harvests, lack of pasture/grass for livestock-less productive livestock, rampant frostbite, prolonged/persistent droughts for up to 2-4 years, food insecurity, drying rivers

Bad- Unreliable/unpredictable rainfall, droughts, poor or little farm harvests, less pasture for livestock, drying rivers, food insecurity, persistent droughts, increased winds and increasing human population

Constant- no comparable observable change in climate

Good- Abundant rainfall accompanied by good farm harvests, plenty of grass/bushes for livestock, improved rains, crop yields enough for subsistence purposes, piped water.

(Ogalleh, Vogl, Eitzinger, and Hauser, 2012).