ANALYSIS OF NOMADIC PASTORALISTS' COPING STRATEGIES TO CLIMATE VARIABILITY IN KATSINA AND ZAMFARA STATES, NIGERIA

BY

Kim, IDOMA

DEPARTMENT OF GEOGRAPHY. FACULTY OF PHYSICALSCIENCES, AHMADU BELLO UNIVERSITY, ZARIA NIGERIA

NOVEMBER, 2016

ANALYSIS OF NOMADIC PASTORALISTS' COPING STRATEGIES TO CLIMATE VARIABILITY IN KATSINA AND ZAMFARA STATES, NIGERIA

BY

Kim, IDOMA
BSc. Geography (Uni. Jos) 2004, MSc Development Studies (BSU) 2010
Ph.D./SCIEN/16665/2011-2012

A THESIS SUBMITTED TO THE SCHOOL OF POSTGRADUATE STUDIES, AHMADU BELLO UNIVERSITY, ZARIA

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF A DOCTOR OF PHILOSOPHY (Ph.D.) DEGREE IN

RURAL DEVELOPMENT

DEPARTMENT OF GEOGRAPHY,
AHMADU BELLO UNIVERSITY,
ZARIA, NIGERIA

NOVEMBER, 2016

DECLARATION

I declare that the work in this thesis titled **'ANALYSIS OF NOMADIC PASTORALISTS' COPING STRATEGIES TO CLIMATE VARIABILITY IN KATSINA AND ZAMFARA STATES, NIGERIA'** has been carried out by me in the Department of Geography, Ahmadu Bello University, Zaria. The information derived from the literature has been duly acknowledged in the text and list of references provided. No part of this dissertation was previously presented for another degree or diploma at this or any other institution.

Kim IDOMA _____ _____

Signature Date

CERTIFICATION

This thesis entitled: ANALYSIS OF NOMADIC PASTORALISTS' COPING STRATEGIES TO CLIMATE VARIABILITY IN KATSINA AND ZAMFARA STATES, NIGERIAby Kim IDOMA meets the regulations governing the award of the doctor of philosophy degree (Ph.D.) in Rural Development of the Ahmadu Bello University, and it is approved for its contribution to knowledge and literary presentation.

Prof. Mamman Moses Signature_____
Chairman, Supervisory committee

Date_____

Prof. J.G. Laah Signature_____
Member, Supervisory Committee

Date_____

Assoc. Prof. B.A. Sawa Signature_____
Member, Supervisory Committee

Date_____

Dr. A.K. Usman Signature _____
Head of Department

Date_____

Prof. KabirBala Signature_____
Dean, School of Postgraduate Studies

Date_____

DEDICATION

This dissertation is solely dedicated to my Father, Mr. John OyaIdoma who gave me both financial and moral support that made this pursuit a reality.

ACKNOWLEDGEMENTS

First and foremost, I would like to thank God for the opportunity given me to run a PhD. Programmme and the care and protection he had taken upon me throughout the period of my study.

I also acknowledge the inestimable contributions of my team of supervisors.

It is a great privilege on my part to express my deep sense of gratitude and indebtedness to Prof. Mamman Moses, the head of the supervisory team for his kind forbearance in accepting so much pain in guiding me all throughout the research period and subsequent preparation of the dissertation. His mentoring and research advising experience have been priceless in encouraging me to finish my Dissertation.

I offer my heartfelt thanks to Prof. J.G. Laah, Dean Faculty of Science, Kaduna State University, Kaduna and member of the supervisory team for his tireless effort in ensuring the quality and successof this work.

I have the pleasure to express my sincere gratitude to Assoc. Prof. Sawa, B.A., member of the supervisory team for his guidance and constructive criticisms during the proposal, execution and write up of this dissertation.

I will be failing in my duties if I do not acknowledge with thanks the help and encouragement given by some members of staff of Geography Department, Ahmadu Bello university, Zaria namely Mr. Mohammed Ismail, Dr. JibrilAbdullahi, Mr. Muktar Ibrahim and Mr.MohammedSalisu to mention a few.

My sincere thanks are due to my parents, Mr. and Mrs. John OyaIdoma and my siblings, Shedd, Kilo, Yokohama, Enenu, Ochela, Onyakwu, Anche, Inda, Ocholongwa and Ngbede for their unprecedented support, understanding, love and care.

I would like to express my deep sense of gratitude to my beloved wife, Mrs. Ehi Kim and My children, Benaiah, John, Priscilla and Rejoice. Without their active prayer, help and co-operation it would not have been possible to complete this present study.

Lastly, I express my sincere thanks to Pastor Andrew Adoga of the Deeper Life Bible Church, Makurdi and Brother Ochoche Musa of the Deeper Life Bible Church, Obagaji for their relentless prayers and moral support through the period of the study. May the Lord bless you all. Amen.

ABSTRACT

This study aimed at analyzing nomadic pastoralists' coping strategies to climate variability in Katsina and Zamfara states, Nigeria. Multi-stage sampling technique was used to sample 367 pastoralists from each state. The research centered on primary data acquired through questionnaire, Focus Group Discussion and in depth Interview. Both descriptive (frequencies, percentages, mean) and inferential statistics(Chi-square and Product Moment Correlation Coefficient) were used to analyze the data. Results indicate that 83% of pastoralists in Katsinaand 77% in Zamfara perceived decrease in rainfall, while 89% in Katsina and 78% in Zamfara perceived increase in temperature. Rainfall is found to have major effects on pastoralists' livelihood activities.Predominant coping strategies embarked upon by pastoralists included moving long distances to find pasture (RII=0.9) anduse of crop residues as animal feeds (RII=0.9). Major constraints to coping strategies in the study area were conflict over scarce resources-pasture and water ($\bar{\chi}$ =2.7) and agricultural expansion limiting livestock movement ($\bar{\chi}$ =2.6). Inferential statistics employed to assess the relationship between climate variability and its impact on animal production as well as pastoralists' coping strategies revealed that rainfall and temperature significantly impacted on forage availability and quantity (r = 0.302, P≤ 0.000) and animal mortality (r = -0.633, P ≤ 0.000),whereas educational qualification (χ^2 =168.150, p≤ 0.05) and level of income (χ^2 =79.062, p≤ 0.05) were among the most important factors influencing the use of adaptation measures. It is the conclusion of this study that climate variability has greatly constrained pastoralists' socio- economic activities in the study area. Hence, the study recommends among others that policy makers, planners, development agencies and donors should invest on livestock breed improvement by introducing

exotic breeds with high resistance to drought and diseases at subsidized prices to pastoralists, increase extension farmers' ratio and make extension services within reach of pastoralists and improve climate information forecasting and dissemination through local awareness campaign.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

CHAPTER ONE- INTRODUCTION

1.1 BACKGROUND TO THE STUDY

Climate variability manifestations through extreme temperature, frequent flooding and drought have become a recurrent subject of debate globally. However, there is a wide acceptance by stakeholders that climate change will affect all nations especially the developing ones like those in Africa (Nicholas *et al*., 2012). Correspondingly, the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC, 2007a) predicted that Africa is highly vulnerable to the various manifestations of climate change and had affirmed that reservations about climate change are inappropriate considering apparent evidences from scientific observations of increases in global average air and ocean temperatures.

Although, remarkable weather extremes have occurred throughout history, however, the current rise in climate related hazards is validating the argument for global warming and climate change (McGuire, Macon and Kilburn, 2002; Odjugo and Ikhuoria, 2003; Nwafor, 2006). The persistent climate variations and the resultant increase in temperature have made some localities to experience excessive weather conditions in the form of floods, droughts, and heat waves, with devastating effects on human existence, agricultural productivity and food security. (Ayoade, 1995; Olaniran, 2002). According to the Nigerian Environmental Study/Action Team (NEST) and Global Strategies International (GCSI) (2004), proofs of climate change in our local environment include; delay in arrival of rains, unusual rainfall patterns, increasing floods, unusually warm periods even at high altitudes, and the harmattans in some years being hardly noticed while in others so prolong and persistent as to be intensely felt even in coastal regions.

Climate change is defined by the Intergovernmental Panel on ClimateChange (IPCC) (2007a) as a variation in the mean state of the climate, persisting for an extendedperiod of time (typically decades or longer). Similarly, the United Nations Framework Conventionon Climate Change (UNFCCC) (1992)referred to climate change as a change of climate which isattributed directly or indirectly to human activity, that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods.According to IPCC (2007), climate change is expressed as deviations from a regional climatology determined by analysis of long-term measurements, usually over a period of at least 30 years, or the normally experienced climate conditions and a different, but recurrent, set of climate conditions over a given region of the world.

Besides, climate variability is variations in the mean state and other statistics (such as standard deviations, the occurrence of extremes, etc.) of the climate on all temporal and spatial scales beyond that of individual weather events. It is therefore changes in climate which occur on shorter time periods. Variability may result from natural internal processes within the climate system (internal variability) or from variations in natural or anthropogenic external forcing (external variability) (IPCC, 2001).

It is imperative to note that studies in recent time (such as Helena and Reimund, 2009; Yohannes, Wolfang and Ann, 2010; Iona, 2011; Tamer, Radhagovil and Patrick, 2012) have focused on the impact of Climate Change on agriculture; with an increased interest in the effects of climate change on pastoralists' livelihood.The way of life of pastoral herders depends largely onmobile grazing of livestock. They practice differing levels of mobility, from sedentary herds that move within a locality, to transhumant herders who move between particular locations on a regular basis, to nomadic herders who have high mobility without regular patterns. (Blench,

2001, Joshi, *et al.*, 2013;). Nomadism is therefore a way of life of people who do not live continually in the same place but move cyclically or periodically. Whereas, Pastoralism is a subsistence system based primarily on domesticated animal production for meat, milk, hides and blood (Encyclopaedia Britannica, 2009). Consequently, the term "pastoral nomads" was broadly used to refer to all households that depended on their livestock husbandry through migratory lifestyle. Hence, for the purpose of this study (nomadic pastoralists' coping strategies to climate variability), the term "nomadic pastoralism" should include every household who are engaged in pastoral lifestyles in order to capture the entire possible coping strategies. Coping strategies in this context, implies the ability to prepare for an anticipated event, respond to that event once it takes place and recover from its effects through accessing alternative sources of food and income when agriculture fails.

The seasonal migration of herders is driven mainly by climatic factors of precipitation and temperature, andcharacterizes a traditional human adaptation to the harsh climate in arid or winter-cold areas (Wu and Yan 2002).Due to inadequate surface water and localized groundwater resources across the sudano-sahelian region of Africa, pastoralists are heavily dependent on rainfall and rainwater storage for their domestic and livestock water needs. Additionally, livestock nutrition and productivity are reliant on the availability of pasture, which is extensively influenced by rainfall. This means that they are extremely sensitive to erratic and unpredicted rainfall and to drought (Sangeda, Maleko and Mtengeti 2013).

Therefore, in Nigeria, pastoral livelihood systems are inherently adapted to the harsh and unpredictable climatic conditions of the sudan-sahel region (Mortimore and Adams, 2001). Consequently, decisions about herd size and composition are made based on the environmental and climatic conditions within the range area. Intuitively, mobility is an indispensable adaptive

strategy, which enables livestock herders to access water, pasture and other vital resources and services by moving with their animals to areas where these resources are more abundant (Jon and Greg, 2012). Accordingly, pastoral communities have evolved various traditional coping strategies to manage shocks, including herd splitting, building up herd sizes as a buffer against shocks and loans or redistribution of livestock and other assets to family or community members (Elasha, 2006, Maxwell and Caldwell, 2008). Traditional institutions play an important role in facilitating sustainable management of land and water resources, mitigating conflicts and promoting mutual support and collective action during times of crisis (Alinovi, Mane and Romano, 2010).

Unfortunately, pastoral communities in Nigeria face numerous challenges that limit their capability to employ these systems successfully (Mohammed, 2011). Increasingly erratic rainfall and more frequent droughts have over stretched the efficacy of traditional strategies to predict and manage these shocks and stresses. Population growth, expansion of farm land and allocation of land for other purposes such as tourism, urban development and industrialization has led to increased competition over land, at times leading to conflict between different communities and between humans and wildlife (Odoh and Chilaka, 2012). Inadequate maintenance of infrastructure such as roads and water points along the migration routes makes movement much more difficult for the herders and their animals. The aforementioned scenario is worsened by poor planning by both government and development actors, including haphazard creation of water points and settlements. Some government policies also support sedentarization, including policies around basic education, which has an impact on mobility and reduces the labour available for herding livestock. The insurgency in Nigeria especially the *Boko Haram* in the

north-east has as well hampered cross border movement and increased insecurity and conflicts (GCSI, 2014)

Furthermore, unsustainable management of land, water and other natural resources has led to rapid deterioration in ecosystem health and reduced quality and availability of critical resources for livelihoods (Nwafor, 2006). These issues are exacerbated by climate change, which acts as a driver of environmental degradation, for example, through increasing soil erosion due to increasingly variable rainfall (Odjugo and Ikhuoria, 2003). Admittedly, climate change may also be a driver of poor resource management, as people resort to increasingly unsustainable coping strategies to manage recurrent shocks to their livelihoods (Abaje, Sawa and Ati, 2014). In the face of these challenges, an increasing number of households are transitioning out of nomadic pastoralism into other livelihood strategies, notably crop production (Nouhoun, Luc and Eva, 2013). Often the household will continue to keep some livestock, but the herd is managed in a different way. Undoubtedly, the shift to agriculture may have some positive results in terms of providing new sources of food and income, but it may expose people to new risks and it may have negative consequences in terms of land use management(Ekaya, 2005). Other vulnerable households are relying increasingly on non-land-based sources of income such as casual wage labour, salaried jobs and remittances (Pius and Christopher, 2010). These strategies are potentially less sensitive to climate impacts; however, they often involve migration to urban centers, either temporarily or permanently. The impacts of the decision to migrate on the workers and on the families left behind are not yet well understood (Terrence, Paul, and Laura, 2010). Diversification of livelihoods is an important strategy for building resilience to climate change, but it must be done in an informed and empowered way in order to be effective (Fratkin and Roth, 2005).

The conditions of Nigeria's pastoralists obviously reveal the interaction of climate change impacts with political, economic and social dynamics, besides worsening ecosystem health. The combined effects of these changes places pastoralists in a state of vulnerability and uncertainty, with more frequent shocks and fewer resources with which to manage them. (Fabusoro, 2007) Adaptation efforts must therefore address immediate risks to pastoral livelihoods, while also putting in place systems, structures and processes that enable resilience in the longer-term (Temesgen, Yahualashetand Rajan (2014). To be effective, these efforts must be locally-driven, addressing the specific context and concerns of particular communities and of different groups within these communities (Eriksen and Otto, 2003).

Although, a large body of literature on climate variability and its impact on agriculture as a whole exists but most of it do not sufficiently disaggregate impacts of climate variability on crop farmers from herders. Instructively, crop farmers and herders have different socio-economic background, hence, levels of vulnerability, perception and response to climate variability differ. Moreover, literature on adaptation is quite broad, much of it centers on policy responses to climate change (either nationally or internationally) or community level often leaving out autonomous adaptation at the individual or household level.

1.2 STATEMENT OF THE RESEARCH PROBLEM

Long term changes in temperature and precipitationand increases in climate variability and extreme weather related events are alreadyevident in many parts of the world. Nigeria, like many other parts of the world has witnessed many climatic anomalies with serious consequences on the environment and society. The Sudan-Sahel zone of northern Nigeria especially has suffered decrease in rainfall in the range of 30-40% or 3-4% per decade since the beginning of nineteenth century (Ojo, 1985; Adejuwon, Balogun, and Adejuwon, 1990). This semi-arid area besides has

experienced inter-annual climatic variability, droughts and desertification since the 1960s and that this situation could be worsened by the expected decrease in rainfall (Sawa, 2010).

Katsina and Zamfara States, like many other States in northern Nigeria, have histories of rampant clashes between pastoralists and sedentary farmers. These conflicts often occur in seasons when rainfall is very low and the graze lands are incapable of sustaining the population of livestock owing to shortage in pasture availability. To compensate for this deficiency in pasture, Fulani headsmen, move their livestock to farm land areas for grazing, which has resulted to violent conflicts between the headsmen and farmers. In addition, Katsina and ZamfaraStates presently are among the states with the highest incidence of cattle rustling in northern part of the country. Cattle rustling, the stealing of grazing cattle is commonly practiced by herders whose cattle have diminished in number due to adverse effects of climate extremesand have to go into rustling in order to make up for the loss. Hence,it is to be noted that in most African countries including Nigeria, a basic causal mechanism links climate change with violence. Hence, poor responses to climatic shifts create shortages of resources such as land and water. Moreover, inappropriate adaptive responses resulting in damage to crops and blocking of transhumant corridors have caused violent conflicts between crop farmers and pastoralists.

Studies (Smith and Lenhart, 1996; Brklacich et al., 1997;Maddison, 2006;Belliveau et al., 2006; Ishaya and Abaje, 2008;Abaje, Sawa and Ati, 2014) have shown that different areas and environments are affected by climate change differently and suggest the need to focus on adaptation research that seeks to investigate actual adaptations at the farm level, as well as the factors that appear to be driving them. Based on the aforementioned, the aim of this study is

therefore to analyze the coping strategies of nomadic pastoralists to climate variability at the local levels, particularly some selected villages in Katsina and Zamfara States.

In order to empirically study the phenomenon of this research, the following research questions provided a guide:

1. What are the socio-economic and demographic characteristics of the pastoralists in the study area?
2. What has been the climate condition (in terms of the trend in rainfall and temperature variability) in the study area in the past nineteen (19) years? i.e. from 1996-2015, a period marked by increasing interest in climate variability in Nigeria with emergent focus on their interaction with socio-economic pressures on pastoral nomads.
3. What do nomadic pastoralists know and perceive of climate variability in the study area?
4. What are the effects of climate variability on the livelihoods of nomadic pastoralists?
5. What are the coping strategies adopted by nomadic pastoralists to mitigate the effects of climate change on their activities?
6. What are the barriers to coping strategies adopted?

1.3 AIM AND OBJECTIVES

The aim of this research is to analyse the coping strategies of nomadic pastoralists to climate variability in Zamfara and Katsina States, Nigeria for the period 1996-2015. However, the specific objectives are to:

i. Identify the socio-economic and demographic characteristics of pastoralists in the study area.
ii. analyse the nature and trend of climatic variations and change in the study area.

iii. examine nomadic pastoralists' knowledge and perception of climate variability and change in the study area.

iv. determine the effects of climate variability and change on nomadic pastoralists' livelihoods.

v. characterise nomadic pastoralists' coping strategies in response to climate variability in the study area.

vi. assess the barriers to coping strategies adopted by pastoralists in Zamfara and Katsina states.

1.4 RESEARCH HYPOTHESES

This research is guided by the following hypotheses:

I. There are no significant differences between pastoralists' perception of climate variability and impact on animal production in the study area.

II. There are no significant relationships between the socio- economic and demographic characteristics of pastoralists and coping strategies to climate variability in the study area.

1.5 JUSTIFICATION FOR THE STUDY

The choice of the states is informed by the high population of pastoralists (who constitute over 80% of the people) and for their relatively large number of grazing reserves (Zamfara grazing reserve and Runka reserve of Katsina among others) (Abubakar, 2010). The States also serve as a transit zone for pastoralists migrating from neighbouring States (e.g. Jigawa, Kano, Sokotoetc)and the Niger Republic towards central and south-western Nigeria in search of greener pasture at the end of the wet season. The frequency and scale of conflicts between farmers and herders in these States is highly alarming.Today, farmers-nomad conflict is second to *Boko-*

Haram among dangers threatening Nigeria.These conflicts, which are triggered by climate fluctuations have resulted in loss of lives, properties and environmental degradation(Kehinde, 2014)

Therefore, studies that address climatic trends and pastoralists' activities in Nigeria and in particular the study area are justifiable. This is because of its peculiarity to the contemporary socioeconomic activities going on in the study area. The findings and recommendations of this research will go a long way to assist the pastoralists in understanding how to respond to the current upsurge in climate change. The information on the past and present climatic trends would be used to forecast future events so as to cope with the incidence of drought, flooding and other climate related hazards.

In addition, the findings of this research would enrich the existing literature on the effects of climate change on development processes in the arid regions. In the same vein, they will assist the government and policy makers to reflect in the national policy or planning framework needs or issues critical to pastoral communities.

1.6 SCOPE OF THE STUDY

Spatially, the study covered selected rural settlements in Zamfara and Katsina States. In Zamfara State, the selected rural communities are Tunga-Miya, Mabangala, Dogon- daji, Hegina-Rama, Karma and Awala. Rural settlements selected in Katsina State are; Ruma -Sanda, Tudu, Garazawa, Gamzoka, Makurdi C and Kwarsu.

The content scope is to examine the effects of climate change on nomadic pastoralists' coping strategies. It covered rainfall and temperature records: temperature and rainfall intensity and

variability, changes in the onset, cessation and duration of seasons, the occurrence of extreme weather events such as flood and drought, pastoralists' perceptions and vulnerabilities to climate change and their mitigation practices and the effect of climatic variability on the socio-economic activities of pastoralists while the temporal scope covers a period of nineteen (19) years, from 1996-2015, which is believed to be a period which has witnessed upsurges of interest in climate variability in Nigeria with increasing focus on their interaction with socio-economic pressures on pastoral nomads (Frank and Christine, 2009).

CHAPTER TWO: THEORECTICAL FRAMEWORK AND LITERATURE REVIEW

2.1. Introduction

This chapter deals with theoretical framework and review of relevant literatures as a platform for investigating and explaining relevant concepts and pertinent issues of climate variability and adaptation measures.

2.2 Theoretical Framework

2.2.1 Climate change adaptation, perceptions and technology adoption paradigm

The mainspring of this research is an analysis of pastoralists' perception of climate variability and their coping strategies. Hence, Climate Change Adaptation, Perceptions and Technology Adoption Paradigm provides a suitable theoretical and structural underpinning of this work. Adaptation is one of the policy options to climate change that is influencing development. In development practice, the term adaptation is viewed as one of the key policy options to climate change (IPCC, 2007b; Tanner and Mitchell, 2008). Adaptation to climate change is understood to mean adjustments to practices, processes and systems to minimize current and/or future adverse effects of climate change and take advantage of available opportunities to maximize benefits (Eriksen*et al*., 2011; Pouliotte*et al*., 2009; Smithers and Smit, 2009). For Smithers and Smith (2009), adaptations can either be planned or autonomous. Accordingly, IPCC (2007)affirmed that autonomous adaptation is carried out without awareness of climate change predictions but based on experience and prevailing conditions, whereas, planned adaptation is based on awareness that conditions have changed and that action is required to remedy the

situation. In the same vein, Eriksen*et al.* (2011) aptly noted that adaptation does not occur devoid of influence from other factors like socio-economic, cultural, political, geographical, ecological and institutional that shapes the human-environment interactions. Hence, adaptation to climate change is desirable both in the short term and long term basis (Adger*et al*., 2003; Eriksen *et al*., 2011; Pittock and Jones, 2009). The adaptation theory, as stated by Smithers and Smith (2009) suggests that social, economic, ecological and institutional systems along with individuals can and do adapt to changing environment. However, it is instructive to note that thedegree of sustainable adaptation rests onthe adaptive capacity, knowledge, skills, robustness of livelihoodsand alternatives, resources and institutions accessible to enhance effective adaptation (IPCC, 2007b). Thus, IFAD (2008)emphasized that the adaptive capacity is determined by factors such as knowledge about climate change, assets, access toappropriate technology, institutions, policies and perceptions *inter alia.* In view of the foregoing, Smithers and Smit (2009) contend that environmental perceptions are among key elements influencing adoption of adaptation strategies. Basically, actions that follow perceptions of climate change are based on diverse processessuch as perception of risk associated with climate change, resource endowments, cultural values, institutional and political environment and it is not certain that having perceptions that climate change is happening would lead to effective adaptation responses (Weber, 2010).

Technology adoption on other hand, encompasses innovation-diffusion paradigm, economic constraint paradigm and adopter perception paradigm. Rogers' innovation-diffusion paradigm as stressed by Rogers (2003), recognizes information dissemination as a key factor in influencing adoption decision. Regarding the economic constraint paradigm,Deressa*et al*. (2008) and Prager and Posthumus, 2010 contend that technology adoption is influenced by utilitymaximization

behaviour and economic constraints due to asymmetric distribution of resources. The adopter perceptions paradigm postulates that the adoption procedure begins with the adopters' perception of theproblem and technology proposed (Adesina and Zinnah, 1993). It is the contention of this paradigm that perceptions of adoptersare imperative in influencing adoption decisions (Prager and Posthumus, 2010). Hence, perceptions are context andlocation specific owing to heterogeneity in factors that impact on them such as culture, education, gender, age, resource endowments and institutional factors (Posthumus, Gardebroek, and Ruerd, 2010).

The theoretical framework used in the present study adequately portrays links between factors that affect the adaptation options of farmers to climate change. It is based on the assumption that there are various driving forces behind farming households' decisions to choose adaptation options to climate change. Some of the influencing factors that lead to adaptation options are economic factors such as Livestock holding, Farm size, Annul income and Non-farm income. The Institutional factors such as Access to market, Extension services, Access to credit, Exposure to information on climate change and Training. Demographic factors such as Sex of house hold, Family size, Education, Age and Farming experience. Psychological factors are Perception of household about climate change

2.3 Conceptual Framework

The conceptual framework presented in Figure 2.1 was adopted and modified from Smit and Olga (2001) and O'Brien, Nyaard and Schjolden (2007) to elucidate the associations between climatic variables, animal performance, crop production, forestry, fishery, adaptation strategies and policy framework and institutions. The framework avows that exposure to climate variability and change affects livelihood patterns and autonomous adaptation strategies. This is because

competition for space leads to conflicts. It further illustrates how policies and institutions directly influence planned adaptation to impacts and vulnerabilities. Planned adaptation reduces vulnerability of households and builds resilience to climate extremes through the adoption of climate-smart agricultural technologies.

Climate-smart agriculture (CSA), therefore, is an integrative approach to address the interlinked challenges of food security and climate change. It is a practice that helps to guide actions needed to transform and reorient agricultural systems to effectively support development and ensure food security in a changing climate. CSA has three main objectives:

I. sustainably increasing agricultural productivity, to support equitable increases in farm incomes, food security and development;
II. adapting and building resilience of agricultural and food security systems to climate change at multiple levels; and
III. reducing greenhouse gas emissions from agriculture (including crops, livestock and fisheries).

CSA is an approach for developing agricultural strategies to secure sustainable food security under climate change. CSA offers the means to help stakeholders from local to national and international levels identify agricultural strategies suitable to their local conditions. CSA is one of the 11 Corporate Areas for Resource Mobilization under the FAO's Strategic Objectives. It is in line with FAO's vision for Sustainable Food and Agriculture and supports FAO's goal to make agriculture, forestry and fisheries more productive and more sustainable (www.climatesmartagriculture.org)

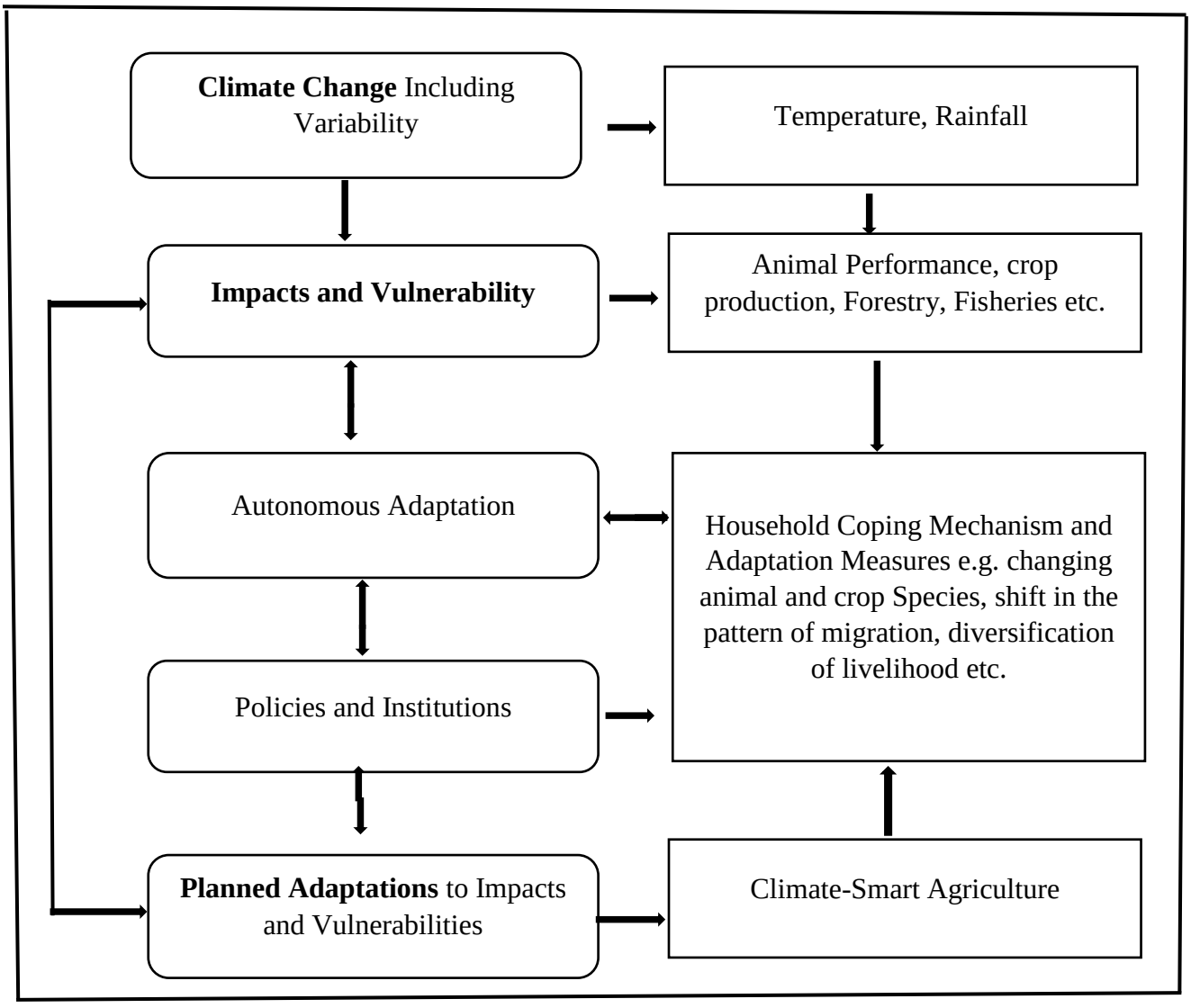

Figure 2.1: Conceptual framework showing steps involved in planned agricultural adaptation to climate change and variability

Source: Modified from Smit and Olga 2001; O'Brien, Nyaard and Schjolden2007.

2.4 Literature Review

2.4.1 Introduction

Climate change is now communally believed to be a foremost global problem. In regard to pastoralists, questions that arise are; what do pastoralists understand about climate change, how will climate change affect their livelihoods and how vulnerable are they to the negative impacts of climate change? To construct answers to these questions, this section reviews literature on climate change and vulnerability. It begins by looking at the definitions of climate, climate change and climate variability, pastoralists' perception of climate variability and change, then goes ahead to analyze its impacts on pastoralists' socio-economic system, pastoralists' climate change adaptation options, barriers to and determinants of effective adaptation measures. Literature on climate change impacts on pastoralists in developing countries including Nigeria is also reviewed.

2.4.2 The concept of climate

According to Wikipedia (2012), Climate is the statistics (usually, mean or variability) of weather, usually over a 30-year interval. It is measured by assessing the patterns of variation in temperature, humidity, atmospheric pressure, wind, precipitation, atmospheric particle counts and other meteorological variables in a given region over long periods of time.

In common parlance the notions "weather" and "climate" are loosely defined. The "weather", as we experience it, is the fluctuating state of the atmosphere around us, characterized by the temperature, wind, precipitation, clouds and other weather elements. This weather is the result of rapidly developing and decaying weather systems such as mid-latitude low and high pressure systems with their associated frontal zones, showers and tropical cyclones. Weather has only limited predictability. Mesoscale convective systems are predictable over a period of hours only;

synoptic scale cyclones may be predictable over a period of several days to a week. Beyond a week or two individual weather systems are unpredictable. “Climate” refers to the average weather in terms of the mean and its variability over a certain time-span and a certain area. Classical climatology provides a classification and description of the various climate regimes found on Earth. Climate varies from place to place, depending on latitude, distance to the sea, vegetation, presence or absence of mountains or other geographical factors. Climate varies also in time; from season to season, year to year, decade to decade or on much longer time-scales, such as the Ice Ages (FAO, 2008).

2.4.3 Climate change and climate variability definitions

Climate Change and Climate Variability are two vital characteristics of climate. They are among the most outstanding challenges facing the global community and as such have been given different definitions by different authors according to their perception and the way it affects them (Ifeanyi-obi, Etuk and Jike-wai, 2012). According to a definition provided by UNFCCC, climate change is a change of climate which is attributed directly or indirectly to any human activity that alters the composition of the global atmosphere and which is in addition to natural variability observed over comparable time periods. On the contrary, climate variability is the departure from normal or the difference in magnitude between climatic episodes(UNFCCC, 2012) . For Ozor(2009), climate change is a 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. Thisdefinition elicits the seriousness of the danger posed by climate change and the urgency of the need for countriesto rise up to this urgent clarion call of combating the negative effects of climate change.Consequently, climatic variations are ascribed principally to natural processes, while the observed climate change is largely attributable to

anthropogenic causes. There is no gainsaying the fact that the two phenomena are already taking place in Nigeria and their effects are being felt (Usman, Yelwa, Gulumbe, and Danbaba, 2013). Instructively, the climatic factors of greatest economic and social significance are temperature and rainfall with the latter, stimulating more concern than the former.

In keeping with Oluwasusi and Tijani, (2013), climate change is often used synonymously with climate variability and yet the two are different. Climate change refers to the long-term significant change in the "average weather" that a given region experiences, while climate variation refers to variation in the mean state and other statistics of climate on all temporal and spatial scales beyond that of individual weather events (IPCC, 2007; Adger, Huq, Brown, Conway and Hulme, 2003). Supporting the forgoing, Opole, (2013) maintained that while Climate Change is definedas the difference between long term mean values of a climate parameter of statistics - where the mean is taken over a specified interval of time; usually a number of decades, climate variability includes the extremes and differences (usually termed anomalies) of monthly, seasonal and annual values from the climatically expected value (temporal mean).

Consequently, a number of important differences between climate change and climate variability can be explored. Climate change is a significant and lasting change in the statistical distribution of weather patterns over periods spanning from decades to millions of years, while climate variation is a short term fluctuation in weather patterns spanning from years to decades. Climate variability is the resultant effect in the alterations of ecosystem structures to satisfy human land use and livelihood potentials of the human race. Effects of climate variation are physical, economic, social and cultural, endangering environmentally based livelihoods of the Nigeria

population. Climate variability have direct impacts that cause vulnerability to the natural and social systems through changes in average temperatures, temperature extremes and extreme weather events like flooding and droughts.

Therefore, Adger, *et al*., (2007) hypothesized that climate variability, poor infrastructure, economic poverty, drought, excess rainfall, poor livestock health, reduced crop yields, low productivity and a range of other problems resulting from climate variability will constitute important challenges for African countries particularly. The effect of climate variation is being felt by the whole population but, it will disproportionately affect vulnerable groups and vulnerable population (Lobell, *et al.*, 2008)

2.4.4The concept of adaptation

The concept of adaptation as used in geography comes close to the notion of natural milieu, which implicates the integration of the physical to the social and of the natural to the cultural. This notion first developed in a determinist sense in its relation with living beings before integrating a complex vision, interdisciplinary and systemic (Blanc-Pamard, 2007). The contributions on geographical distribution and the influence of the milieu on the populations appeared in the 18th century in the wake of maritime exploration. The explanatory argument was of divine intent, which has "always welcomed environmental theories because both systems rest on the concept of adaptation" of the living to its environment (Glacken, 2005).

The idea of a humanity that modifies its milieu (by collective action, according to A. Comte) appeared in the 19th century, creating the notions of natural or transformed landscape. Just as in biology, the concept of adaptation in geography was debated during an epistemological analysis that was guided by reflections on the importance to be given to mankind in nature. Several

authors focused on the influence of the milieu on mankind, his culture or his character traits. The behaviorism marked the extreme: the milieu, endowed with a powerful influence, dominates the heredity and the genetics of the individual; behaviors are neurobiological responses or adaptations to stimuli of the milieu. The limits that the environment imposes on life are also evoked. The acceleration of technical progress on the extraction of resources, knowledge on the transformations of nature, and then on evolution, precipitated the emergence of a multi-disciplinary study of the relation of man/nature (Moran, 2000). A geography that integrates human beings emerged to counterbalance the physical geography that prevailed (Reghezza, 2007).

In the United States, links wove between ecology and geography touched the different schools of thought of the 20th century. The 1920s saw an urban sociology that was formed to study the relation between man and his urban environment that had become man's natural environment in society (Philifert, 2007). The Chicago school of geography borrowed the concept of adaptation to geography to define it as the fruit of deliberate choice, so as to escape the constraints of the milieu, thus distancing itself from biological determinism descended from natural selection and leaning more on the notion of adjustment: the object of geography is the adjustment of man to the environment and not to the influence of this environment (Reghezza, 2007). Henceforth, this notion of adjustment, an occasional response to a punctual event, strayed from the concept of adaptation, a long drawn out process, the capacity of which allows the reduction of the vulnerability of social systems faced with any crisis (Burton et al., 1993).

In the 1960s, research into natural disasters questioned the interactions between the social system and environment, as well as the social response, when faced with a risk. The interdisciplinary

works were orientated towards the analysis of adaptation of populations to the natural risks by the capacity to face and respond to them, the study of the choices of engineers in public politics, and the analysis of the influence of perceptive and cognitive factors, as well as the elaboration of the concept of vulnerability. Recently, a geography of adaptation was mentioned by Mainguet (2003) during his studies on the importance of man in dry environments, whereas Pumain (2007) defined cities as many complex and evolving objects that are endowed with a remarkable capacity for adaption and transformation.

2.4.5 Climate change adaptation

Climate Change Adaptation is a very broad concept, and different authors defined adaptation differently. For instance, Burton(1992) defined climate change adaptation as the process through which people reduce the adverse effect of climate on their health and well-being, and take advantage of the opportunities that their climatic environment provides. According toTemesgen, Yehualashet and Rajan (2014), adaptation is a term used to describe all activities aimed at preparing for or dealing with the impacts of climate change,be it at the level of individual households, communities and firm,or of entire economic sectors,watersheds and countries. Stakhiv (1993) uses the term adaptation to mean any adjustment, whether passive, reactive or anticipatory, that is proposed as a means of ameliorating the anticipated adverse consequences associated with climate change. On the other hand, the IPCC (2001b) defines adaptation as adjustments in ecological, social or economic systems in response to actual or expected stimuli and their effects or impacts. This term takes into account changes in processes, practices and structures to moderate potential damages or to benefit from opportunities associated with climate change. Hence, the word adaptation is broadened to include adjustments to decrease the vulnerability of communities, regions, and nations to climate variability and change and in

promoting sustainable development. A summary of the definitions of adaptation is given in Table 2.1.

Table 2.1: Summary of Adaptation

Definitions Source	Definition
Burton *et al* (1992)	refers to all those responses to climate change that may be used to reduce vulnerability.
Burton, (1992)	Adaptation to climate is the process through which people reduce the adverse effects to climate on their health and well-being and take advantage of the opportunities that their climatic environment provides
Downing *et al*, (1997)	Adaptation is synonymous with "downstream coping"
Fusel and Klein, (2002)	All changes in a system, compared to a reference case, that reduce the adverse effects of climate change.
IPCC, (2001)	Adjustment in ecological, social, or economic systems in response to actual or expected climatic stimuli and their effects or impacts. This term refers to changes in process, practices, or structures to moderate or offset potential damages or to take advantage of opportunities associated with changes in climate. It involves adjustments to reduce the vulnerability of communities, regions, or activities to climate change and variability.
Pielke, (1998)	Refers to adjustment in individual, group and institutional behaviour in order to reduce society's vulnerabilities to climate.
Rennie and Singh, (1996)	Adaptive strategies are ways in which local individual, households and communities have changed their mix of productive activities, and modified their community rules and institutions in response to vulnerabilities, in order to meet their livelihood needs.
Scheraga and Gramsch,(1998)	Adaptive actions are those responses or actions taken to enhance resilience of vulnerable systems, hereby reducing damages to human and natural systems from climate change and variability.
Smit, (1993)	Involves adjustments to enhance the ability of social and economic activities and to reduce their vulnerability to climate, including its current variability and extreme events as well as longer term climate change.
Stakhiv, (1993)	Means any adjustments, whether passive, reactive or anticipatory, that is proposed as a means for ameliorating the anticipated adverse consequences associated with climate change.

Source: Oladipo, 2012

2.4.5.1 Nature and purpose of adaptation

In essence, the goal of climate change adaptation is to build the resilience of communities to diverse kinds of vagaries in their environment. According to Adger (2001) resilience is the capacity to maintain competent functioning in the face of major life stressors. For Easterling, Hurd and Smith (2004), the foregoing definition demonstrates the capacity of human systems or entities to bend without breaking in the face of disturbance and, once bent, to spring back to its pre-disturbance steady state. Consequently, Folke, *et al.* (2002) submitted that contrary to natural ecosystems, human systems have the capability of foreknowing and adjusting to potential environmental changes. This presupposes that once a social or ecological entity loses resilience, it becomes more susceptible to changes that hitherto could be absorbed and adapted to. Basically, sustainability of human beings in the world is closely allied to resilient socio-ecological systems, which is in turn subject to human capital and institutional arrangements (O'Brien, *et al.*, 2012).

Thus, Acquah (2011) asserted that adaptation to climate change has the potential to considerably lessen quite a number of the adverse impacts of climate change, moderate vulnerabilities and enhances sustainable development through improving the well-being of the underprivileged members of society. This could be achieved through the enhancement of food security, boosting access to safe water and shelter, growth in income and promoting sustainability of prevailing resources. Consistent with the foregoing, Stern (2007) highlighted that adaptation to climate change is crucial as it allows farmers to offset the anticipated negative impacts of climate change. Furthermore, Bryan, Deressa, Gbetibouo and Ringler (2009) reiterated that adaptation can protect the livelihoods of poor farmers and ensure food security.

Basically, adaptation is a means of decreasing exposure, boosting resilience, curbing the risk of climate impacts on lives and livelihoods, and taking advantage of prospects posed by actual or expected climate change.

Essentially, the broad use of the term 'coping' is sometimes equated with 'adaptation'. As stated by Okumu, (2013), the expressions "coping" and "adaptation" are frequently used interchangeably to reflect techniques for adjustments to changing climatic and environmental conditions. However, it is pertinent to note that the two are linked to different time scales and denote different processes (Eriksen, O'Brien and Rosentrater,2008). They reiterated that while coping is a short term reactive response to climate variability, adaptation is allied with longer time scales and points at adjustments as vital changes of the systems practices, processes or structures to changes in mean conditions. However, Smit and Wandel (2006) noted that with adaptations, new coping range is established. Hence, Anderson, Morton and Toulmin (2010) remarked that coping strategies maybecome adaptive strategies when people are forced to use them over a run of bad years and across seasons rather than just at the worst time of the year. Moreover, the way families handle crises can either boost or restrain the future coping strategies, along with their potentials to adapt in the longer term (O'Brien *et al*., 2012).

2.4.5.2 Types of adaptation

Depending on its timing, goal and motive of its implementation, adaptation can either be reactive or anticipatory, private or public, planned or autonomous (Klein *et al*.,1999). Adaptations can also be short or long term, localized or widespread (IPCC, 2001b). Adaptation types have been distinguished on the basis of several characteristics(Okumu, 2013). Smith and Olga(2001) stated thatforms of adaptation normally differ depending on purposefulness and timing.Thus, the IPCC (2007) identifies three forms of adaptation: First, we have what can be called autonomous, or

spontaneous adaptations. These forms of adaptations occur in reactive response to actual manifestation of the impacts of climate change without the intervention of public policy. The second is referred to as anticipatory, or proactive adaptation, which takes place before the impacts of climate change are evident. The Third form is planned adaptation.It is based on an awareness that conditions have changed or are about to change and that action is required to return to, maintain, or achieve a desired state. Nevertheless, because of institutional limitations, planned adaptation has been relaxedin many developing countries, and residents are most in danger of interrupted agricultural production(Maddison, 2006) (Maddison, 2006).

Furthermore, Smith (1996) found that planned adaptations are intervention strategies, while, autonomous adaptations happen naturally without interventions by public agencies. Based on the aforementioned, it can be deduced that autonomous and planned adaptations are generally associated with private and public adaptation respectively. Yet, it is the autonomous adaptation that forms a standard for assessing the need for planned anticipatory adaptation (Smith and Olga, 2001).

In a nutshell, given the various conceptions of different authors, adaptation to climate change in this study is taken to mean adjustments made by community and individual in reacting to the fluctuations in climate over time with the purpose of curbing adverse impacts or boosting the coping capability of community and individual. Therefore, the understanding of adaptation perceptions forms a baseline for appraising and ascertaining effects of climate change. This is because farmer's ability to perceive is a key precondition to choosing the appropriate adaptation measures so as to ameliorate negative impacts of climate changes, moderate considerably the inherent vulnerability and risk for human, environment and nature in climate change situation.

2.4.5.3 Levels of agricultural adaptation

Kandlinkar and Risbey (2000) have identified two phases of agricultural adaptation. In their analysis, adaptation occurs at two main levels i.e. the farm-level and macro-level. Farm level adaptation focuses on micro analysis of farmer decision making, whereas the macro level deals with national agricultural production and its connections with domestic and international policy. Furthermore, Okumu (2013) deduced that farm-level decisions are made within a short-range and usually in reaction to seasonal climatic shifts. Consequently, they are usually determined by socioeconomic variables such as household characteristics, household resource endowments, access to information and availability of formal institutions., however, macro-level analysis is long-term strategic national decisions and policies made in response to long-term changes in climatic and market conditions.

2.4.5.4 Common adaptation strategies

The most common adaptation approaches in agriculture comprise changing crop varieties, irrigation, planting trees, crop diversification, soil conservation, early and late planting, increasing plant spacing, use of clay soil, and adjusting the level and timing of applying fertilizer (Bradshaw, Dolan and Smit, 2004; Nhemachena and Hassan, 2007). However, with respect to pastoralism, Sanjit, et al. (2014) itemised popular adaption options pursued by pastoralists to include:

I. Change in Migration Pattern: Intuitively,migratory pastoralism is an adaption to a harsh and unstable environment, and pastoral herders have traditionally adapted to environmental and climatic change by building on their in depth knowledge of this environment (Joshi *et al.*,2013). However, owing to sedentarization and expansion of cultivated land, the amount of grazing has been drastically reduced forcing pastoralists to vary their pattern of migration.

Livestock mobility facilitates opportunistic grazing mangement strategies that pastoralists' employ to counter environmental variability in rangelands. One of such is moving livestock to temporary camps that are closer to areas of underutilized forage during times of drought.

II. Herd Diversification: Recurring droughts have induced many pastoralist groups in Africa to raise more drought-tolerant livestock as a coping strategy. Hence, Opiyo*et al.,* (2015) contended that diversification of herd composition benefits from the varied drought and disease tolerance as well as fecundity of diverse livestock species. Boru, Schwartsz, Kam and Dengen (2014) asserted that livestock diversification would vary according to geographic location (drought severity and proximity to an urban centre) and resources available (wealth, labour).

III. Portfollio Diversification:Diversification is routinely promoted to improve poor rural people's livelihoods. Rural livelihoods diversification is generally accepted as desirable and a key focus of poverty reduction strategies in developing countries. Ellis (2000) holds that livelihood diversification is the process by which rural households construct an increasingly diverse portfolio of activities and assets in order to survive and to improve their standard of living. While a considerable body of empirical evidence indicates that diversification can facilitate improved standards of living, the association from livelihood diversification to increased incomes or other manifestations of higher quality of life is not automatic. However, diversification is now generally expected bygovernment and donor policymakers to be necessary for the rural poor.

IV. Feed supplemetation:Production of pasture and fodder grasses is low in the semi-arid regions of Nigeria's rangelands as a result of unreliable and low rainfall regimes. Consequently, a sustainable livelihood in the region is endangered by climate change as a

result of frequent droughts and erratic rainfall. Technologies meant for increasing rural communities' resilience are required to support their capacity to adapt and respond to new hazards. Pastoralists in most cases depend on crop residue during scarcity,it is only when it is exhausted that herdsman opt for other strategies like purchase of feeds and movement of animals to distant grazing lands.

V. Water harvesting. Many areas that experience drought, also have excessive rainfall during the rainy season. If the rain is saved, it can provide enough water for animals to drink throughout the dry season. Capturing this water and storing it as surface water is called rainwater harvesting.

VI. Adoption of drought tolerant and disease resistant species of animals: Climate change leading to adverse changes in temperature, precipitation and sea level will disturb the food, water and livelihood security systems. Hence, checkmating the adverse impact of unfavourable weather is highly imperative. Biotechnology has helped to increase livestock productivity by introducing such qualities as disease resistance and increased drought tolerance to the animals.

However, Nze and Eboh (2010) recommended other relevant adaptation strategies that can be adopted in addressing agricultural failures due to climate change in the country. They include among others:

I. Provision of Accurate and Timely Weather Forcasting: A key element of poor animal performances and low productivity is poor status of weather forecasting for the country. It is important to note that timely and accurate weather forecasting are vital to improving faming activities. This would require developing human capacity and appropriate

infrastructure for weather forecasting and information sharing. Responsible agencies are the relevant research institutes and their extension arms. The option is of very high priority in every part of the country.

II. Enhancing agricultural extension: Agricultural extension officers have significant roles to play in improving farm productivity. They are trained to link farmers with scientist working on how to improve farm operations. They also help farmers to deal with difficulties that they may have on the field. In adapting to climate variability and change, this category of professionals would need to be further developed and empowered to function effectively. They would for instance be relevant in providing weather information based on local and indigenous knowledge and information about adaptive efforts that are working elsewhere.

III. Control of pests and diseases: pests have been real threats to harvests from time past.Climate change is likely to aggravate their impacts. For pests attacking crop plants and animals on the farm, early detection of their breeding sites is critical in controlling the pests before the swarms begin to move. There are biological, mechanical and chemical methods of controlling pests and diseases. The biological method if carefully selected is generally more effective and environment friendly.

IV. Helping herders to secure agricultural insurance: The insurance sector has a major role to play in the nation's effort to build resilience to climate change. The sector should be strengthened and supported beyond the recent recapitalization to assist individuals particularly farmers to cope with the adverse effects of climate change such as crop failures, damages to farms and crops and loss of life.

In addition, Agrawal and Perrin (2009) identified five major livelihood adaptation strategies in the context of policy and climate variations in the semiarid pastoral regions: mobility, storage, livelihood diversification, communal pooling, and market exchange. The studyexpatiated on these livelihoods that mobility used to be the most common adaptation strategy in pastoral areas, and it can pool risks across space. The storage of forage, water, and food can pool climate risks over time. Livelihood diversification reduces climate risks across various assets owned by local households or collectives, and it includes diversification in consumption structures and employment opportunities. Communal pooling spreads risks across people in local communities, and it usually involves sharing labor, assets, income, and resources. Market exchange is an important strategy when communities have accessibility to markets. According to the study, depending on the variations in local biophysical, socioeconomic, and institutional contexts, households may implement diverse combinations of the five livelihood adaptation strategies.

Consequently, Bryan, Deressa, Gbetibouo and Ringler (2009) identified three dynamics that guide agriculturalists' choices of adaptation. These consist of household characteristics, institutional factors and social capital. Household characteristics comprise age, education, gender, household size, farm size, farming knowledge and wealth. Institutional factors entail access to extension services, climate information, access to credit, off farm employment opportunities and land tenure. Social capital consists of farmer-to-farmer extension and the number of close relations. The aforementioned variables are determining factors of farmers' adaptation options.

2.4.5.5 Barriers to climate change adaptation

Philip, Andrew and Lindsay (2013) have acknowledged that in spite of the international importance attached to climate change adaptation, there exists a dearth of knowledge regarding the basic barriers that inhibit the actual operation of adaptation strategies by households across

sub-Saharan Africa(SSA). They researchers further contended that enhanced knowledge of the susceptibility of agriculture-reliant households to climate variability necessitates investigation of the barriers that restrain the implementation of adaptation strategies. This is because the existing empirical evidence on barriers to climate adaptation in SSA is highly fragmented and context-specific. According to Moser and Ekstrom (2010), barriers are defined as factors, conditions or obstacles that reduce the effectiveness of adaptation strategies. Hence. Yesuf, Falco, Deressa, Ringler and Kohlin (2008) and Deressa, Hassan, Ringler, Alemu and Yesuf (2009) asserted that the main barriers to adaptation include lack of information, lack of access to credit and land, and water shortages. In the same vein, Philip, Andrew and Lindsay (2013) suggest that households are constrained by a range of barriers to climate change adaptation, the most important of which included financial barriers, institutional barriers and a lack of information on climate change characteristics.

2.4.5.6 Determinants of Adaptation strategies

Maddison (2006) and Gbetibouo (2009) have identified a variety of household and farm characteristics, institutional factors, and local climatic and agro-ecological conditions as the key determining factors of the speed of adoption. In effect, the adaptation decisions taken by most farmers are not merely those that boost adaptive capacity and promote climate resilience, but also those that will address conservation of natural and environmental resources. Therefore, Deressa *et al.* (2009) and Nhemachena and Hassan (2007) have found that the household characteristics which have substantial influence on adoption decisions composed of age, education level, gender of the head of the household, family size, years of farming experience, and wealth. As a result, Gbege and Akubuilo (2013) acknowledged that the age of a farmer may positively or negatively influence the decision to adopt new technologies. It is instructive to note

that older farmers have more experience in farming and consequently have a higher probability of adopting modern technology than younger farmers. Contrariwise, Adesina and Forson (1995) posited that older farmers could be more reluctant in taking risk and more resistant to changes than younger farmers. This may probably decrease the probability of undertaking new technologies. Similarly, Marenya and Barrett (2007) noted that since younger farmers have inadequate experience, the cost of changing to new farming practices would be greatly minimized.

Furthermore, it is apparent from adaptation literature that education and human capital endowments increase the chances of implementing new technologies. The preceding view is supported by Nkonya, et al. (2008) who acknowledged that education and human capital endowments increase farmers' ability to perceive climate change. Similarly, Adesina and Forson (1995) and Gbegeh and Akubuilo (2013) have found that education empowers households to access and conceptualize information relevant to making innovative decisions. Though, higher educational attainment can inhibit adoption for the reason that it offers alternative livelihood strategies, which may compete with agricultural production(Okumu, 2013).

In terms of gender, Gbetibouo (2009) has noted that the influence of gender of the household head on choice of adoption is locale specific. It has been generally observed that in various parts of Africa, womenfolk are often deprived of property rights owing to social barriers (Gbegeh and Akubuilo, 2013). As a result, they tend to have lesser capabilities and resources than men (Marenya and Barrett, 2007; Gbegeh and Akubuilo, 2013). This has in no small measure weakened their capacity to adopt labour-intensive agricultural innovations. In opposition, Nhemachena and Hassan (2007) and Gbetibouo (2009) reported that female-headed households

are more likely to take up climate change adaptation measures. The likely reason for this observation is that in most rural smallholder agricultural communities in Africa, more women than men live in rural areas where bulk of the agricultural work is done. In view of this, Nhemachena and Hassan (2007) submitted that women tend to acquire more farming experience and information on various management practices depending on existing information on climatic conditions and other factors such as markets and food needs of the households.

As regards asset endowments and wealth, Nkonya*et al*. (2008) and Gbetibouo, (2009) found out that they have a major impact on the capability of smallholder farmers to undertake certain technological practices. Thus, Shiferaw and Holden (1998) upheld that households with higher income and greater assets are less risk averse than lower income households. This places household with higher income at an advantaged position to adopt new farming innovations. Moreover, the effect of household size on the choice of adaptation strategy is ambiguous. As Marenya and Barrett (2007) aptly stated 'household size is a function of labour availability, which may perhaps influence the adoption of a new technology positively as its availability reduces the labour constraints. In the same vein, Nkonya*et al*. (2008) observed that since the greater proportion of labour for most farm activities in sub-Saharan Africa is provided by the family rather than hired, it the follows that inadequate family labour coupled with inability to employ labour can really constrain adoption practices. On the other hand, Tizale (2007) and Gbetibouo (2009) held that households with several family members may be required to divert part of the labour force to off-farm activities. This could be with the intent of earning more income to ease the consumption burden imposed by a large family size.

Farm size and Soil fertility are among the farm characteristics that could influence the adoption decisions. Basically, farm size influences both the access to information and the adoption

decisions. Marenya and Barrett (2007) suggested that more crop land is likely to boost the information exposure to site-specific crop management technologies since these skills would likely be promoted by larger farms. In addition, Gbetibouo (2009) and Gbegeh and Akubuilo (2012) considering the uncertainty and the fixed transaction and information costs associated with innovation, postulated that there may be a critical lower limit on farm size that prevents smaller farms from adapting. Thus, large mechanized farms will possibly be the earliest to adjust to climate change.

Institutional factors that that have effects on implementation of new technologies comprises access to credit, information provision, off-farm employment, and land tenure. There is no doubt that Institutional reinforcement through access to formal and informal institutions and meteorological capability intensifies the probability of uptake of adaptation techniques. Hence, households with access to formal agricultural extension, farmer - to - farmer extension and information about impending climate change are more likely to modify their farming practices in reaction to climate change (Smit*et al*., 2001; Mariara andKaranja 2007; Yesuf*et al*., 2008; Nkonya*et al.*, 2008).

Besides, farmers with access to extension services are likely to perceive changes in the climate because they have information about climate and weather changes (Gbetibouo, 2009). Though, certain information sources can be more effective "change agents" than others and several information bases can impact on the likelihood of adoption in different ways (McBride andDaberkow, 2003). In the same way, it is to be noted that diverse sources of information can become effective during different phases of adoption process. For instance, the mass media plays vital role in the early awareness period, while interpersonal information sources like extension officers and other farmers are essential in the transfer of more technical and adoption-promoting

information. Though, technical information from extension services is considered most imperative to the prospective adopter, the extension-farmer links are very weak in some parts of Sub-Saharan Africa and consequently, most agricultural information is acquired by means of farmer-farmer contacts (Adesina andForson, 1995). This underscores the fact that farmers are also vital sources of technology information as well as agents of technology transfer. Various studies have also indicated that adoption technologies run through social networks, and do not essentially spread on account of geographical proximity (Maddison, 2006). As a result, prospective extension ought to involve farmer cooperatives in investigation process and on-farm trials for various assessments and demonstrations. This will enable the trained farmers to diffuse the adoption technologies diversity of farm condition could make it hard to make available government extension (Pannell, 1999)

It is noteworthy that under conditions of imperfect credit, studies have revealed that smallholder farmers and resource users will embrace certain conservation practices (Reardon andVosti 1995; Gbetibouo, 2009). This is owing to the fact the adoption of new technologies necessitates loaned or owned capital. Therefore, low borrowing capacity may possibly impede some efforts to embrace adaptation measures that involve substantial investment upfront such as irrigation, terracing, tree planting and fertilizer use.

The prevailing system of property rights is another institutional element conditioning the adoption of adaptation technologies (Gbetibouo, 2009; Shiferaw, Okello and Reddy, 2009). Instructively, tenure security can influence adoption of technologies that have linkage to land e.g. irrigation equipment or soil conservation practices. Farmers may be unwilling to invest their time and money if they cannot capture the full paybacks of their savings. This situation may perhaps

prevail when they have doubtful rights to land or when the natural resource is run by open access property regime.

2.4.6 Climate change perception

The term perception is generally understood to mean an attitude or understanding based on what is observed or thought. Perception (from the Latin perceptio, percipio) is the organization, identification, and interpretation of sensory information in order to represent and understand the environment. All perception involves signals in the nervous system, which in turn result from physical or chemical stimulation of the sense organs.Perception can as well be defined as our recognition and interpretation of sensory information. Perception also includes how we respond to the information. We can think of perception as a process where we take in sensory information from our environment and use that information in order to interact with our environment. Perception allows us to take the sensory information in and make it into something meaningful (Wikipedia, 2010)

Ban and Hawkins (2000) use the term 'perception' to refer to the process by which we receive information or stimuli from our environment and transform it into psychological awareness. It is instructive to note that individuals understand certain situations or phenomena in different ways using very similar or dissimilar sets of information. Hence, Banjade (2003) opined that knowledge, interest, culture and many other social processes can shape the behaviour of an actor who uses information and attempts to influence that particular situation or phenomenon. A further definition is given by Saarinen (1976) who describes perception as an extremely complex concept. He identified 'social perception', which he termed the effects of social and cultural factors on cognitive structuring of our physical and structural environment. Therefore, Saarinen (1976) and Banjade, (2003) have shown that perception varies with the individuals' past

experiences and present sets or attitudes acting through values, needs, memories, moods, social circumstances, and expectations. In the same way, Whyte (1977) maintained that man's decisions and actions concerning his environment are based not only on objective factors, but also on subjective ones.

Hence, Ovuka and Lindqvist (2000) noted that human perceptions of climate, its variability and its potential change have become an important challenge in understanding climate–society interactions, as more attention is given to studies of human adaptation to climate change. Consequently, Meze-Hausken (2004) have established thatpeoples' subjective observations of climate may be confirmed by statistical data, but extreme events may sometimes be interpreted as a confirmation of ongoing human induced climate change. She further stressed that perceptions of climate change may wellbe influenced by the overlooking of other social and environmental factors such as deforestation, population growth, or soil erosion. This would result in crediting specific impacts to climatic causes instead of to the actual causes, which are usually an amalgamation of climatic, environmental and social factors.

According to Adger, *et al.,* (2009) and Pauw (2013), perception has intense impact on how farmers respond to climate-induced risks and opportunities as well as the precise nature of their behavioural reactions to this awareness will shape adaptation options. This includes the process involved and adaptation outcomes. As a result, Grothmann and Patt, (2005) admitted thatmisconception about climate change and its associated risk may end in no adaptation or maladaptation, ensuing increase in the negative impact of climate change. Additionally,Debela, Mohammed, Bridle, Corkrey and McNeil, (2015) have found out that perception of climate change among rural communities is driven by multiple forces. Supporting the forgoing view,

Deressa, Hassan, and Ringler (2011) asserted that different households and farm factors influence whether and to what extent farmers perceive climate change and its impact on local agriculture. For instance, the age of a subsistence farmer is closely correlated with farming experience plus their accumulated knowledge of the environment, which includes changes in climatic conditions (Juana, Kahaka and Okurut, 2013; Patt and Schröter, 2008). Similarly, Mustapha, Sanda and Shehu (2012) revealed that studies conducted in African smallholder farming systems have shown that the level of formal education reached by farmers influences their aptitude to perceive climate change and its impact. Moreover, Ndambiri, *et al*.(2012) stressed that homes with many members are more likely to engage in non-farm income generating activities. This isbecause non-farm income cushions against financial losses from farming, hence, householders are less likely to perceive climate change. Also, Maddison (2007)noted that accessibility to support services such as extension services and climate information is alleged to increase farmer perception of climate change and its associated risks.

2.5 Livestock Production and Climate Change in Developing Countries

A vast amount of literature is pointing to the fact that climate change does affect livestock production and livestock systems. For example, Thornton (2010) contends that the biggest impacts of climate change are going to be seen in livestock and mixed systems in developing countries where societies are at present highly vulnerable. Hence, the need to adapt to climate change and to mitigate greenhouse emissions will certainly increase to the costs of production in diverse places and the estimated growth in bio-fuels may have considerable impacts on competition for land and on food security.

Accordingly, Naqvi and Sejian (2011) maintained that the livestock production system is sensitive to climate change and at the same time itself a contributor to the phenomenon.

Therefore, climate change has the likely hood of posing tough challenge to the development of the livestock sector. In responding to this challenge, there is the need for the formulation of appropriate adaptation and mitigation options for the sector. IFAD, 2011 remarked that livestock population will increase enormously over the next few years. Consequently, creating a database for GHG inventory are vital pointers to the studying of the future impacts of livestock on climate change. It is to be noted that in pastoral and agro-pastoral systems, livestock are crucial resources for people, as they provide multiple economic, social, and risk management functions. Some of the impacts that climate change and variability might possibly generate are intensifying the vulnerability of livestock systems and strengthening prevailing factors such as rapid population and economic growth, increased demand for food (including livestock) and products, increased conflict over scarce resources (i.e. land tenure, water, bio fuels etc.) that are concurrently distressing livestock production systems. The effects of losing livestock to rural communities is catastrophic. This is because it can lead to the collapse into chronic poverty with long-term effects on their livelihood.

In a similar vein, FAO (2008) pointed out that the resultant effects of climate change manifesting through high temperatures and changes in rainfall patterns, can be increased spread of existing vector-borne diseases and macro parasites of animals as well as the occurrence and spread of new diseases. It is instructive to note that climate change may also lead to new transmission models and these effects will be noticed by both developed and developing countries, however, developing countries will be most impacted owing to meagre resources, inadequate knowledge, low veterinarian and extension services and research technology development. Some of the unforeseen effects could manifest through changes in feed resources

connected to the carrying capacity of rangelands, the mitigating abilities of ecosystems, incessant desertification processes, unceasing scarcity of water resources, poorer production of grain etc.

Related studies indicated that climate change has an impact on livestock production. For instance, Abate (2009) established that drought and delay in the onset of rain led to poor regeneration of grass, water shortage and heat stress on livestock. The study further revealed that the drought and delay of rainfall led to increased mortality of livestock, susceptibility to diseases and physical exhaustion on account of long distance travel for water and pastures. Besides, Digambar (2011) asserted that climate change and variability manifesting through severe drought, has direct impact on the growth of appetizing grass species. He stressed further that replenishment of fodder species in pasture and forest fodder is declining due to reduction in rainfall ensuing shortage in diversity and quality of livestock fodder. Digambar (2011) reiterated that variability in climate has led to a decrease in livestock population which hasfurther affected production of milk, milk products and meat. The effect of drought on livestock is revealed by drying wetlands, pasture land, water resources, streams and diminishing availability of drinking water for livestock. Temperature rise led to outbreak of new borne diseases and scarcity of fodder led to change in livestock pattern (Digambar, 2011)

Pastoralism is a complex livelihood system seeking to maintain an optimal balance between pastures, livestock and people in uncertain and variable environments. Nori et al., (2008) stated that despite the important role pastoralism plays in supporting local livelihoods, in contributing to national and regional economies in some of the world's poorest countries, and in providing diverse ecological services, its capacity to adapt to change is facing many challenges, including those posed by climate change. The quality, quantity and spatial distribution of natural pastures are mainly shaped by rainfall. Predicted changes in rainfall patterns are bound to result in

increasingly scarce, scattered and unpredictable pastures (Baiand Bent 2006) There are also significant negative consequences including loss of livestock through heat stress or colder seasons; increase in animal pests and diseases; loss of land to agricultural encroachment as the rise in rainfallraises the productive potential of the dryland areas; an increase in frequency of flooding, and the spread of human and livestock diseases that thrive during the wet season; declined animal performance such as growth, milk production, and reproduction (Oxfam 2008; Elasha et al. 2007; Seo and Mendelsohn 2008; McDermott 2001; McCarthy et al. 2001; Thornton et al. 2006; Osbahr and Viner 2006).

2.6 Impact of Climate Variability On Livestock Production in Nigeria.

Ozor (2009) stated that livestock production systems in Nigeria would be vulnerable to climate change in respect of anticipated decrease in rainfall in the Sudan-sahelian zone and consequent reduction in the available pastureland. This he explained further by listing the various ways the anticipated decrease in rainfall will affect livestock as declining availability of surface water resources for animals, possible increase in salinity at water resources for animals, possible increase in salinity at watering points due to increase in temperature and evaporation in the face of reduced rainfall. This is to say that further changes in rainfall and temperature will affect livestock production as well as availability of animal species. Some species might be unable to adapt quickly enough and habitants might not be available for them to move into. If global temperatures rise by 2 degrees Celsius, 30 percent of all land-living species may be threatened by an increased risk of extinction. Though increase in temperature is generally seen to be destructive to the production of crops and human lives, FAO (2009) noted that livestock production could be boosted by temperature increase. Similarly, Nze *et-al.* (2010) maintained that the proliferation of pests and crop diseases (again originating with climate change) can

attack crops and animals. The current warming trend hinders livestock production and reproduction by reducing animal weight gain and dairy production. As well, livestock are usually subjected to long treks to find water and grass in the more southerly areas of the country during the dry seasons. Warming trends also affect the growth of/farming systems of grain crops such as maize, guinea corn, and rice, and makes storage of root crops and vegetables difficult. This in turn affects the availability of crop residues used as animal feeds. Supporting the aforementioned, Kim, Ikpe and Sawa (2015) stated that in the sub humid zone of Nigeria, infectious diseases continue to be the most common cattle health hazard. The principal ones are rinderpest, foot-and-mouth disease, and contagious bovine pleuropneumonia. These have led to the deaths of many livestock. Conversely, Deressa and Hassan (2009) found increasing temperature damaging to the Ethiopian agriculture; a situation that is not uniformly distributed across agro-ecological zones.Issa (2009) in agreement with the findings of Deressa and Hassan (2009) reported that commercial Livestock producers are negatively affected by rising temperature. This to say that varying climate has varying effects on crops and livestock depending on the agro-ecological location.

2.7 Empirical Studies On Climate Change Adaptation

Previous studies have investigated farmers' perception of climate change and variability, and their adaptation practices in the Sudanian and Sahelian zone of Africa. For instance, Mahmud et al., (2008) studied impact of climate change on food production in a typical low-income developing country. Their analysis relies on primary data from 1,000 farms producing cereal crops in the Nile Basin of Ethiopia. The thin plate spline method of spatial interpolation was used to interpolate the specific rainfall and temperature values using each household's latitude, longitude and elevation information. The study found that climate change adaptations, namely,

changing crop varieties, adopting soil and water conservation measures, water harvesting, tree planting, and changing planting and harvesting periods have significant impact on farm productivity.

Similarly, Deressa, Hassan and Ringler (2010) examined the perception of adaptation to climate change by farmers in the Nile Basin of Ethiopia. The study employed the Heckman sample selection model to analyze the two – step process of adaptation to climate change, which requires that farmers should first perceive that climate is changing and afterwards respond to it through adaptation. Results of the study indicated that age of the household head, wealth, information on climate change, social capital, and agro-ecological settings have significant effects on farmers' perceptions of climate change. Whereas, adaptation measures to climate change were greatly influenced by education of the head of the household, household size, whether the head of the household was male, whether livestock were owned, the use of extension services on crop and livestock production, the availability of credit and the environmental temperature.

Besides, Nhemachena and Hassan (2008) used a multinomial choice model to identify the factors that affect farmers' use of adaptation strategies in Africa. Data were collected from a cross-sectional survey of over 8000 farms from 11 African countries. Modeling results confirm that awareness of climate change is an important determinant of farm level adaptation while access to credit, market and free extension services significantly increase the livelihood of farmers adopting adaptation measures.

In addition,Nouhoun, Luc and Eva (2003) examined perception and adaptation strategies of pastoralists and agro-pastoralists across different zones in Burkina Faso using survey data and meteorological record. The study employed both descriptive statistics and logistic regression.

Results showed that farmers were partly aware of climate change, particularly of changes in temperature and rainfall patterns. Also, the most important adaptation strategies of agro-pastoralists were crop diversification, combination of cropping and livestock operations, use of water harvesting technologies and anti-erosive measures whereas strategies adopted by pastoralists included seasonal, annual and permanent migration and taking up of cereal cropping. However, logistic regression analysis indicated that agro-ecological zone, cultivated surface, ruminant herd size, household size and education were the most important variables affecting farmers' choice of adaptation strategies.

Also, Abaje, Sawa and Ati, (2014) investigated local peoples' perceptions on climate variability and change and strategies adopted in combating the impacts of the changes. Their analysis is based on primary data from 242 household heads in the eleven wards of Dut-sinma Local Government Area of Katsina State.Descriptive statistics such as frequency distribution, percentage and mean scores were used in data analysis. The study revealed that majority of the local people have a very good knowledge of climate variability and change in terms of higher temperature, higher rainfall intensity and variability, and the occurrence of extreme weather events such as flood and drought. Findings also revealed that sustainable adaptation strategies adopted by the local people were water harvesting, the use of fertilizer/animals dung to improve crop yield, irrigation agriculture, planting of crop varieties and drought resistant crops.

Assessments of previous studies revealed that emphasis were more on crop farmers. Though, crop farmers and pastoralists are two groups of rural producers,but they face different socio-economic circumstances, are differently vulnerable to and probably perceive and react differently to variations in climate and weather conditions (Nouhoun, Luc, and Eva, 2013). Hence, the lack

of adequate scientific knowledge about the impact of climate change on pastoralism is a limitation in planning for effective management of rangelands and sustainable development of the livestock industry.

Furthermore, results from most of the studies are highly aggregated and failed to capture the location specificity of smaller areas. Though, efforts have been made towards fighting climate change through scientific views, research and policies directed towards local knowledge and perceptions are highly needed.

2.8 Relevance of Materials Reviewed

Literature review on climate change adaptation showed that, adaptation to climate change is imperative for rural people. Rural producers can use it to increase their productivity, boost income and use the resources, on which they depend, in sustainable ways. Hence, adaptation to climate change is an issue of great importance to rural population, especially to pastoralists whose socio-economic activities are highly vulnerable to climate variations. Adaptation to climate change is influenced to a large extent by the level of understanding of climate change, how to adapt to it and climatic information exchange between farmers on the one hand, and a broad range of other actors on the other hand to plan effective adaptation activities.

CHAPTER THREE:STUDY AREA AND RESEARCH METHODOLOGY

3.1 Introduction

This chapter presents the study area and methodology employed in data generation and analysis. Statistical analysis usedwere both descriptive and inferential statistics.

3.2 Study Area

3.2.1 Location and size

The precise location of Zamfara and Katsina states is between latitude 10˚7' 50"N-13˚05' 38"N, and Longitude 6˚52'30"E - 9˚20'40"E and a total area of 62,610 km² (Patrick, 2012). Katsina State is bounded to the north by Niger Republic, to the south by Kaduna State, to the east by Kano and Jigawa States and to the west by Zamfara State. While, Zamfarais bounded to the North by Sokoto State, Kebbi and Niger States to the southwest, Kaduna State to the south east and Katsina to the east. Katsina State has thirty-four (34) Local government Areas, whereas Zamfara consists of fourteen (14) LGAs. See (Fig.3.1 and 3.2)

3.2.2 Physical setting

3.2.2.1 Relief and geology

Katsina and Zamfara States form part of the extensive plains known as the High Plains of Northern Nigeria. The states are composed of undulating plain which generally rise gently from 360m to 600m (Udo, 1970). Geologically, the State is characterized by very old igneous and metamori rocks, formed during the Precambrian Paleo; State era. Two rock types are found granites and metasediments. The granites (including undifferiated granites), gneisses and migmatites are lively resistant to erosion, but when weathered they result into poor soils.

The metasediments, on the other hand, consist of phyllites, quartzites and metaconglomerates. Although, metasediments are also resistant to erosion, if weathered, they give rise to more fertile soils on account of the fact that the schists are rich in magnesium minerals. In general, the relief of the State bears relationship to its geology. The States' land is made up of mainly the high plains (being part of the Hausa High Plains of Northern Nigeria) (Moretimore, 1989).

The only exception to this is the area extending northeastwards from TalataMafara ' and Moriki. Here can be found a dissected plateau crystalline rock composed of a series or range hills around Maru, as well as the characteristic and large, steep sided smooth dome shaped hills called, the inselbergs, exemplified by the Kotorkoshi Hill. Surrounding the inselbergs are plains which are used for farming. The general elevation of the land ranges from 244m to 366m above sea level (Udo, 1970)

3.2.3 Climate

The climate of Katsina and Zamfara states is fairly that of semi-arid continental zone. It is driven by two principal wind currents; one from the south-west which carries a high degree of moisture and clouds called rainy season and the other from the north bringing cool dry air dust and haze called dry season or harmattan. The moist wind begins to blow in May or from late June until October, within which the state receives its rainfall. Warm humid condition persists some weeks after the end of rainy season (Max Lock group, 1978). By November, the dry wind begins to blow, the atmosphere becomes dried (hot in the day and cold at night). By mid-December until mid-march, the dry wind blows with intensity day and night. This ushers in the chilling harmattan, lowering the temperature to a minimum of 12˚C. The hottest weather occurs

between late March and mid-May. The temperature in this period of the year increases daily to maximum of between 38˚C-39˚C (Patrick, 2012).

3.2.4 Drainage

Katsina state has been built on a spur of land between Ginzo and Tilla streams which flow in a north easterly direction and is at a narrow neck of watershed between the Gada and Tagwai river basins. (Ladan, 2014).Major rivers which originate in or traverse the states include; the Koza, Sabke, Tagwai and Gada systems in the northern half of the state (all flowing either north or northwestwards). Rivers in the south include the Karaduwa, Bunsuru, Gagare, Turami, Sokoto, Tubo, Chalawa and Galma rivers (flowing either North West, southeast or east).

However, all these river systems contain water in their channels only during the rainy season and have little or no water in the dry season. Among them, rivers Gada, Karaduwa and Sabke have been dammed mainly for irrigation purposes and the Dams are known as Jibia, Zobe and Daberam dams respectively (Adamu, 2002).

In Zamfara state, Zamfara river is the most prominent. The river takes it source from Funtua in Kastina State of Nigeria and passes through Gusau and Bungudu before getting to Maru and drains into Bakalori Dam in Maradun Local Government Area in Zamfara state. This river served as a major source of domestic water and food, where they fish during the raining season and during the dry season, they dig a well/ hole on the path of the river to get water. At its highest point the Zamfara River flows through an area that is 188 metres (617 ft) above sea level. There are various names for Zamfara river in different regions that it flows through. Some of the most common ones include GulbiGindi, GulbiZamfara, River Gindi, River Zamfara, GulbiGindi,

GulbiZamfara, and River Gindi. The river is at latitude 12°2'2.22" and longitude: 4°2'22.85" (Salawu, *et al.*,2014).

3.2.5 Soils and vegetation

Two major soil types ferruginous tropical soils and lithosols dominateZamfara and KatsinaStates. The ferruginous tropical soils can be found particularly around Gummi, Bukkuyum, Anka and Bakura. Other areas in which such soil occur include Talata-Mafara, Zurmi, Birnin-Magaji, Shinkafi and Kaura –Namoda in ZamfaraState. The soils are characterized by a sandy surface horizon, with clayey subsoil, both of which are fertile for agricultural production.

They are susceptible to erosion, since the top soil is easily washed off by rainwater, especially if the vegetation cover is removed. On the other hand, lithosols, usually associated with ferruginous soils, can be found towards the eastern part of Zamfara State, particularly in such areas as Tsafe, Gusau, Maru and Bungudu. The soil is not only of low agricultural productivity but are also susceptible to erosion.

In Katsina state, underlying rocks are overlain by sandy 'drift' deposits laid down during the last arid phase about twelve thousand years ago. In the Southern part of the state, the covering material is largely clayey soil, about five metres in depth and very fine in texture. The soils are difficult to work, tending to become waterlogged with heavy rains and to dry out and crack during the dry season. The characteristic crops of this area include: cotton, maize and guinea corn. In the north, the drift deposits are coarser, resulting in light sandy soils of buff or reddish colours of low medium fertility. These soils are easily worked and well suited to crops such as

millet and groundnut which are less demanding in their requirement than cotton, maize and guinea corn.

The vegetation of Katsina and Zamfara States consists of Sudan and Northern Guinea Savannah. The Sudan Savanna occurs in the western, northern and eastern parts of the States. Like in other parts of the country where this biome occurs, it is structurally characterized by woodlands, where grasses occur either totally or mixed with other herbaceous or shrubby plants. They are green in the rainy season with fresh leaves, but become dry during the dry season. To the southern part of the States, is found the Northern Guinea Savannah. This vegetation type is largely found in the safe Gusau and Anka LGAs in Zamfara state.

3.2.6 Ecological problems

Zamfara and KatsinaStates suffer from the perennial ecological problems of drought, desertification and the menace of pest invasion. These are experienced mostly in the northern part of the state. The marked fall in the level of underground water has also compounded the problem of sustaining the ecological balance in some parts of the state.

Soil erosion is also experienced particularly at the northern fringes which are under the threat of wind erosion as a result of desert incursion. Gully erosion is also present in Kayauki (Batagarawa LGA), Kusa and GurbinBaure (Jibia LGA) and Dan Rimi (Malurnfashi LGA) in Katsina State.

Drought is a product of drier climatic change which manifested itself conspicuously in the early 1970s as a result of the decline of mean annual rainfall in the northernmost states of Nigeria since 1965 (Mortimore,1989b). Desertification on the other hand, though partly accounted for by

drier climatic conditions, is largely as a result of Man's devastation of the vegetation for various reasons leading to soil degradation and desert intrusion.

The increasing menace of pest invasion is probably due to this climatic change, and desertification, which have brought about conditions favourable to the breeding of pests.

3.2.7 Historical Development

Katsina and ZamfaraStates were among the pre-jihad Hausa city states which was conquered and annexed into the Sokoto caliphate by MallamUrnmarunDallaji in the early part of the 19th Century. After the British colonial conquest in 1903, the erstwhile Katsina and Daura emirates became Katsina Province of the former Northern region of Nigeria (Abubakar, 2012). Later, Katsina and Zaria Provinces together formed the North Central State under the Gowon regime's twelvestate structure.North Central State was left intact in 1976 when the number of states was increased to nineteen under the new name of Kaduna State. Katsina State came into existence on the 23rd of September, 1987 covering the same area of the former Katsina Province of the defunct Northern Region. Whereas Zamfara state was created on 1st October, 1996 by General Sani Abacha, the then Nigerian Head of state.

Katsina and Zamfara are states in north-western Nigeria, which are predominantly Hausa Fulani ethnic group. Most people speak only Hausa. However, a sizeable number of otherlanguages like Yoruba, Igbo, etc., live in the state (www.Katsinastate-igac.com/history). A great majority of the people are settled cultivators and traders. But there areconsiderable numbers of nomadic cattle Fulanis, whose males' rear livestock, while the females hawk locally prepared fermented milk in towns and villages (Moretimore, 1989a). The states are predominantly Muslim communities. Though, there are some indigenesparticularly from Kafur and Malumfashi Local Government

Areas that practice the Christianreligion, while some practice traditional religion *(maguzanci).* According to National Resource Development (2003), the states possesses a large livestock population mainly made up of cattle, goats and sheep. There are many traditional cottage/craft industries which produce a wide range of highly qualitative, beautiful and aesthetically important products. On sallah days, the palaces of Katsina and Daura attract both local and foreign tourists who come to watch the colourful durbar (Mortimore, 1989).

According to 2015 projected population figures, Katsina state has a population of 7,599,868 persons. Out of this figure, about 49 per cent are males and 51 percent females. On the average, there are 189 persons living per square km in terms of the density of population. Seasonal migration takes place, especially of able bodied males in the dry season to the southern part of the state in search of part time jobs. This is known as *cinrani*. In drought years, many more people tend to migrate southwards from the northern part of the state on either temporary or permanent basis to avoid the consequence of the drought menace. Indeed, the southern part of the state receives migrants from both within and outside the state.

The states have no problem of urban primacy. The urban, semi urban locations and nodal villages which more or less approximate to the present headquarters of the thirty-four and fourteen local government areas are evenly spread and are surrounded by other rural settlements. These two types of settlements form close knit economic, cultural, administrative and historical inter-relationships. Furthermore, each has a fairly long historical link with Katsina city which has subsequently served as the headquarters of Katsina Emirate, then of Katsina Province, and now the capital of Katsina state.

3.2.8 Infrastructural Facilities

3.2.8.1 Education

Katsina State has a total enrolment of over 430,000 pupils in 1,792 primary schools with a staff strength of 11,716 teachers, in the area of post primary education, the state possesses various categories of secondary schools numbering 107 with a total enrolment figure of 74,722 students and a staff strength of 2,071 teachers. The Ministry of Education administers the institutions through seven zonal offices (stationed in Katsina, Daura, DutsimMa, Malumfashi, Kankia, Funtua and Mani towns) and the Board for Technical Education.There are two federal unity secondary schools namely the Federal Government College, Daura and Federal Government Girls' College, Bakori. The institutions of higher learning include the Federal University, Dutsima, the Federal College of Education and the Katsina Polytechnic, all located in Katsina town. The state College of Education (Technical) at DutsimMa; the College of Administration at Funtua town; the School of Nursing and Midwifery at Katsina; and the School of Health Technology each at Kankia and Daura towns, and the Health Auxiliary Training School, Funtua.

In addition, the state has a school each for the blind and the deaf. There are numerous educational institutions which are community based or privately/commercially run. They range from nursery, primary, postprimary and tertiary institutions.There are also many categories of Islam based institutions. The most notable include the Riyadul Quran (nursery/primary school) and the Othman Danfodiyo Institute which is a certificate and diploma awarding institution affiliated to the UsmanuDanfodiyo University, Sokoto.

ZamfaraState, on the other hand, had 1,160 primary schools (both public and private) as at September 1999 with total enrolment of 299,915, made up of 217,643 males (or about 72.6 per

cent) and 82,272 females (or about 27.4 per cent). Only six LGAs have total enrolment exceeding 20,000 with Gusau, TalataMafara, KauraNamoda topping the list with total enrolments of 42,416, 25,254 and 23,831 respectively.

Zamfara state has a total of 13 junior secondary schools, with a total enrolment of 14,410 students, of which only one school, the junior secondary school at KasuwarDaii in KauraNamoda LGA is a co-educational (mixed) school, but with only 36 female students. Furthermore, there are 24 Senior Secondary Schools in the State with a total enrolment of 51,090 students made up of 37,662 males (or about 74 per cent) and 13,662 females (or about 26 per cent).

The distribution pattern of secondary schools reveals that while there are no junior secondary schools at Anka, Bakura, Bukkuyum, Gummi and Tsafe, it is only in one LGA B/Magaji that there is no senior secondary school. Except in four LGAs Gummi, Gusau, TalataMafara and Zurmi where there are coeducational schools, all the other LGAs have maleonly secondary schools.

In addition, there are four schools under the Science and Technical Education Board. These are located at Gusau, with a total enrolment of 2,814 students; KauraNamoda, Shinkafi and TalataMafara with enrolments of 796, 635 and 763, respectively. There is also the Arabic and Islamic Education Board, as well as the Agency for Mass Education in the State. Federal and State parastatals and institutions of higher learning.

3.2.8.2 Health

Regarding health facilities in Zamfara State, there are only eight General Hospitals, six Primary Health Centres, three Basic Health Service Centres, one centre for VesicoVaginal Fistula, a Mental Home and a Federal Medical Centre. Gusau, the State capital, has the largest concentration of health facilities.

However, Katsina State has twelve General Hospitals, one Specialist Hospital and an Asylum; over 107 Health Care Centres Dispensaries including many maternity and child clinics and dozens of leprosy clinics. There also eightyseven private clinics.The Health System Fund Project aimed at providing each Local Government area with a General Hospital), has taken off in the State. Its functions also include improvement of health care infrastructure. It is currently engaged in the up grading of twelve Primary Health Care centres to general hospitals.Already, three have been up graded and commissioned in 1999. In addition, a comprehensive diagnostic Medical Centre is nearing completion and will soon be equipped for commissioning. The government has also been concerned towards the success of preventive primary health care programmes. The need for the development of prevention culture through enlightenment campaigns and procurement of vaccines and other necessary supplies are emphasized. In this vein, there exists the National Immunization Exercise for the eradication of killer diseases. The government procured a good quantity of health care equipment from the Petroleum (Special) Trust Fund (PTF), and drugs from the PTF drugprocurement scheme.

Katsina state has 110 medical doctors and 610 other paramedical staff all distributed across various hospitals and healthcare centres. In order to attract qualified and dedicated medical personnel, the government offers special incentives. All nursing and paramedical manpower in the state trained in its four health institutions namely: School of Nursing and Midwifery, Katsina,

the Schools of Health Technology in Daura and Kankia, and the Health Auxiliary Training School, Funtua.

3.2.8.3 Water and Electricity Supply

Water supply in Katsina state is sourced through the damming of rivers and digging of wells and boreholes that reach subsurface or underground water sources. Existing dams include Ajiwa Dam (supplying Dutsim-Ma town and environs), Malumfashi dam (supplying Malumfashi town and environs), Jibia Dam (supplying Jibia town and environs), and Mairuwa Dam (supplying Funtua town and environs).

Plans have reached advanced stage for the completion of the state's multipurpose regional water scheme. This is in order to boost water supply for both domestic and industrial consumption, as well as for irrigation development and the promotion of recreation.

Under this, the Zobe, Ajiwa and Jibia dams and the just completed Gwaigwaye dam (in Funtua) will supply water for both consumption and irrigation purposes. So far, up to twenty-four urban, and many other semi urban and rural locations, are supplied with pipe borne water such that over 50 per cent of the state's populationenjoys this facility. In addition, there are over 1000 boreholes. There are also twenty-seven windmills which have either been reactivated or rehabilitated in various rural locations in the state. Electricity is a major source of power in the state. All major towns and villages have been connected by PHCN to the National Grid.

There is no gainsaying the fact that portable water supply continues to be a chronic problem in the young Zamfara State. But, concerted efforts have been made to remedy the water supply problem. For example, there has been the rehabilitation of KoramasWanke pumping station, as

well as the utilization of the Damba dam to improve the overall water supply situation in the state capital and its environs on a regular basis. In addition to these, 40 hand pumps were constructed within Gusau and its environs to ease the water shortage problem. Similarly, efforts were made by the State Government in conjunction with the now defunct Petroleum Trust Fund (PTF), to rehabilitate a number of rural water supply schemes in the State.

Except Gusau, the state capital, and TalataMafara, both of which are linked to the national grid, most parts of the state lacked electricity at the beginning. However, several LGAs are now either linked to the national grid or serviced through the Rural Electrification Scheme. Thus, most parts of the state can now boast of electricity supply.

3.2.8.4 Transport and Communications

Zamfara State is served with a good road network (Trunk A) which links it to the neighbouring states of Sokoto, Kebbi, Katsina, Kaduna and even to Niger Republic. In the same vein, most of the LGA headquarters are linked to Gusau, the State capital, with good tarred roads. The Zamfara State Transport Authority has increased the number of buses plying between the state and other states in the federation.

Recently the Authority received several additional buses from the Federal Urban Mass Transport Authority. There is a rail line from Kaduna which passes through Gusau and terminates at KauraNamoda. The state government is proposing to upgrade the functional air strip at Gusau to an international airport. Telephone facilities also exist in all the major towns in the State. It is expected that the digital telephone line at Gusau and K/Namoda would soon be extended to other towns in the state. There are also privately run courier mail delivery agencies.

Katsina state is served with both Trunks A, Federal Roads, Trunk B, State Roads, and rural feeder roads (built and/or maintained by the now defunct DFRRI, Local Government councils and Community efforts). Specifically, there are 842km of asphalt laid and 55km. of laterite covered Federal Roads; there are also state Roads, all surface dressed which are 551 km. long; while feeder rural roads which are laterite covered are 485km. long.

All these roads link the nooks and crannies of the state. Funtua and Faskari Local Government Areas are also lined by the Zaria-Kaura-Namoda Railway line. The line traverses about 60 km of the state and historically served to open up the vast cotton producing areas of the North western part of the country. Katsina State has one Airport in Katsina town which has the potential of facilitating business and emergency trips to other urban centres in the country.

3.3 METHODOLOGY

The study employed a cross sectional survey design.Using this design, a sample of the population of nomads was selected, and from these nomads, data was collected to help answer the research questions.Data collection tools included secondary data review, Focused Group Discussions (FGDs), questionnaire, key informant interviews and personal observation (Fig. 3.2).

The field work was carried out in three main stages. They are:

I. Reconnaissance Survey
II. Pilot Study
III. Full Field Work

Reconnaissance survey was conducted in November,2013, while the pilot survey took place in July, 2014.The in depth field work for the study lasted from October to December, 2014.

Focus Group Discussions (FGDs) was used to bring together selected groups of Pastoralists - local chiefs, religious leaders and opinion leaders with long time experience to explore pertinent issues affecting nomadic pastoralism in the study area. Two sessions i.e. one in Katsina and another in Gusau were organized with at least 6-10 persons. Key interview session was conductedonce on nomad leaders (Miyyeti-Allah) and opinion leaders. The interview session was held with five persons among whom was the secretary of Miyyeti-Allah. The researcher took time to jot down on papers and recorded all the discussions on a handset to aid remembrance during analysis. Two field assistants who were graduates in Geography, fluent in Hausa language and residing in the study areas were used to assist the researcher in the distribution of the questionnaire to respondents and interpretation during FGD and interview sessions.

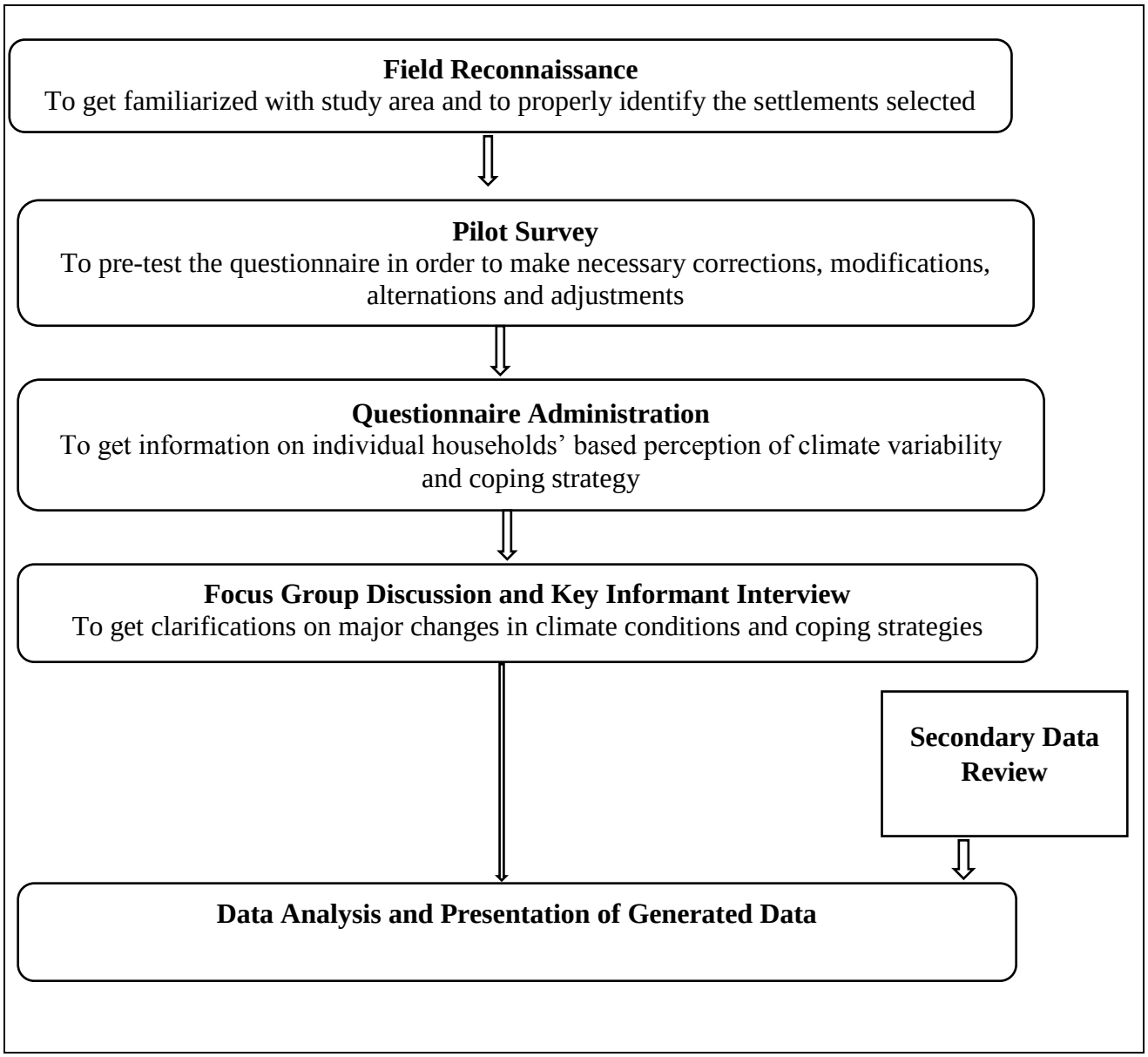

Figure 3.3: Study Design Framework

3.3.1 Types and sources of data needed

The types of data needed and sources of acquiring them were both primary and secondary.

Table 3.1 gives the summary of the types and sources of data required for the study.

Table 3.1: Types and Sources of Data

Data required	Sources	Materials used
Socio-economic and Demographic characteristics of pastoralists	Interview Session and Focus Group Discussion	Questionnaire and FGD Guide.
Daily rainfall and temperature records, occurrence and frequency of flood and drought.	Nigerian Metrological Agency, Gusau	Archives of the Nigerian Meteorological Agency.
Nomadic pastoralists' perception of climate variability.	Interview Session and Focus Group Discussion	Questionnaire and FGD Guide.
Impact of climate change on nomadic activities	Interview Session and Focus Group Discussion	Questionnaire and FGD Guide.
Pastoralists' coping Strategies	Interview Session and Focus Group Discussion	Questionnaire and FGD Guide.
Pastoralists' perceived barriers to coping strategies	Interview Session and Focus Group Discussion	Questionnaire and FGD Guide.

Source: Fieldwork, 2014.

3.2.2 Validity and reliability of the research instrument

In order to give the final shape, the questionnaire was pre-tested with 37 respondents. Based on the pretest results, necessary corrections, modifications, alternations and adjustments were made through expert counseling. Furthermore, to determine the internal consistency of the data, it was finally subjected to statistical analysis (Cronbach Alpha) using SPSS, where a reliability co-efficient of 0.84 was obtained. This indicates that the items were consistent and reliable to be used for the study.

3.2.3 Sample size determination.

To obtain the sample size for the study,Krejcie and Morgan's (1970) technique of sample size determination was employed.The 2015 projected population of sampled communities from Zamfara state was 7,893, while that from Katsina state was 7,715 (See Tables 3.2 and 3.3).

Based on Krejcie and Morgan's (1970) table of sample size, a population size range between 7,000 and 8,000 could be **367**(i.e. 4.64% of the population of selected communities in each state.). Hence, a sample size of 367 was used for each state (i.e. Zamfara=367 and Katsina= 367). The 1991 Census Figures were projected for 2015 for the reason that the population of LGAs was disaggregated into localities according to the 1991 census. The projection of sampled localities' population was based on the Zamfara and Katsina States population growth rate of 3% using the formula: $\mathbf{P_{t+n} = P_t e^{r*n}}$

Where, P_{t+n} = Future population (2015), P_t =Base year (1991), e= exponential, r =Growth rate (3%), n =Interval between future population and base year population (2015-1991=24years)

3.2.4 Sampling techniques

Multi-stage sampling technique was employed for the study. Firstly, the Local Government Areas (LGAs) in the States were clustered into three senatorial zones of North, Central and West.

Secondly, purposive sampling was employed to select previously identified LGAs with sizeable number of nomads. Hence, one local government area from each of the senatorial zones was selected. This gave a total of six (6) LGAs; three (3) from each state. See (Tables 3.2 and 3.3).

Thirdly, systematic random sampling was used where the various wards from each of the six LGAs were listed alphabetically and serially numbered. Thereafter, every first and last ward was selected per LGA to give a total of twelve wards.

The fourth stage involved the use of purposive sampling technique to determine the actual settlements from which respondents were drawn. Consequently, settlements already identified to

have the greatest number of nomads were chosen; one from each ward to make a total of twelve (12) communities for the study.

In administering questionnaire, households were employed as units of observation. Hence, open transverse survey was conducted along each path in every selected village to mark every household. Using systematic random method, every third household in each path that engaged in livestock farming was selected till the required number of the sample for the community was obtained. The head of each household was chosen as the sampling point and where the head was not available, eldest person was selected to represent the household.

Table 3:2 Selected Settlements and Allotment of Questionnaire in Zamfara State

Zamfara State Senatorial zones	LGAs in the Senatorial zones	Selected LGA	Selected Wards	Selected community	Population 1991	Projected population 2015	Proportion of Questionnaire
	K/Namoda						
	T/ Mafara	T/Mafara	Makera	Mabangala	523	1,074	50 (4.66) *
			Matusgi	Tunga Miya	610	1,253	58 (4.63)
	Zurmi						
	Bungudu						
Zamfara Central	Gusau	Gusau	Damba	Hegin Rama	596	1,224	57 (4.66)
			Wanke	Dogon Daji	667	1,370	64 (4.67)
	Maru						
Zamfara West	Anka						
	Gummi	Gummi	GidanIllo	Awala	596	1,224	57 (4.66)
			Umbutu	Karma	851	1,748	81 (4.63)
	Maradun						
TOTAL		**3**	**6**	**6**	**3,843**	**7,893**	**367 (4.65)**

SOURCE: FIELDWORK (2014)Note: *Figures in parentheses are in percentages

Table 3.3: Selected Settlements and Allotment of Questionnaire in Katsina State.

Katsina State Senatorial Zones	LGAs in the Senatorial Zones	Selected LGAs	Selected Wards	Selected Settlements	Population 1991	Projected Population 2015	Proportion of questionnaire
Katsina North	Baure						
	Daura	Daura	Madobi	Tudu	478	982	47 (4.77) *
			Sabongari	RumaSanda	717	1473	70 (4.75)
	Kankia						
Katsina Central	Batsari						
	Dutsin-ma	Dutsin-ma	Dabawa	Gamzoka	491	1009	48 (4.76)
			Tsauri	Garazawa	850	1746	83 (4.75)
	Katsina						
Katsina South	Bakori						
	Malumfashi	Malumfashi	Malumfashi	Kwarsu	542	1114	53(4.76)
			Ungwa-Arzuka	Makurdi	677	1391	66 (4.74)
	Musawa						
TOTAL		**3**	**6**	**6**	**3755**	**7715**	**367 (4.76)**

SOURCE: FIELDWORK (2014)Note: * Figures in parentheses are in percentages.

.

3.2.5 Questionnaire administration

A total of 734 copies of the questionnaire were administered in Katsina and Zamfara states, while 548 copies representing 74.6% were retrieved. In Katsina State, 367 copies of questionnaire were administered but 300 (96 in Daura, 107 in Dutsin-ma and 97 in Malumfashi LGAs) copies of the questionnaire were retrieved representing 81.7%. In Zamfara state, 367 copies of questionnaires were administered as well, however 248 (73 in T/Mafara, 82 in Gusau and 93 in Gummi LGAs) copies of the questionnaire were reclaimed signifying 67.5% response rate. The number of questionnaires not retrieved amounted to 186 (25.34%). This was due to

perceived insurgence in the region as at the time of data collection, which made it difficult to access some of the villages. The distribution of the questionnaires by each community is presented in Table 3.4

Table 3.4: Questionnaire Administration

State	LGA	Community	Copies of Questionnaire Administered	Copies Retrieved	Percentage
Zamfara	T/Mafara	Mabangala	50	33	8.9
		Tunga Miya	58	40	10.9
	Gusau	Hegin Rama	57	37	10.1
		Dogon Daji	64	45	12.3
	Gummi	Awala	57	38	10.4
		Karma	81	55	14.9
Total			**367**	**248**	**67.5**
Katsina	Daura	Tudu	47	35	9.5
		RumaSanda	70	61	16.6
	Dutsin-ma	Gamzoka	48	38	10.4
		Garazawa	83	69	18.8
	Malumfashi	Kwarsu	53	47	12.8
		Makurdi	66	50	13.6
Total			**367**	**300**	**81.7**
Grand Total			**734**	**548**	**74.6**

Source: Field Work 2014

3.2.6 Methods of data analysis

Table 3.5 summarizes the major statistical tools used along with their purposes and the software used.

Table 3.5: Statistical Techniques for Analyzing pastoralists' coping strategies to climate variability.

Objectives	Statistical tools	Purpose of use	Software used
Assessment of pastoralists' socio-economic characteristics	Frequencies and Percentages	For analyzing categorical variables, e.g., socio-demographic profile of respondents	SPSS 16
Analysis of the trend of climate variability	Line chart	To observe the trend in climate variables	Excel 2016
Investigation of nomadic pastoralists' perception of climate variability	Likert Scale	To represent the Pastoralists' perception of climate variability.	Excel 2016
Assessment of the effects of climate variability on nomadic pastoralists' livelihood	Relative Importance Index (RII)	For coding and ranking the perceived impacts of climate variability on animal performance in terms of their severity.	SPSS 16
Examination of nomadic pastoralists' coping strategies	Descriptive statistics such as mean, average or counts	For analyzing the various coping strategies adopted by pastoralists in terms of their significance	SPSS 16
Examination of Barriers to pastoralists' coping strategies	Descriptive statistics such as mean, average or counts	For analyzing the various barriers to coping strategies adopted by pastoralists in terms of their severity	SPSS 16
Significant relationship between pastoralists' demographic and socio-economic characteristics and choice of adaptation practices	Chi-square test	To compare the relationship between two categorical variables, e.g., analysis of association between pastoralist's socio-economic variables and use of climate change adaptation measures.	SPSS 16
Significant relationship between pastoralists' perception of climate variability and impact on animal production	Pearson Product Moment Correlation Coefficient	To assess the relationship between selected elements of climate variability and pastoralists' perception of the impact of climate variability.	SPSS 16

Source: Field Work 2014.

Five percent (0.5) and one percent (0.01) levels of probability were used throughout the study as the basis for statistical significance.

3.2.7 Measurement of variables

3.2.7.1 *Identification of the socio-economic and demographic characteristics of pastoralists*

Information on the number of male and female population, ages in years, literacy rate- level of educational attainment, average income and number of persons in a household were elicited from the pastoralists and analyzed with the aid of frequencies, percentages and counts.

3.2.7.2 *Analysis of the trend of climate variability*

Quantitative changes indicators (temporal changes in daily maximum and minimum rainfall and temperature from 1996-2015 in the study area) were determined by employing the time series analysis. Daily temperature and rainfall measurements were used to calculate monthly anomalies, which were averaged to find annual temperature and rainfall for each year. Trends in temperature and rainfall were calculated from annual data by linear regression (the straight line that fits the data best)

3.2.7.3 *Investigation of nomadic pastoralists' perception of climate variability*

The primary qualitative data on farmers' perception of temperature and rainfall variations was categorized into increase, decrease and no change and was analyzed using descriptive statistics - percentage and frequencies.

3.2.7.4 *Assessment of the effects of climate variability on nomadic pastoralists' livelihood*

The impacts of climate variability on nomadic pastoralists' livelihood were evaluated by means of the following variables and units of measurements: Decreased animal performance (milk production per day), Increased Animal Mortality(average animal mortality rates), Reduction in Income from Livestock(household average income per year), Decreased Forage Availability and Quality (annual average forage consumed in kg/household/year), Reduction in Water Quality and

Availability (rainfall amount in mm/year),Exacerbated Conflicts over Scarce Resources (rate of recurrence of cattle raids), Increased Incidence of pests and diseases (number of new diseases noticed)and shift in rangeland vegetation structure or boundaries (percentage of communal grazing land lost to farming). To achieve this objective, a three-point likert rating scale was used. Each respondent was required to indicate opinion by checking any of the three options i.e. agree. disagree and undecided. Values that were assigned to these options were 3. 2 and 1 respectively. The contribution of each of the factors to the perceived impacts of climate variability in the study area was examined and the ranking of the attributes in terms of their criticality as perceived by the respondents was done by use of Relative Importance Index (RII); depicted by RII=$\sum W / A*N$ ($0 \leq RII \leq 1$) Where: W – is the weight given to each factor by the respondents, A – is the highest weight and; N - is the total number of respondents. The guide for RII rating is given as: very significant=0.76 above, Significant=0.67-0.75, fairly significant=0.45-0.66, not significant=0.44.

3.2.7.5 *Examination of pastoralistscoping strategies*

Evaluation of pastoralists' coping strategies was done with the aid of the following variables- Move long distance to find pasture (average daily distance covered in kilometers in search of pasture), Use of Crop Residue as animal feeds (average amount paid for local input /household/year), Diversification of livelihood (number of other sources of income aside from herding by household), Herd splitting (number of units of cattle owned by household.), Herd destocking (the frequency and number sale of cattle by household), herd diversification (average number of different species of livestock kept by household/year), Concentrate feeding (average amount paid for processed input / year), Water Harvesting (number of sources of water for livestock consumption). A 3-point Likert Rating Scale (LRS) 'agree' (3), 'disagree' (2) and

'neutral'(1) was employed to judge pastoralists' response to questions on coping strategies to climate variability. Using an interval scale of 0.5, the upper limit is 2.5 while the lower limit is 1.5.Any response option with mean score less than 1.5 was regarded as not a significant adaptation strategy while options with mean score equal or above 2.5 were regarded as significant adaptation strategies adopted by nomadic pastoralists.

3.2.7.6 ***Examination of Barriers to coping strategies***

Respondents were requested to select from the list of variables: Conflict over scarce resources (degree of access to communal grazing), Limited Market Access (insecurity and infrastructural facilities), Inappropriate policy (type of land tenure). Minimal Extension Services (number of visits of extension agents), Agricultural expansion(farm encroachment into transhumant corridors) that provided barriers to coping strategies employed by pastoralists. A three point LRS was also used (agree=3, disagree =2 and neutral=1). Using an interval scale of 0.5, the upper limit is 2.5 while the lower limit is 1.5. Any response option with mean score less than 1.5 was regarded as not a strong impediment to adaptation while options with mean score equal or above 2.5 were regarded as solid impediments to adaptation strategies adopted by nomadic pastoralists.

CHAPTER FOUR: RESULTS AND DISCUSSION

4.1 Introduction

This chapter is concerned with the presentation of and full discussion on the results obtained from the analysis carried out. Results presented include; socio –economic characteristics of the respondents, trends of climate variability in the study area, pastoralists' perceptions of climate variability and its impact on animal performance, pastoralists' coping strategies as well as barriers to coping practices.

4.2 Demographic and Socio-Economic Characteristics of Respondents

This section deals with the socio- economics characteristics of the pastoralists' in terms of their age and sex distribution;marital status, type of union and household Size; educational level, income and occupational status; size of cattle, duration of animal rearing and types of animals reared.

4.2.1 Age and sex distribution

Results inTable 4.1 reveals the distribution of respondents by age and sex. Regarding sex, nearly all the pastoralists were males (88.32%). This implies that herding as an occupation is male dominated in the study area. In actual fact, the tending of cattle requires long distance travelling on daily basis. This is probably beyond the scope of the female(Ayanda, Oyeyinka, Salau, and Ojo, 2013). Moreover, Montle and Teweldemedhin (2014) observed that female-headed households might be slow to respond to changing climate conditions through the adaptation of

diversified strategies due to the challenge posed by their customary household duties (e.g. childcare) and the fact that they are more engaged in processing and marketing of livestock products. Accordingly, Nhemachena and Hassan, (2008) asserted that male-headed households are often considered to be more likely to get information about new technologies and take on risks than female-headed households. This is owed probably to gender bias occasioned by possible cultural or religious afflictions which greatly minimize women's level of social interactions.

The age distribution of respondents has indicated that 17.15% of respondents (i.e. majority) are between the ages of 20 -24. This by implication suggests that pastoralists in the study area are made up of young and able bodied youths. A higher number of young pastoralists is found in Zamfara state, which has 39.52% of the population of pastoralists within the age of 15-24. At this age bracket, Falola, Segun, Akangbe and Ibrahim (2012) reported that pastoralists are capable of handling tedious farming activities such as covering long distances to graze animals, fetching water from well for the animals to drink, collection of fodder or hay for the animals during scarcity etc.

Similarly, Onubuogu and Esiobu (2014) agreed with the foregoingthat majority of farmers within the age range of 41 to 50years are still in their active ages, more receptive to innovation and could withstand the stress and strain involved in agricultural production and ease adaptation to climate change.

Table 4.1: Distribution of Respondents by Age and Gender

		KATSINA STATE (n=300)		ZAMFARA STATE(n=248)		POOLED (n=548)	
		Frequency	**Percentage**	**Frequency**	**Percentage**	**Frequency**	**Percentage**
Gender: Male		270	90.0	214	86.3	484	88.3
Female		30	10.0	34	13.7	64	11.7
Age	**<15**	18	6.0	21	8.5	39	7.1
	15-19	12	4.0	64	25.8	76	13.9
	20-24	60	20.0	34	13.7	94	17.1
	25-29	30	10.0	43	17.3	73	13.3
	30-34	18	6.0	17	6.9	35	6.4
	35-39	36	12.0	26	10.5	62	11.3
	40-44	42	14.0	13	5.2	55	10.0
	45-49	24	8.0	9	3.6	33	6.0
>50		60	20.0	21	8.5	81	14.8

Source: Field work, 2014.

4.2.2 Marital status, Type of union and Household Size

Results on marital status, type of union and household size are presented in Table 4.2.

Table 4.2 Distribution of Respondents by Marital Status, Type of Union and Household size

	KatsinaState (n=300)		**ZamfaraState (n=248)**		**Pooled (n=548)**	
	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
Marital Status						
Married	240	80.0	223	89.9	463	84.5
Single	24	8.0	9	3.6	33	6.0
Divorced	24	8.0	12	4.8	36	6.6
Widow/widower	12	4.0	4	1.6	16	2.9
Type of Union						
Polygamy	265	88.3	223	89.9	488	89.1
Monogamy	35	11.7	25	10.1	60	10.9
Household Size						
($\bar{\chi}$= 17)						
< 5	86	28.7	45	18.2	131	23.9
6-10	112	37.3	98	39.5	210	38.3
11-15	40	13.3	57	22.9	97	17.7
16-20	31	10.3	23	9.3	54	9.9
21-25	18	6.0	17	6.9	35	6.4
>26	13	4.3	8	3.2	21	3.8

Source: Field work, 2014.

It can be seen from the data in Table 4.2 that 84.5% of the pastoralists are married, 6.0%, 6.6% and 2.9% are single, divorced and widowed respectively. The probable reason for the high number of married people is not far-fetched. The study area is largely pastoral and a Muslim

setting, where early marriage is encouraged owing to cultural and religious beliefs. Moreover, the low proportion of widowed and divorced respondents could be attributed to the high rate of remarriage prevalent in Muslim dominated areas, where staying without a husband or wife is considered an act of irresponsibility. This is similar to the finding ofAyanda *et al.*,(2013) which revealed that 58.8% of transhumant pastrotralists in Ogun state were married, whereas only 15% and 10% were widowed and divorced respectively

The foregoing result implies that there may be abundance of labour supply in the study area since most of the people of the area are married and they are likely to have children. It is instructive to note that labour abundance is critical to climate change adaptation owing to its high labour requirements. Hence Sofoluwe, Tijani, and Baruwa, (2011) aptly noted 'if farmers do not have sufficient family labour or the financial means to hirelabour, they cannot adapt to climate variability'.

In terms of the type of marital union, Table 4.2 reveals that 89% of the married respondents is in polygamous union, whereas 11% is in monogamous union.The reason for the aforementioned is that the study area is Muslim-dominated and Islam permits and encourages polygamy. A study conducted by Berkowitz (2002) notes that about eighty-three percent of human societies permit polygamy.

Regarding household size, Table 4.2 reveals that the mean household size is 17 persons. It is apparent from Table 5.2 that the study area has abundant family labour supply that could be used to carry out herding operations as this would save cost. This investigation is in harmony with Gbetibouo (2009) who noted that large households are more willing to choose labour-intensive adaptation measures. In keeping with this findings, Deressa, Hassan, and Ringler, (2010)

maintained that household size positively and significantly leads to an increase in the likelihood of adapting to climate change.This is probably because large family size is normally associated with a higher labour endowment, which would enable a household to accomplish various agricultural tasks especially during peak seasons .

On the other hand, Yirga (2007) observed a negative relationship contending that household with large families may be forced to divert part of the labour force to off-farm activities in an attempt to earn income in order to ease the consumption pressure imposed by a large family.

5.2.3 Educational Level, Income and Occupational Status

Information on the educational level, income and occupational staus of respondents are presented in Table 4.3. As can be seen from Table 4.3, pastoralists in Zamfara and Katsina states were litrate to varying degrees. Data from Table 4.3 has shown that majority (36.1%) had Koranic education.This is followed by secondary education (22.3%) and tertiary education (21.5%). The high proportion of respondents with Koranic education is suggestive of the fact that the study area is Muslim dominated and Koranic education is the rudimentary learning stage in Islam.This indicates further that the Fulanis are typical devotees of the Islamic faith. A closer look at Table 4.3 apparently revealed that Katsina state has a higher proportion (78%) of pstoralists who have gone beyond secondary school. A possible explanation to this revelation is that Katsina people were the first to embrace Western Education among the moslem people of Northern Nigeria. Recalled that Katsina College was where the First Republic Northern leaders were educated. Infact, the first public secondary school in Northern Nigeria was established in Katsina in 1921.

According to Kehinde(2014)low level in education could prevent farmers from keying into the Agricultural Transformation Agenda of theFederal Government of Nigeria and the

NomadicEducation Programme which may thus affect theirsocio-economic status. Hence, exposure to high level of education is an added advantage in terms of climate change adaptation measures. Consequently, Esiobu, Onubuogu and Okoli (2014) noted that higher education was likely to enhance information access to the farmer for improved technology uptake and higher farm productivity.

Table 4.3: Distribution of Respondents by level of Education, Occupation and Income Status

	Katsina State (n=300)		**ZamfaraState (n=248)**		**Pooled (n=548)**	
	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
Level of Education						
Tertiary	78	26.0	40	16.1	118	21.5
Secondary	67	22.3	55	22.9	122	22.3
Primary	40	13.3	60	24.2	100	18.3
Islamic	109	36.3	89	35.9	198	36.1
Informal	6	2.0	4	1.6	10	1.8
Level of Income						
<100,000	40	13.3	15	6.1	55	10.0
100,000 – 200,000	60	20.0	115	46.4	175	31.9
201,000 – 300,000	100	33.3	18	7.3	118	21.5
301,000 – 400,000	58	19.3	66	26.6	124	22.6
>400,000	42	14.0	34	13.7	76	13.9
Occupation						
Animal rearing	213	71.1	154	62.1	367	66.9
Arable farming	28	9.3	22	8.9	50	9.1
Trading	13	4.3	37	14.9	50	9.1
Civil Servants	10	3.3	3	1.2	13	2.4
Artisan	26	8.7	17	6.9	43	7.8
Others	10	3.3	15	6.0	25	4.7

Source:Field work, 2014.

They reiterated that education is likely to enhance the farmers abilityto receive, decipher and comprehend information relevant to making innovative decisions in their farms. Thus,higher level of education determines the quality of skills of farmers, their allocative abilities, efficiency

and howwell informed they are to the innovations, technologies and awareness levels and adaptation to climate change(Onubuogu and Esiobu, 2014)

Considering the income level of respondents, Table 4.3 also shows that majority (31.9%) earned between N100,000 to N200,000 annually. This is followed by 22.6% who earned between N301,000-N400,000 and 21.5% whose annual income is between N201,000 to N300,000. This investigation discloses that in general, pastoralist in Zamfara and Katsina states are in the medium economic, living above one USD per day and hence may be bouyant enough to adopt improved adaptation practices. Onubuogu, Chidebelu and Eboh (2013) corroborated this findings by noting that farmers' incomes (whether on-farm or off-farm income) have a positive relationship with the adoption of agricultural technologies since the latter requires sufficient financial wellbeing to be undertaken. In addition, Deressa and Hassan, (2009)reported the significant impact of farm income on household choice of conserving soil, using different crop varieties and changing planting date as climate change adaptation strategies.

On the basis of occupation, animal rearing predominates (66.9%). Others include arable farming and trading (9.1%), artisan (7.8%) and civil servant (2.nm4%). The preceding result indicates that pastoralists in the study area are undergoing livelihood diversification. According to Mcbe, Lesile and Deluca, (2010), pastoral peoples in Africa, and in fact in many areas around the world, have been rapidly diversifying their economies. Reasons advanced to explain this change in livelihood strategies have included the alienation of rangelands due to the expansion of parks and protected areas (McCabe, 2003), changes in land tenure and the privatization of land held as common property (Leserogol, 2008), the loss of livestock due to drought and disease (O'Malley,

2000) and the increase in the human population while the livestock population remained steady or declined (McCabe, 2003).

4.2.4 Number of herds, Years of experience and Types of livestock Reared

Concerning respondents' cattle size, Table 4.4 has shown that a larger propotion (34.7%) of the respondents had cattle size between 501 to 1000. Emeka, (2015) opined that the number of cattle a man has is considered as a sign of his wealth, therefore, those with 5000 and above herds are considered richest amongst the nomadic famers.

Table 4.4: Distribution of Respondents by Size of Cattle, Duration of Animal Rearing, and Types of Animals reared.

	KATSINA STATE(N=300)		ZAMFAR STATE(N=248)		POOLED	
	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
Cattle size						
Less than 100	66	22.0	48	19.4	114	20.8
100 -500	75	25.0	67	27.0	142	25.9
501- 1000	100	33.3	90	36.3	190	34.7
1001- 5000	45	15.0	35	14.1	80	14.6
Greater than 5000	14	4.7	8	3.2	22	4.0
Duration of animal rearing						
Less than 10 years	50	16.7	32	12.91	82	14.9
10-19	120	40.0	81	32.7	201	36.7
20 – 30	100	33.3	112	45.2	212	38.7
Greater than 30	30	10.0	23	9.3	53	9.7
Types of Animal Reared						
Cattle	118	39.3	105	42.3	223	40.7
Goat	40	13.3	33	13.3	73	13.3
Sheep	52	17,4	42	16.9	94	17.2
Camel	27	9.0	20	8.1	47	8.6
Donkey	21	7.0	17	6.9	38	6.9
Chicken	24	8.0	19	7.7	43	7.8
Others	18	6.0	12	4.8	30	5.5

Source: Field work, 2014.

This result agrees with the findings of Osotimehin, Tijani, and Olukomogbon, (2006) that the size of herd is traditionally considered a measure of wealth and social status among the nomads; the larger the size of the herd of a nomad, the greater the security such an individual enjoys. In the same vein, Athuman (2009) observed that pastoralists usually accumulate large number of livestock as a symbol for wealth status. He stressed further that large head size is also well thought-out as insurance against drought losses, thus a strategy to manage and survive drought incidences. This is based on the idea that the large herd size a man has, the more the likelihood that a good number of his herd will survive drought.

Instructively, economic status of pastoralists is critical to climate change adaptation measures. This finding is validated by Deressa and Hassan (2009) who indicated that lack of money, lack of information, inadequate labour, inadequate land and poor potential for irrigation are the major barriers which prevented farmers from adopting various adaptations measures.

Regarding duration of animal rearing, majority (38.7%) of the pastoralists have had between 20 to 30 years of animal rearing experience. In view of this long time experience, pastoralists in the study area might have acquired basic knowledge and relevant skills in livestock production and management, which could serve as boofer to climate change . Gbetibou (2009) in a similar study of farmers' perception of climate change in South Africa confirmed that experienced farmers have diverse skills in farming techniques and management, and are able to spread risk when faced with climate variability. Hence, higly experienced farmers tend to have more knowledge of changes in climatic conditions and the relevant response measures to be applied.

In addition, Table 4.4 shows the varoius types of animals kept by the pastorlists. Cattle (40.7%) were the majority.This is followed by sheep (17.2%) and Goats (13.3%).This implies that most

of the pastoralists were engaged in multiple animal farming systems. The higher percentage of cattle reared in the study area may be explained by the fact that cattle were the major animals used for dairy purposes and hence the main source of wealth and income.These results are in accord with the submissions of Desiere, Niragira, D'Haese and Vellema (2015) that cattle are used by pastoralists as instruments of savings and insurance. They are used to solve urgent need of the family members and to procure food in times of shortages. The aforementioned is in concurrence with a large body of published studies (Barret and Luseno,2004; Bellemare amd Barret, 2006; Franklin, 2007) describing the economic importance of livestock to pastoralists. These studies opined that aside from meat, milk and blood for food, cattle as well provide herders incomes to meet basic expenditure such as procurement of grains, equipment, clothing and settlement of bills e.g school fee and medical charges. Similarly, an FGD discussant alluded to the foregoing notoion that,

> ---*tending of cattle is a must for us. Butter and Cheese are our main livelihood support products. It is the only reliable source for us* (Umaru, 06/06/2015)

4.3 Trends in Rainfall and Temperature Attributes

The trend analysis of the temporal changes in rainfall and temperature over 19 years show a consistent rising trend in annual mean surface temperature and inter-annual variability in precipitation in the study area. The trend of annual rainfall in Zamfara and Katsina states for 40 years is depicted graphically in Figure 4.1A, whereas the trend of annual temperature in Zamfara and Katsina states for 19 years is represented graphically in Figure 4.1B.

Figure 4.1A shows a steady increase with much fluctuations-rising and falling trend in annual mean rainfall in the study area with the average maximum rainfall (314.9mm) between 2006 -

2007. The speed of increase is higher for 1990 to 2000 and 2003 to 2012.Figure 4.1B reveals the trend analysis of record of the level of temperature between 1996-2015 in the study area which shows an increasing trend with the average minimum (20.2^{o}C) and average maximum (34.5^{o}C) temperature recorded in 2005 and 2008 respectively.

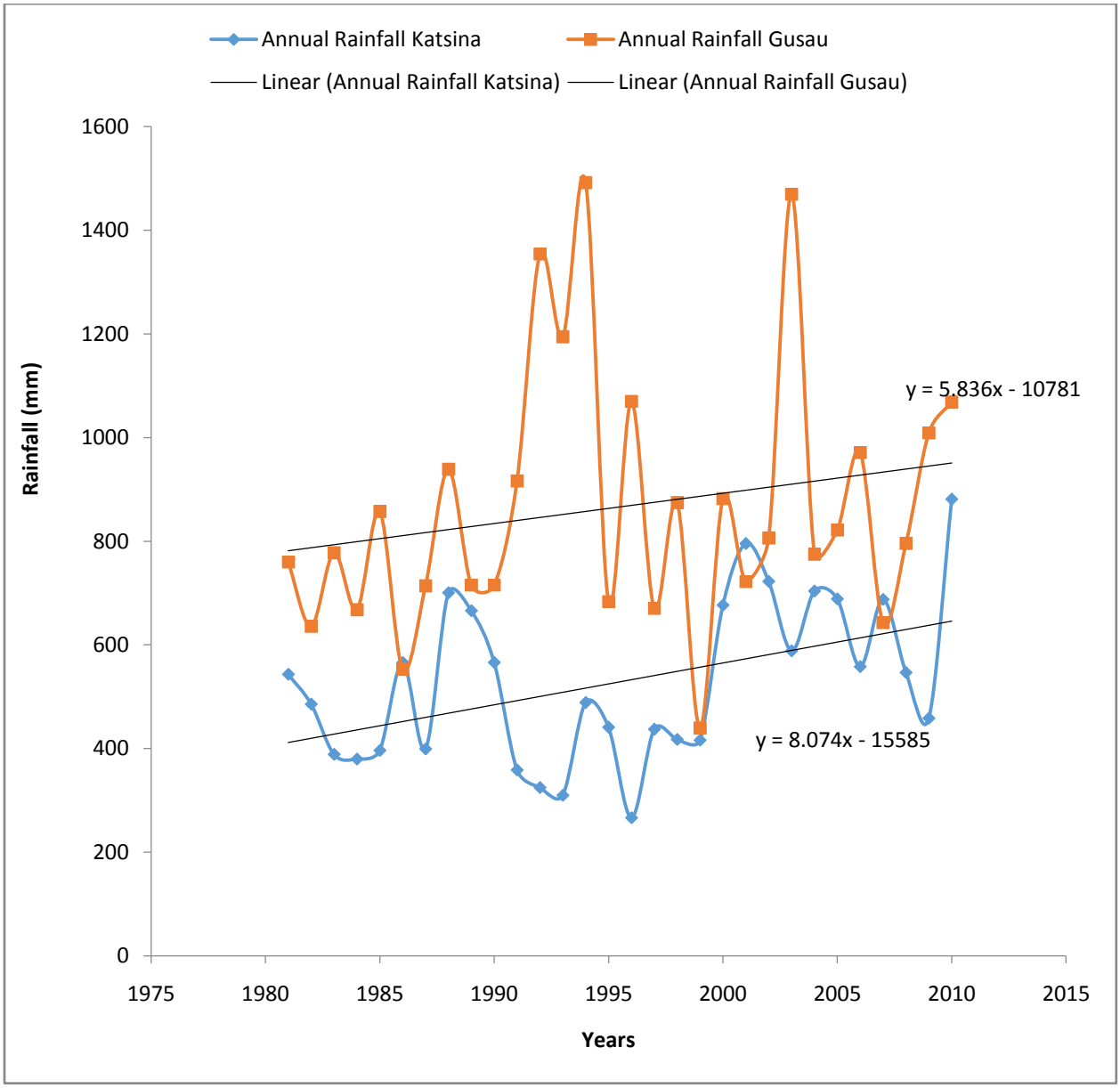

Figure 4.1A: Annual mean Rainfall for Katsina and Zamfara states (1975-2015)
Source: NMetSGusau

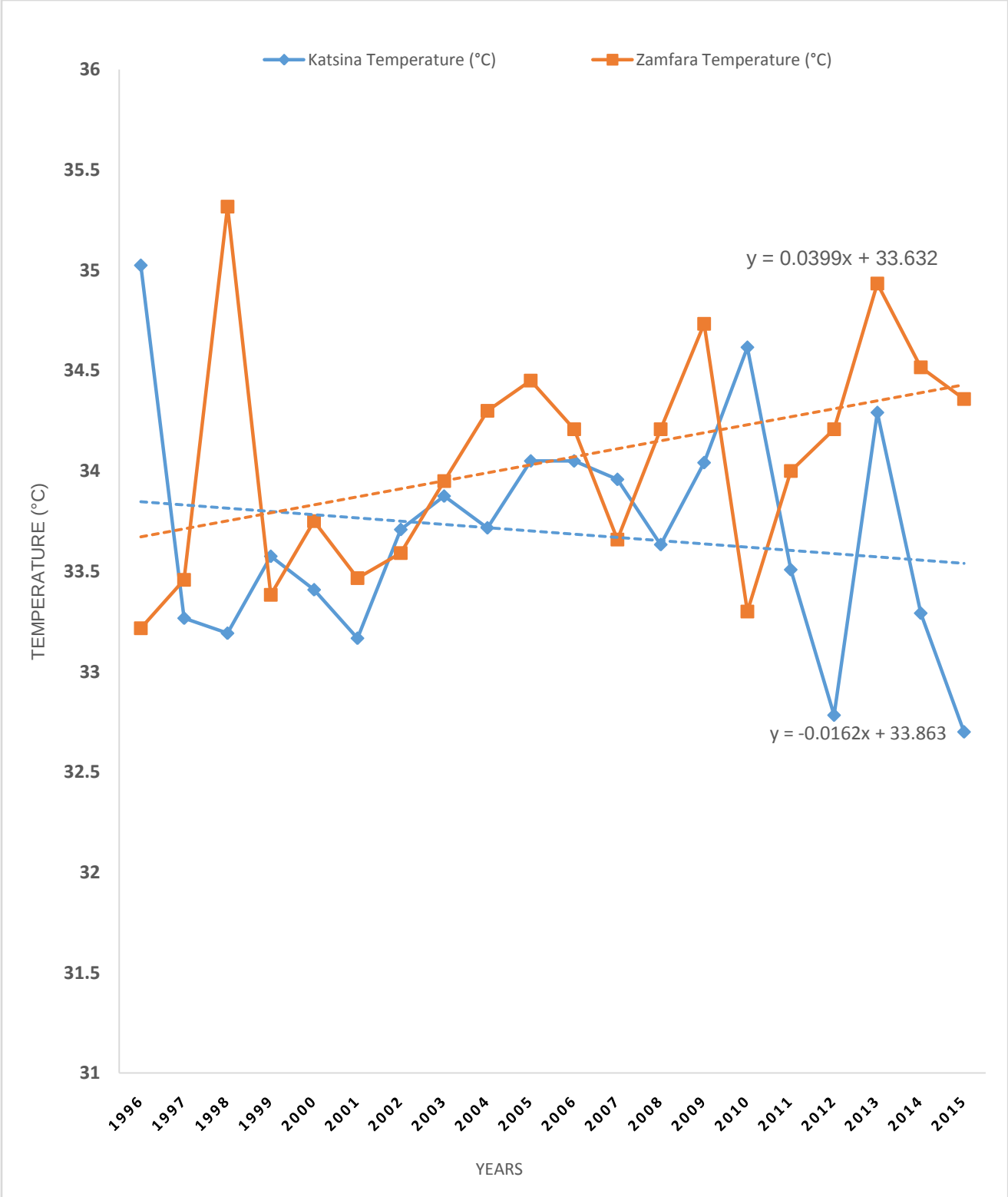

Figure 4.1B: Annual mean Temperature for Katsina and Zamfara states (1996-2015)
Source: NMetS, Gusau,

The preceding analysis is validated by Odjugo (2010) indicating that the temperature trend in Nigerian since 1901 shows increasing pattern. The increase was gradual until the late 1960s and this gave way to a sharp rise in air temperatures from the early 1970s, which continued till date. Odjugo (2010) furher stressed that the mean air temperature between 1938 and 2007 in the semi-arid region of Nigeria was 28.96^{O}C while the rainfall amount was 847 mm. Between 1938 and 1972climatic period, the temperature was 28.24 ^{OC} and the rainfall amounted to 937 mm while it was 29. 67^{OC} and 758 mm respectively for the period of 1973-2007. This indicates an increase of 1.43^{OC} for temperature and reduction of 178 mm of rainfall for the two climatic periods. This greatly hampered both crop animal production.

4.4 Nomadic Pastoralists' Perception of Climate Variability

It is factual, that the issue of climate change is no longer news but now commonly believed to be a leading global problem. Perception is having an understanding of a subject, issue or situation based on what is observed or taught.It is perhaps, the level of perception that determines the strategies to be employed in minimizing the impacts of climate variations. The surveyed pastoralist household heads were asked about their perceptions of changes in various climate variables over the past 19 years. The most important components were yearly temperature, rainfall, drought, and the incidence of pests and diseases. Perceptions on climatic components were categorized into three: increased, decreased and remaining same.Figures4.2 shows Pastoralist perception of changes in Rainfall, Temperature, Drought, Pests and Diseases incidencesin Katsina and Zamfara States respectively from 1996-2015.

Table 4.5: Pastoralist perception of changes in Rainfall, Temperature, Drought, Pests and Diseases Incidences.

	KATSINASTATE (n=300)		ZAMFARASTATE(n=248)		POOLED (n=548)	
PERCEPTION	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
RAINFALL						
No change	21	7	7	3	28	5
Decrease	30	10	50	20	80	15
Increase	249	83	191	77	440	80
TEMPERATURE						
No change	12	4	10	4	22	4
Decrease	267	89	193	78	460	84
Increase	21	7	45	18	66	12
DROUGHT						
No change	81	27	25	10	106	19
Decrease	207	69	136	55	343	63
Increase	12	4	87	35	99	18
PESTS AND DISEASES						
No change	120	40	139	56	259	47
Decrease	162	54	77	31	239	44
Increase	18	6	32	13	50	9
PASTORALISTS' PERCEPTION OF CHANGES IN THE ONSET AND OFFSET OF SEASONS						
COLD SEASON						
Comes Early	198	66	112	45	310	56
Delay	87	29	124	50	211	39
No change	15	5	12	5	27	5
HOT SEASON						
Comes Early	261	87	151	61	412	75
Delay	27	9	69	28	96	18
No change	12	4	27	11	39	7
RAINY SEASON						
Comes Early	36	12	84	34	120	22
Delay	231	77	139	56	370	68
No change	33	11	25	10	58	10
PASTORALISTS' PERCEPTION OF CHANGES IN THE DURATION OF SEASONS						
COLD SEASON						
Increase	60	20	87	35	147	27
Reduce	219	73	136	55	355	65
No change	21	7	25	10	46	8
HOT SEASON						
Increase	201	67	129	52	330	60
Reduce	84	28	94	38	178	33
No change	15	5	25	10	40	7
RAINY SEASON						
Increase	75	25	67	27	142	26
Reduce	180	60	144	58	324	59
No change	45	15	37	15	82	15

Source: Field work, 2014.

From Table 4.5, we can see that majority (83%in Katsina and 77% in Zamfara) of the pastoralists perceived decrease in rainfall, while 89% (Katsina)and 78% (Zamfara) perceived increase in temperature, above half (69% in Katsina and 55% in Zamfara) observed increase in drought, whereas 54% in Katsina and 31% in Zamfaraperceived increase in pests and diseases. The accuracy of farmers' perceptions of climate change was assessed by comparing their perceptions of long-term changes in temperature and precipitation with climate trends recorded at nearby meteorological stations. This perception was confirmed by the statistical record for Zamfara and Katsina States between 1986 and 2015, which showed the increase in temperature occurring mostly in the summer months (October to March) and varying trend in rainfall. An analysis of climate data at the regional level shows the same general trend of increasing temperature with some minor variations in terms of the severity of the increase and its timing.

Thus, farmers' perceptions are supported by the statistical record. Additionally, the forgoing analysis of pastoralists' observation of climate variability is in harmony with the work of Ishaya and Abaje, (2008)in which 73% of the respondents were of the opinion that temperature has been increasing over thepast few decades. This is also in agreement with the study of Oladipo (2011) that the country has beenexperiencing temperature increase of about $0.2^{\circ}C - 0.3^{\circ}C$ per decade in all its ecological zones. However, decrease in rainfall as perceived by the pastoralists is in sharp contrast with similar studies in the region. For instance, Ati, Iguisi, and Afolayan (2007); Odekunle, Andrew and Aremu, (2008) and Abaje, Ati, Iguisi, and Jidauna, (2013) using recorded rainfall data observed that the sudano-sahelian zone of Nigeria is now experiencing wetter

conditions in recent years. Hence, Odjugo (2009) opined that while rainfall duration and amount is decreasing, the intensity is increasing.

Similarly, pastoralists' perception of increase in drought occurrences is inconsistent with most of the recent studies related to drought occurrences in the northern parts of the country using recorded climatic data. These researches include Odekunle, Andrew, and Aremu (2008); Abaje, Ati, and Iguisi, (2012) and Abaje, Ati, Iguisi, and Jidauna, (2013) who observed that drought occurrences in this zone is decreasing lately.

Considering the criticality of rainfall to pastoral economies, the foregoing investigation has demonstrated that pastoralists in the study area are highly constrained. This is because the perceived reduction in rainfall by pastoralists and inter annual variability trend recorded at Gusau meteorological station in recent timesaffect pasture availability, which implies that the pastoralists would wander a longer distance in search of pasture and water. Ward, Saltz, and Ngairorue(2004) and Ayanda,*et al.*,(2013) authenticated this result stating that livestock populations generally increased with increasing rainfall due to the importance of rainfall on vegetation production. In the same way,Le Houerou and Hoste (1977); Herlocker and Dolan (1980) and Mortimore (1998) asserted that rainfall unpredictability, both in space and time, causes uneven and unpredictable levels of forage productivity.

In terms of onset and cessation of seasons, Table 4.5 illustrate Nomadic Pastoralists' perception of changes in the onset and cessation of seasons in Katsina and Zamfara States. Results in Table 4.5 expresses that a greater proportion of the Nomadic pastoralists (66%) in Katsina and nearly half (45%) in Zamfara observed cold season to have come earlier, 87% in Katsina and 61% in

Zamfaraperceived hot season to have started early, whereas 77% in Katsina and 56% in Zamfara observed rainy season to have delayed.

These findings are corroborated by Akponikpe, Johnston, and Agbossou, (2010) who revealed that onset of the rainy season was perceived by farmers to be later these days.

Likewise, Kamruzzaman, (2015) noted that majority of the farmers perceived hot season to come early but ends late, while cold season starts late and cessation comes early. Conversely, Nyanga, Johnsen, and Aune, (2011) found no change in onset and cessation of hot season and no change in onset but delays in cessation of cold season in Zambia.

Regarding duration of seasons, Table 4.5 shows pastoralists perception of the duration of seasons in Katsina and Zamfara states. The figures demonstrate that more than half (73% in Katsina and 55% in Zamfara) of the pastoralists perceived reduction in the duration of cold season, 67%in Katsina and 52% in Zamfaraobserved increase in the length of hot season, while more than half (60% in Katsina and 58% in Zamfara) perceived decrease in the length of rainy season.

The preceding result is confirmed by Kamruzzaman, (2015) who found that greater proportion of farmers (80.7%) believed that duration of rainy season reduced, hot season increased and cold season reduced. Additionally, Mertz, Mbow, Reenberg, and Diouf (2009) revealed that in rural Sahel, households generally agreed that cold periods have become shorter, hot periods longer and a reduction in rainy season.

Reduction in the length of rainy season could lead to poor pasture growth, which may also lead to decline in fodder supplies from crop residues,weight less and increased deaths among stock. Wheras longer hot periods have the tendency to aggravate heat-related diseases and

stress,impairing growth and reproduction, milk production and lactation length (Singh, Meena, Kolekar, and Singh, 2012)

4.5 Effects of Climate Variability on Nomadic Pastoralists' Demographic and Socio-Economic Activities

Results in Table 4.6 expresses adverse effects of climate variability as perceived by pastoralists in the area of study. Table 4.5 further displayed the ranking of the effects based on their level of severity. The results show that all the perceived effects were very severe because they all ranked 0.76 and above on the relative importance index (RII). However, exacerbated conflicts over scarce resources (0.89), decreased animal productivity (0.88), decrease in forage availability and quality (0.86), reduction in income from livestock and water quality and availability (0.84) ranked higher on the relative importance index (RII).

The high impacts of climate variability and change on pastoralists' socio- economic activities cannot be unconnected with the increase in temperature, high rainfall variability, and high incidence of drought occurrences in the area as revealed in Figures 4.2A and B. This could impair animal performance and hence results to increase in the cost of meat, milk and other animal products as well as high incidence of crop farmers-headers conflict in the study area.

The results of the pastoralists perceived effect of climate variability agreed with BNRCC (2008) that the impact of climate change can be vast in Nigeria. Hence, Ayanda, Oyeyinka, Salau, and Ojo, (2013) remarked that some stable ecosystems such as the Sahel Savanna may become vulnerable because warming will reinforce existing patterns of water scarcity and increase the risk of drought in Nigeria and indeed most countries in West Africa. Similarly, NRC (2002) confirmed that climate change could impact the economic viability of livestock production systems worldwide.

Table 4.6 Pastoralist perceived impacts of climate variability

	KATSINA STATE								ZAMFARA STATE								TOTAL	
Impacts of Climate Variability																		
	1	2	3	∑f	∑fx	$\overline{X}$	RII	R	1	2	3	∑f	∑fx	$\overline{X}$	RII	R	RII	R
DAP	10	90	200	300	790	2.6	0.88	1	8	70	170	248	658	2.7	0.88	2	0.88	2
IAM	60	60	180	300	720	2.4	0.80	5	40	40	168	248	624	2.5	0.84	4	0.82	5
DFAQ	40	25	235	300	795	2.7	0.88	1	8	100	140	248	628	2.5	0.84	4	0.86	3
RIL	30	90	180	300	750	2.5	0.83	4	10	98	140	248	626	2.5	0.84	4	0.84	4
RWQA	60	90	150	300	690	2.3	0.77	6	20	58	170	248	646	2.6	0.87	3	0.82	5
ECSR	40	60	200	300	760	2.5	0.84	3	5	43	200	248	691	2.9	0.93	1	0.89	1
IIPD	60	90	150	300	690	2.3	0.77	6	30	78	140	248	606	2.4	0.81	8	0.79	8
SRVS	60	90	150	300	690	2.3	0.77	6	20	78	150	248	626	2.5	0.84	4	0.81	7

Legend: 1=Neutral, 2= Disagree, 3= Agree
Source: Field work, 2014

DAP=Decreased Animal Productivity, **IAM**=Increase in Animal mortality, **DFAQ**=Decrease Forage availability and quality, **RIL**=Reduction in Income from Livestock, **RWQA**=Reduction in water quality and availability, **ECSR**=Exacerbated conflicts over scarce resources, **IIPD**=Increase incidence of pests and diseases, **SRVS**= Shift in rangeland vegetation structure or boundaries

4.6 Pastoralist's Coping Strategies

Over time, livestock producers have traditionally adapted to climatic changes by building on their in-depth knowledge of the environment in which they live. Farmers' perception and local traditional knowledge help them in developing measures and technique to deal with situations arising due to climatic vagaries. These measures and techniques are locale specific and are inherently scientific. Documentation of such practices and techniques, farmer to farmer dissemination and sharing such innovative approaches at large platforms have helped in

influencing research agenda of academic institutions and setting the priorities. A number of questions were asked to assess the strategies adopted by the local communities to cope with climate change. The respondents reported a diversity of coping strategies that included both modern and traditional methods. Table 4.7 presents information on various coping strategies adopted by pastoralists in the study area.From Table 4.7, the following inferences can be easily drawn. The predominant coping strategies adopted by pastoralists in the study area include; moving long distances to find pasture (RII=0.9), use of crop residues as animal feeds (RII=0.9), herd splitting (RII=0.9) and praying to God (RII=0.9). These strategies had RII score above 0.76, hence considered the most significant coping strategies implemented in the study area. The submission of Ayanda, Oyeyinka, Salau, and Ojo (2013) is in line with this finding that more than half of the pastoralists engaged in the use of crop residue as feed supplements and herd size reduction as measures to ameliorate adverse effect of climate variability on their activities. Similarly, Kirimi, John and Nalunkuuma (2013) opined that migrating to other areas was highly practiced by pastoralists in Kenya during shortage of grasses.

According to Heltberg, Siegel and Jorgensen (2009), climate change related challenges have forcedmany households to change livelihoodchoices. Other choices included use of traditional fodder especially for the goats, conserving fodder, renting pasture land and to reduce livestock numbers by selling.It is obvious from the foregoing result that the major coping strategy embark upon by pastoralists is moving long distances to find pasture.Generally, mobility is a well-known primary risk reduction strategy, particularly in times of drought employed by pastoralists exploiting rangelands.

Coping Strategies									POOLED									
	1	2	3	∑f	∑fx	$\bar{\chi}$	RII	R	1	2	3	∑f	∑fx	$\bar{\chi}$	RII	R	$\bar{\chi}$	**RII**	**R**
MLD	30	20	250	300	820	2.7	0.9	1	30	18	200	248	666	2.7	0.9	1	2.7	0.9	1
UCR	60	60	180	300	720	2.4	0.8	4	8	40	200	248	688	2.8	0.9	1	2.6	0.9	1
DLA	30	120	150	300	720	2.4	0.8	4	30	108	110	248	576	2.3	0.8	1	2.4	0.8	5
HDS	10	80	210	300	800	2.6	0.9	1	20	70	158	248	634	2.6	0.9	1	2.6	0.9	1
HDK	30	120	150	300	720	2.4	0.8	4	30	108	110	248	576	2.3	0.8	7	2.4	0.8	5
HDF	60	120	120	300	660	2.2	0.7	8	48	100	100	248	548	2.2	0.7	8	2.2	0.7	8
CTF	20	100	180	300	760	2.5	0.8	4	8	100	140	248	628	2.5	0.8	7	2.5	0.8	5
WHT	30	10	200	240	650	2.1	0.7	8	18	40	190	248	668	2.7	0.9	1	2.4	0.8	5
PTG	20	70	210	300	790	2.6	0.9	1	20	50	178	248	654	2.6	0.9	1	2.6	0.9	1

Table 4.7: Pastoralists' Coping Strategies
Standard Reference Mean: 2.5 **Sources: Fieldwork, 2014**
Legend: 1=Neutral, 2= Disagree, 3= Agree

Note: MLD=Move Long Distances to find Pasture, **UCR**=Use of crop residue as animal feeds, **DLA**=Diversification of livelihood activities, **HDS**= Herd splitting, **HDK**=Herd destocking, **HDF**=Herd Diversification, **CTF**= Concentrate Feeding, **WHT**=Water Harvesting, **PTG**=Praying to God

Dabi, Nyong, Adepetu and Ihemegbulem (2008) noted that labour migration was one of the key methods identified by rural households in northern Nigeria as both a past and present climate change adaptation approach. Similarly, a study by Scheffran, Marmer and Sow (2012) shows that migration could contribute to resilience and innovation in climate adaptation in northwest Africa. This is for the reason that migrant workers can boost livelihoods and build the resilience of the original home communities through remittances.Furthermore, Niamir (1991) stated that pastoral seasonal mobility is a paramount adaptation option whereby livestock needs are met in an ever-variable environment. He reiterated that the ability of pastoralists to survive admist variable forage supplies and water distribution is contingent upon their opportunistic mobility and

diversified livestock husbandry.Hence, in an extensive livestock keeping, taking livestock to feed and water is less costly than bringing feed and water to livestock owing to lower labour demand and lower input. Discussion with key informants confirmed this, as one of the opinion leaders aptly stated:

We don't stay in one place, any where we notice there is enough grass for cattle we move there, especially during the dry season we used to go far to the southern and middle belt region of the country, where there are enough grasses and water for our animals. Nowadays our movements have been very restricted due to conflicts with crop farmers
(Ibrahim, 06/06/ 2015)

Musembi and Kameri-Mbote, (2013) confirmed that these movements by herders are often affected by violent conflicts, diseases outbreaks and recurrent drought.

Affirmatively, McCabe (2006) and Niamir-Fuller, (2000) maintained that this form of mobility is pursued primarily for livelihood purposes and that movement of livestock to areas with secure water and pasture resources is an effective strategy against droughts, which has remained important for herders in Africa.

4.7 Barriers to Adaptation Options

The coping strategies embarked upon by pastoralists are not without constraints. Pastoralists reported a number of limitations to their strategies. Table 4.8 shows data on barriers to coping strategies in the area of study. The analysis of barriers to adaptation to climate change presented in Table 4.8 indicates that there are three major constraints to adaptation in the study area. These are conflict over scarce resources-pasture and water ($\bar{\chi}$=2.7), agricultural expansion limiting livestock movement ($\bar{\chi}$ =2.6) and minimal extension services ($\bar{\chi}$ =2.5).

Table 4.8: Barriers to coping strategies

KATSINA STATE							ZAMFARA STATE						TOTAL
BARRIERS TO COPING STRATEGIES	1	2	3	∑f	∑fx	$\bar{\chi}$	1	2	3	∑f	∑fx	$\bar{\chi}$	$\bar{\chi}$
COS	10	80	210	300	800	2.7	20	70	158	248	634	2.6	2.7
LMA	60	90	150	300	690	2.3	40	40	168	248	624	2.5	2.4
IKC	50	100	150	300	700	2.3	8	100	140	248	628	2.5	2.4
IPC	40	110	150	300	710	2.4	10	108	130	248	616	2.4	2.4
MES	60	60	180	300	720	2.4	20	58	170	248	646	2.6	2.5
URB	120	120	60	300	540	1.8	8	40	200	248	688	2.8	2.3
POV	30	120	150	300	720	2.4	30	78	140	248	606	2.4	2.4
AEM	30	60	210	300	780	2.6	20	78	150	248	626	2.5	2.6
LSI	90	60	150	300	660	2.2	22	68	158	248	632	2.5	2.4

Source: Field Survey, 2014Standard Mean Reference: 2.5

Legend: **COS**=Conflict over scarce resources-pasture and water, **LMA**=Limited Market Access, **IKC**=Inadequate Knowledge and Information on Climate Variability, **IPC**= Inappropriate policy, **MES**= Minimal Extension Services, **URB**= Undefined Regional Boundaries, **POV**= Poverty, **AEM**= Agricultural Expansion Limiting Livestock Movement, **LSI**=Limited Skill to engage in new income

Other impediments include; limited access to market ($\bar{\chi}$ =2.4), inappropriate policy ($\bar{\chi}$ =2.4) in adequate knowledge and information on climate variability ($\bar{\chi}$ =2.4) and limited skill to engage in new income ($\bar{\chi}$ =2.4). Further probing with FGDs participants revealed that some of these desired strategies, such as development of water sources, concentrate feeding and grain and

fodder storage facilities require an initial investment capital that is beyond the reach of many households. Access to improved livestock breeds and suitable veterinary services are also problematic, because of financial constraints. Insecurity and conflicts associated with livestock raids are also major constraints to some of the coping responses in the study area. A discussant succinctly declared:

> *We are aware of some of the new and better ways of taking care of cattle but not all of us have the money to purchasethe materials. Please help us tell government to assist usin the area of bore holes, health facilities and conflict management* (Umaru, 06/06/2015)

A study by Schilling, Opiyo and Scheffran(2012)contended that violent conflicts can undermine the gains of adaptation programme, if not managed properly. For instance,water and pasture resources can only be accessed in areas with security(Francis, Wasonga, Nyangito, Schilling, and Munang, 2015)

4.8 Relationship between Climate Variability (Rainfall, Temperature, Drought, Pests and Diseases) and Pastoralists' Perception of its impact on livestock production.

Awareness of the impacts of climate change is an important component of the adaptation process to manage the impacts, enhance adaptive capacity and reduce overall vulnerability. Correlational analysis was used to quantify effects of temperature, rainfall, drought and pests and diseases on livestock production. The Pearson Product Moment Correlation coefficient was used to test the significant relationship at 0.05 and 0.01. Table 4.9 depicts information on the relationship between climate variability and pastoralists' perception of the impact on livestock production. The variable pairs indicated in Table 4.8 represent the significant correlation the hypothesized perception of climate change indicators has on animal production.

Hence, in Table 4.9, rainfall ($r = 0.301$, 0.302 and 0.355, $p \leq 0.000$) was found to impact significantly on the perception that animal performance is declining, forage availability and quantity are decreasing as well as reduction in income from livestock. The implication of this is that rainfall affects the availability of animal feed and water for livestock rearing. Changes in rainfall patterns will likely affect the quantity and quality of water available for livestock consumption. This would affect livestock health, with potential impacts on the quality of meat and milk.

Solomon (2001), Kgosikoma (2006) and Abdeta (2011) reported that there are correlations between rainfall variability and livestock population dynamics-rainfall variability greatly influences herd dynamics in terms of herd die-off and lower birth rates, which also considerably affects milk production.

Table 4.9: Correlation Between Pastoralists' Perception of Climate Variability and Impact on Animal Production

Variable pairs	r- value	p-value	Decision
Decrease in Rainfall and decreased animal performance	0.301	0.000	Significant
Decrease in Rainfall and decreased forage availability and quantity	0.302	0.000	Significant
Decrease in Rainfall and reduction in income from livestock	-0.355	0.000	Significant
Increase in Temperature and increase in animal mortality	-0.633	0.000	Significant
Increase in Temperature and increased incidence of pests and diseases	0.456	0.000	Significant
Increase in Drought and reduction in water quality and availability	-0.745	0.000	Significant

**Correlation is significant at the 0.01 level (2-tailed). Source: Field Work, 2014

Similarly, Mwang'ombe, et al. (2011) stated that changes in rainfall patterns and increased temperature have resulted in the drying up of surface water and sub-surface water sources, which can affect livestock production interms of weight loss of the animals, increased diseases and death of livestock as well as reduced livestock fertility and milk production. Hence, Sejian and Knaqvi (2012) asserted that climate variability could have potential impact on the econmic prospect of livestock production system globally.

Temperature ($r = -0.633$ and 0.456, $p \leq 0.000$) was found to have significant impact on the perception that animal mortality is increasing and there is higher incidence of pests and diseases. This relationship implies that extremelyhigh temperature is a critical challenge to livestock productivity. Erratic weather conditions render livestock more vulnerable to diseases such as trypanosomiasis. A large amount of literature on climate variability impact on pastoral livelihood has indicated that higher temperature may increase heat stress for animals causing them to eat less, resulting in less weight gain and decreased performance and reproduction (Alemayedu and Fatahun, 2012; Mwang'ombe, et al., 2011; Chase, 2006). Furthermore, Hatfield (2008) used heat stress models to predict the impact of climate variability on livestock production.The study revealed that by 2040 in central USA, swine may take 1.5 to 3.7 days longer to reach slaughter weight. In cattle, it could take 2.8 to 4.8 days longer, and milk production could be reduced up to 2.9 percent.

The correlational analysis also found that drought ($r = -0.456$, $p \leq 0.000$) has significant relationship with the perception that there is reduction in water quality and availability. Drought is a long period of dry weather during which there is very little or no rain.Therefore, a likely effect of drought on livestock production systems is a fall in fodder availability and reduction in

the quality and quantity of drinking water. As a direct consequence of feed inadequacy, dairy stock on most smallholder resource-poor farms are often in poor body condition (emaciated).

In effect, many research reports (Leister, Paarlberg and Lee, 2015; Bekele and Amsalu, 2012; Shafiq and Kakar, 2007 ; De Kruit, 1978) have clearly demonstrated that fertility levels and the timing of conception are strongly correlated to the nutritional status of female animals. Hence, milk production decreases as female's access to fodder is lessened.This has adverse effect on the animal's nutritional status as well as the herder's family welfare. In the same vein, Lanyasunya, Musa, Yang, Mekki and Mukisira (2005) stressed that inadequate nutrition is a major cause of low liveweight gains, infertility and low milk yields in dairy cattles. In addition, Opiyo, Wasonga, Nyangito, Schilling and Munang (2015) conclude that the impact of drought among pastoral communities normally manifests itself in the form of livestock losses, which adversely affects the provision of subsistence, income, and other sociocultural goods and services to a pastoral household.

4.9 Relationship Between the Socio-Economic Characteristics of the Pastoralists and their Coping Strategies to Climate Change (n = 548)

To assess the association between socio-economic characteristics of pastoralists and their coping strategies in Zamfara and Katsina states, a chi square analysis was conducted (Table 4.10). The table revealed that sex has a significant and positive relationship (χ^2= 321.898, P≤ 0.05) with coping strategies for climate extremes. A possible implication of this relationship is that male headed households are likely to choose more laborious and risky strategies such as livestock migration, herd splitting and feeding on crop residue than the female headed household. This is due to the physical and natural capability difference in male and female. In addition, male headed households have a greater likelihood of acquiring information regarding different

farming technologies than their female counterpart due to the traditional social barriers placed on women. In most cases, women are found to adopt less laborious strategies like selling of firewood and charcoal, petty trades, feeding on wild fruits and roots, reducing food intake etc.

The preceding investigation is in concurrence with Asfaw and Admassie (2004) who found that male headed households have a greater possibility of obtaining information regarding new farming technologies as well as undertake riskier ventures than female headed households. In a related vein, Tenge and Hella (2004) observed that female headed households are not likely to adopt soil and water conservation practices as women might have limited access to information, land, and other resources caused by traditional social barriers.

On the contrary, Nhemachena and Hassan (2007) asserted that female headed households are more likely to adopt different methods of climate change adaptation than male headed households.

Table 4.10 has also revealed that age (χ^2 =219.664, p≤0.05) of pastoralist is significantly related to the coping strategies. Effect of age on coping strategies has been varied in the literature. First and foremost, age may have a negative effect on the decision to adopt new farming technologies basically because older farmers may be more risk-averse and therefore, less likely to be flexible than younger farmers. Gbetibouo (2009) and Ayanda, *et al.* (2013) corroborate the foregoing results that the youth are highly travelled, venturesome and can take on risky ventures more than the adults.

Second, age could have a positive effect on the decision of the farmer to adopt for the fact that older farmers may perhaps have more experience in farming and as a result, more capable of assessing the features of a new farming technology than the younger farmers. Maddison (2006)

and Nhemachena and Hassan (2007) supported the aforementioned that experience in farming increases the probability of uptake of adaptation measures to climate change.

Table 4.10: Association Between Pastoralists' Socio-Economic Characteristics and Coping Strategies to Climate Change (N = 548)

Variable	Degree of Freedom	χ^2calculated	χ^2tabulated	Probability	Comment
Gender	1	321.898	3.841	000	Significant
Age	3	219.664	7.815	000	Significant
Marital Status	3	1046.730	7.815	000	Significant
Household Size	3	326.248	7.815	000	Significant
Education	4	168.150	9.488	000	Significant
Income	4	79.062	9.488	000	Significant
Occupation	4	793.807	9.488	000	Significant
Size of Cattle	4	147.639	9.488	000	Significant
Types of animal reared	5	270.168	11.070	000	Significant
Duration	3	270.168	7.815	000	Significant

Source: Fieldwork, 2014

Regarding educational attainment of respondents, Table 4.10 revealed a positive and significant relationship (χ^2=168.150, p≤ 0.05) with coping practices. Basically, educated farmers are expected to have more knowledge and information about climate change and agronomic practices that they can use in response. Ayanda, *et al.* (2013) concurred with the forgoing view by admitting that educational attainment will enable farmers to access information on animal husbandry practices through the print or electronic media that can assist them to mitigate adverse effects of climate change. On the other hand, Aymone (2009) established that education level and gender did not have a significant impact on the probability of choosing any adaptation techniques.

With regards to income of respondents, Table 4.10 has demonstrated a significant connection (χ^2 = 79.062, p≤ 0.05). Income of the farmers, irrespective of sources- whether farm or nonfarm, signifies the wealth of individual households. Consequently, Knowler and Bradshaw (2007) indicate that farmers' income has a positive relationship with the uptake of farming technologies as any adoption/adaptation process requires that the farmer has sufficient financial wellbeing.

Household size of respondents is also significantly related (χ^2 =326.248, p≤ 0.05) to their coping strategies. Rogers (2003) asserted that the larger the size of the household the ease with which tasks can be accomplished and innovations are adopted. Similarly, Croppenstedt, Demeke and Meschi (2003) argued that larger households have a larger pool of labour and as a result, they are more likely to adopt agricultural technologies than smaller households. Furthermore, Yirga (2007) established that households with large families may be forced to divert part of the labour force from farm to off-farm activities in an attempt to earn some income that can ease the consumption pressure imposed by a large family in the face of climate change.

CHAPTER FIVE: SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

This chapter presents the summary of the study; conclusions drawn and recommendations made from the findings.

5.2 Summary

Climate change poses a great menace to human security through erratic rainfall patterns, rising temperature, decreasing crop yields and animal performance contributing to increased hunger. Adaptation is considered an appropriate response to climate change especially for rural producers. Therefore, this study examined pastoralists' perception of climate variability, its effects on nomadic pastoralists' livelihood activities and coping strategies adopted in response to climate variability. The study also provided a description of the pastoralists' socio-economic characteristics. The primary data used in the study were collected through structured questionnaire, Focus Group Discussions and Key Informant Interview. A multi-stage sampling procedure was employed to obtain a total of548 respondents for the study. The data were analyzed using both descriptive and inferential statistics. The descriptive statistics included frequencies, percentages and means while the inferential statistics used were Chi-square and Pearson Product Moment Correlation Coefficient.

Results indicate thatherding as an occupation has been greatly constrained by rainfall. The study also establishes that the predominant coping strategies of the pastoralists to climate variability are: move long distance to find pasture (RII=0.9**),** use of crop residues as animal feeds (RII=0.9),

herd splitting (RII=0.9) and praying to God (RII=0.9). The research as well discovers that 89% of the pastoralists in Katsina State and 78% in Zamfara State perceived increase in temperature, while 83% Katsina and 77% Zamfara perceived decrease in rainfall.Against this, the trend analysis of the temporal changesin rainfall and temperature for over 19 years show a consistent increasing trend in both annual mean surface temperature and annual mean rainfall in the study area. The study as well shows that the major impediments to adaptation in the study area are conflicts over scarce resources (pasture and water) ($\bar{\chi}$= 2.7), agricultural expansion limiting livestock movement ($\bar{\chi}$=2.6) and minimal extension services ($\bar{\chi}$=2.5).Results of the hypothesized relationship between climate variability and its impact on animal production revealed that rainfall had significantly impacted on forage availability and quantity (r = 0.302, P≤ 0.000) and reduction in income (r = -0.355, P≤ 0.000). Whereas, temperature is found to have significant impact on animal mortality (r = -0.633, P ≤ 0.000) and high incidence of pests and diseases (r = 0.456, P ≤ 0.000). Drought (r = -0.456, p ≤ 0.000) had significant link with reduction in water quality and availability.

In addition, the postulated relationships between pastoralists' socio-economic variables and the use of climate change adaptation measures revealed that educational qualification (χ^2=168.150, p≤ 0.05), level of income ((χ^2=79.062, p≤ 0.05), household size ((χ^2=326.248, p≤ 0.05) and ages of pastoralists ((χ^2=219.664, p≤0.05) were the most important factors influencing the use of adaptation measures.

5.3 Conclusion

It is evident from this study that pastoralists are experiencing change in climate and havebeen undergoing series of adaptations in response to climate variability already. However, the persistent increase in the magnitude of changeis expectedto present heightened risk, new

combinations of risks and potentially grave consequences, which could stifle their ability to cope effectively.

Irregular rainfall pattern affects the availability of water and pasture which is crucial to animal productivity. Consequently, livestock are usually subjected to long treks to find water and pasturein the more southerly areas of the country during the dry seasons. Hence,reduction in rainfall and its inter-annual variability in the study area necessitates adaptation of pastoralists and environmentally induced conflicts especially by the cattle rustlers as well as crop farmers owing to space contestation.

The inconsistency of pastoralists' perception of climate variability with recorded climatic data in the study area indicates low knowledge of climate variability and change among the pastoralists. This could pose a threat to acceptance of new innovations in adaption strategies by pastoralists in the study area.

Excessive warming hinders livestock production and reproduction by reducing animal weight gain and dairy production as well as income. Hence,the increasing warming trend in the study area poses a threat to animal performance. In addition, the decline in animal productivity, reduction in income from livestock farming and shortage in forage availability and quantity identified in the study area have shown that pastoralists in the study area are highly constrained by unproductive agricultural practice and hence prone to out-migration to favourable environment or diversification of livelihood. Basically,Fulani herdsmen, in the seasons when rainfall is very low and the graze lands are unable to sustain the population of livestock in the zone, geared their livestock to farmland area in the zone or down south in the country, situation which has caused violent conflicts between the herdsmen and farmers. Examples include,

clashesin Makera and Usi villages in Birnin- Magaji district of Zamfara state on the 5th of January, 2013 and nomadic village in Faskari District of Katsina state on the 19th of May, 2013. Hence, climate change is the bane of incessant resource use conflicts in the study area.

5.3 Recommendations

Based on the findings of this study, it is suggested that policy makers, planners, development agencies and donorsshould put in place the followingpolicy measures to mitigate the adverse effects of climate change on pastoralists.

I. **Breed Improvement:** Government and NGOs should promote the use of improved cattle breeds by introducing exotic breeds have high resistance to drought and diseasesat subsidized prices to pastoralists.

II. **Improvement in livestock health care:** Government and other development partners should invest in equipping and establishment of veterinary health centres in pastoral communities as well as training educated pastoralists in the correct use and application of veterinary drugs.

III. **Improvement in the extension service:** This could be achieved by increasing extension farmers' ratio and making the extension services more accessible to pastoralists

IV. **Improving climate information forecasting and dissemination:**

Since adaptive capacity is relatively determined by knowledge (local knowledge inclusive) and the awareness of climate change threats, it will be vital to increase pastoralists' awareness of potential climate related hazards, as well as suitable mechanism to address such risks. This could be done through local awareness campaign, mainstreaming climate change issues into other trainings and conducting awareness meetings.

V. **Making credit available to livestock farmers**: Government and NGOs should facilitate the availability of credit to pastoralists through encouraging micro finance institutions to widen their coverage of credit delivery to smallholder farmers and relax some of the requirements to give loans. These would enable pastoralists afford adaptation options that are somehow expensive given rise to high levels of productivity under changing climatic conditions.

VI. **Enhancement of adaptive capacity**: Government and other development partners shouldcreate conducive policy that will improve adaptive capacity of the pastoralists.In view of the high degree of climate variability and pastoralists' vulnerability, government policy intervention in the States should centre largely on addressing the fundamental causes of vulnerability of the pastoralists and their low adaptive capacity such as their high dependence on natural resources, medium income, inadequate education and employment alternatives/opportunities. Such policy must be adjusted to local content and integrated into broader long-term development plan at different scales.

VII. **Creation of alternative investment opportunities:** Government and NGOs should encourage pastoralists to invest on non-farm engagements-wage paying activities, self-employment in commerce (distribution and provision of farm inputs), manufacturing (agro processing) and other services to reduce the pressure on natural environment. This would go a long way in increasing the profitability of farming by increasing the availability of inputs and improving access to market outlets.

VIII. **Improvement in ranch management:** Government policy in this regard should aim at transforming nomadic subsistence livestock production into sedentary and more commercially oriented system. Hence, government should establish ranches, where

animals will be kept and grazed exclusively within the ranch boundaries to curtail crop farmers –herders conflict.

IX. Furthermore, boosting informal social networks and introducing adaptive technologies from other countries with related socio-economic and environmental settings could improve the adaptive capacity of Nigerian herders.

5.4 Contributions to Knowledge

I. The study is vital to policy developers in planning for policies and adaptation strategies that are precise to specific location. This is because the study digressed from top to down conventional approach centred on climate situations generated through general circulation models to bottom to top approach which concentrates more on holistic impact assessment and adaptation to climate change.

II. The study validated local knowledge and perception of climate variability and adaptation practices in two states north-western Nigeria.

III. The study contributed to general adaptation literature by forming a base line data for policy implementation and opening new frontiers for future research.

5.5 Suggestions for Further Research

The following areas which constitute lacunae created by the present study have been suggested for further research.

I. Investigation of the pastoralists perception of the causes of climate variability and change.

II. Determination of factors that influence pastoralists choice of coping strategies

III. A more extensive research on pastoralists coping strategies to climate variability and change covering the entire nation supported by morerigorous analysis.

REFERENCES

Abaje, I. B., Ati, O. F., and Iguisi, E. O. (2012). Changing climatic scenarios and strategies for drought adaptation and mitigation in the Sudano-Sahelian Ecological Zone of Nigeria. In M. Iliya, and I. Dankani, *Climate Change and Sustainable Development in Nigeria* (pp. 99-121). Ibadan: Crown F. Publishers.

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

Abaje, I., Sawa, B., and Ati, O. (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.

Abdeta, A. (2011). *Effects of Drought on Cattle Herd Dynamics and its Implication on Local Livelihood Systems in Borana, Ethiopia.* Food Security Centre (FSC) Brief No 1, 16.

Abubakar, I. (2010). *Adaptive Strategies developed by local farmers to cope with Climate Change:A case study of Jibia Local Government,Katsina State.* Ahmadu Bello University,Zaria: Unpublished Undergraduate Project.

Abubakar, M. (2012). *A sociological assessment of nomadic pastoralists and sedentary farmers conflictsin Katsina State*(2007-2011). Unpublished M.sc Thesis,Department of Sociology, Ahmadu Bello University,Zaria.

Acquah, H. (2011). Farmers Perception and Adaptation to Climate Change:A Willingness to Pay Analysis. *Journal of Sustainable Development in Africa*, 13(5):!50-161.

Adamu, M. (2002). *The role of the native authority inthe agrarian and pastoral economy of Katsina Emirate 1903 to 1960.* Unpublished Ph.D thesis submitted to History Department,Ahmadu bello University,Zaria .

Adejuwon, J., Balogun, E., and Adejuwon, S. (1990). On the Annual and Seasonal Patterns of Rainfall Fluctuations in sub-Sahara West Africa. *International Journal of Climatology*, 10 (8): 839-848.

Adesina, A. A., & Forson, J. (1995). Farmers' perceptions and adoption of new agricultural technology: Evidence from analysis in Burkina Faso and Guinea, West Africa. *Agricultural Economics*, 13:1–9.

Adesina, A. A., and Zinnah, M. M. (1993). Technology characteristics, farmers' perceptions and adoption decisions:A Tobit model application in Sierra Leon. *Agricultural Economics*, 9:297-311.

Adger, N., Dessai, S., Goulden, M., Hulme, M., Lorenzoni, I., Nelson, R., . . . A., W. (2009). Are there social limits to adaptation to climate change? . *Climatic Change.*, 93:335–354.

Adger, W. (2001). Scales of governance and environmental justice for adaptation and mitigation of climate change. *Journal of International Development*, 13 (7): 921-931.

Adger, W. N., Hug, S., Brown, K., Conway, D., and Hume, M. (2003). Adaptation to Climate Change in Developing World. *Progress in Development Studies*, 3(3):179-195.

Adger, W., Agrawala, S., Mirza, M., Conde, Q., O'Brien, K., Pulhin, J., . . . Takahashi, K. (2007). Assessment of adaptation practices, options, constraints and capacity:Impacts, Adaptation and Vulnerability. In M. Parry, O. Canziani, P. Palutikof, L. van der, & C. Hanson, *Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate change* (pp. 717-743). Cambridge,UK: Cambridge University Press.

Adger, W., Huq, S., Brown, K., Conway, D., & Hulme, M. (2003). Adaptation to Climate Change in the Developing World. *Progress in Development Studies*, 3(3):179-195.

Admassie, A., Burhanu, A., and Abebe, T. (2008). *Stakeholders' Perception of Climate Change and Adaptation Strategies in Ethiopia pp1-4.EEA Research Report(Addis Ababa:EthiopianEconomicAssociation)Availableat:http://www.eeaecon.org/Research% 20 materials.htm(Accessed 22/01/2015.*

Agwal, A. and Perrin, N. (2009) Climate Adaptation, Local Institutions and Rural Livelihoods. In Adger, W.N., Lorenzoni, L., O'Brien, K.L., ed. *Adapting to Climate Change: Thresh hold, Values, Governance.* Cambridge University Press, New York, USA.

Akinsanola, A., and Ogunjobi, K. (2014). Analysis of Rainfall and Temperature Variability over Nigeria.*Global Journal of Human-Social Science:B Geography,Geo-science,Environmental Disaster and Management*, 14:(3)1-17.

Akponikpe', P., Johnston, P., and Agbossou, E. (2010). Farmers' Perception of climate Change and Adaptation Strategies in Sub-Saharan West-Africa. *Climate, Sustainability and Development in Semi-arid Regions.* Fortaleza-Ceara,Brazil.

Alemayedu, K. and Fatahun, T. (2012). The Effects of Climate Change on Ruminant Livestock Population Dynamics in Ethiopia. *Livestock Research for Rural Development*, 24(10)

Alinovi, L., D'Errico, M., Mane, E., & Romano, D. (2010). *Livelihoods Strategies and Household Resilience to Food Insecurity: An Empirical Analysis to Kenya. Paper Prepared for the conference on promoting Resilience through Social Protection in Sub-Saharan Africa.* Senegal, 28-30 June,2010: organised by the European Report of Development in Dakar.

Anderson, S., Morton, J., & Toulmin, C. (2010). Climate Change for Agrarian Societies in Drylands:Implications and Future Pathways . In R. Mearns, & A. Norton, *Social Dimensions of Climate Change.Equity and Vulnerability in a Warming World.* Washinton, D.C.: World Bank.

Andrew, O., and Olorunfemi, F. (2010). Climate change perceptions and determinants of adaptation strategies among rural farmers in coastal communities in Delta State. *IFe Resarch Publications in Geography*, 9(1):70-80.

Anonymous. (2000). New Nigerian, Monday,January 10,pp.2.

Asfaw, A., and Admassie, A. (2004). The role of education on the adoption of chemical fertilizer under different socioeconomic environments in Ethiopia. *Agricultural Economics,* 30 (3), 215–228.

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

Ayanda, I., Oyeyinka, R., Salau, S., and Ojo, F. (2013). Perceived Effects of Climate Change on Transhumance Pastoralists in Ogun State,Nigeria. *Global Journal of Human Social Science (B)*, 13(1):38-47.

Ayoade, J. (1995). *Climate and Human Welfare. Inaugural lecture.* University of Ibadan,Nigeria. pp. 17-20.

Ban, A. V., & Hawkins, H. (2000). *Agricultural Extension.* UK.: Blackwell Science,.

Banjade, M. (2003). *Local Perception and Use of Information for Forest User Groups: Case Studies from Dhankuta District, Nepal.* . Wageningen University.: MSc thesis Tropical Forestry. .

Barret, C.B. and Luseno, W.K. (2004) Decomposing Producer Price Risk: A Policy Analysis Tool with an Application to Northern Kenya Livestock Markets. *Food Policy,* 29(4):393-405

Basu, A., and Bandhyopadhyay, P. (2004). The effect of season on the incidence of ticks. *Bull Anim Health Prod Afr*, 52(1):39–42.

Bekele, A., and Amsalu, A. (2012). Effects of Drought on Pastoral Household in Fantale Woreda of Oromia Regional State, Ethiopia. *Journal of Environmental Issues and Agricultural in Developing Countries*, 4(3):5-19.

Bellemare, M.F. and Barret, C.B. (2006) An ordered Tobit Model of Market Participation: Evidence from Kenya and Ethiopia. *American Journal of Agricultural Economics*, 88 (2): 324-337

Belliveau, S., Smith, B., Reid, S., Ramsey, D., Tarleton, M., and Sawyer, B. (2006). *Farm level adaptation multiple risks:Climate change and other concerns.* Canada,University of Guelph: Occasional paper No 27.

Berkowitz, A. D. (2002). Guidelines for consent in intimate relationships. *Campus Safety and Student Development,* 3, 49-50.

Blench, R. (2001). *Pastoralism in the New Millenium.* FAO, pp. 11-12.

BNRCC (2008). *Vulnerability, Impacts and Adaptation to Climate Change in Nigeria.* Ibadan, Nigeria.: 1,Oluokun Street, Bodija, U, I. P. O. Box 22025.

Boru, D., Schwartz, M., Kam, Michael and Dengen, A.A. (2014), Cattle Reduction and Livestock Diversification Among Borana Pastoralists in Southern Ethiopia, *Nomadic Peoples.*18(1)

Bradshaw, B., Dolan, H., & Smit, B. (2004). Farm-level adaptation to climatic variability and change: crop diversification in the Canadian prairies. *Climatic Change*, 67(1):119–41.

Brklacich, M., McNabb, D., Bryant, C., and Dumanski, I. (1997). Adaptability of Agriculture systems to global climate change: A Renfrew county. In B. Liberty, Q. Chiotti,andT.Richard,*Agricultural reconstructuring and Sustainability:geographical perspective.* Ontario,Canada: Willingford:CAB International.

Bryan, E., Deressa, T., Gbetibouo, G., & Ringler, C. (2009). Adaptation to climate change in Ethiopia and South Africa: options and constraints', . *Environmental science and policy*, 12(4): 413–26.

Burton, I. (2002). From impacts assessments to adaptation priorities: the shaping of adaptation policy. *Climate Policy*, 2: 145-159.

Burton, I. (1992). *Adapt and thrive.* Downsview, Ontario: Canadian.

Burton, I., Kates, R.W. and G.F. White (1993). The Environment as Hazard, Guilford Press, 290 p.

Chase, L. (2006). *Climate Change Impacts on Dairy Cattle.*Cornell University, Ithaca,N.Y.Retrievedfromhttp://climateand farming.org/pdf/factsheets/iii.3cattle.pdf

Croppenstedt, A., Demeke, M. and Meschi, M. (2003). Technology adoption in the presence of constraints: the case of fertilizer demand in Ethiopia. *Review of Development Economics*, 7 (1), 58–70.

Dabi, D., Nyong, A., Adepetu, A. and Ihemegbulem, V. (2008). Past,Present and Future Adaptation by Rural Household of Northern Nigeria. In N. Leary, J. Adejuwon, V. Barros, I. Burton, J. Kulkarni and Lasco.R., *Climate Change and Adaptation.* London: Earthscan Publications Ltd.

Dauda, S., Chado, S. and Igbashal, A. (2009). Agricultural Information Sources Utilized by Farmers in Benue State, Nigeria. *Production Agriculture and Technology*, 5 (1): 39-48.

De Kruit, A. (1978). Factors Influencing the Fertility of Cattle Population. *Journal of Reproduction Fertility*, 54:507-518.

Debela, N., Mohammed, C., Bridle, K., Corkrey, R., & McNeil, D. (2015). Perception of Climate Change and its Impacts by Small holdres in Pastoral/Agro-pastoral Systems of Borana, South Ethiopia. *SpringerPlus*, 4:236.

Deressa, T., and Hassan, R. (2009). Economic Impact of Climate Change on Crop Production in Ethiopia: Evidence from cross-section maesures. *African Journal of Economics*, 18:529-554.

Deressa, T., Hassan, M., & Ringler, C. (2011). Perception of and adaptation to climate change by farmers in the Nile basin of Ethiopia . *Journal of Agricultural Science*, 149:23–31.

Deressa, T., Hassan, R. M., Alemu, T., Yesuf, M., and Ringler, C. (2008). *Analysing the Determinants of Farmers' Choice of Adaptation Methods and Perceptions of Climate Change in the Nile Basin of Ethiopia,IFPRI Discussion Paper 00798.* International Food Policy Research Institute.

Deressa, T., Hassan, R., and Ringler, C. (2010). Perception of and adaptation to climate Change by Farmers in the Nile basin of Ethiopia. *Journal of Agricultural Science*, 149:23-31.

Deressa, T., Hassan, R., Ringler, C., Alemu, T., & Yesuf, M. (2009). 'Determinants of farmers' choice of adaptation methods to climate change in the Nile Basin of Ethiopia. *Global Environmental Change*, , 19(2): 248–55.

Desiere, S., Niragira, S., D'Haese, M., and Vellema, W. (2015). Cow or Goat? Population Pressure and Livestock Keeping in Burundi. *International Conference of Agricultural Economics(ICAE).* Milan, Italy.

Easterling, W. E., Hurd, B. H., & Smith, J. B. (2004). *Coping With Global Climate Change: The Role of Adaptation in the United States.* . Pew Centre on Global Climate Change.

Ejeh, L. and Sawa, B. (2014). Adaptation to climate change impacts:Some village examples in Semi-Arid Nigeria. *International Conference on Climate Change and Sustainable Economic Development* (pp. 219-226).Organised by Nigerian Meteorological Society (NMetS) and held at Benue State University, Makurdi from 9th-12th November, 2014: Seron Press Makurdi.

Ekaya, W. (2005). The Shift from mobile pastoralism to sedentary crop-livestock farminginthe drylands of eastern Africa:Some issues and challenges for research. *African Crop Science Conference Proceedings*, 7:1513-1519.

Elasha, B. (2006). *Environmental Strategies to increase Human Resilience to climate change: Lessons for Eastern and Northern Africa. A final Report submitted to Assessments of Impacts and Adaptations to climate change (AIACC),*. Sudan: Project No. AF 14 Higher Council for Environmental and Natural Resources(HCENR), .

Ellis, F. (2000). *Rural Livelihoods and Diversity in Developing Countries*. Oxford; New York: Oxford University Press.

Emeka, N. (2015). The Effects of Migration by Nomadic Farmers in the Livelihoods of Rural Crop Farmers in Enugu State, Nigeria. *Global Journal of Science Frontier Research: D Agriculture and Veterinary*, 15(3):21-28.

Ericksen, S., Aldunce, P., Bahinipati, C. S., Martins, R. D., Molefe, J. I., Nhemachena, C., . . . Ulsrud, K. (2011). When not every response to climate is a good one:Identifying principles for sustainable adaptation. *Climate and Development*, 3:7-20.

Eriksen, S., and Otto, N. (2003). *Pro-poor Climate Adaptation.Norwegian Development Cooperation and Climate Change Adaptation:An Assessment of issues,Strategies and Potential Entry Points.* Oslo: NORAD.

Eriksen, S., O'Brien, K., & Rosentrater, L. (2008). *Climate Change in Eastern and Southern Africa: Impacts, Vulnerability and Adaptation.* University of Oslo: Global Environmental Change and Human Security Report.

Esiobu, N., Onubuogu, G., and Okoli, V. (2014). Determinants of Income from Poultry Egg Production in Imo State, Nigeria: An Econometric Model Approach. *Global Advanced Research Journal of Agricultural Science*, 3(7):186-199.

Falola, A. F., Segun, B., Akangbe, J. A., and Ibrahim, H. (2012). Climate Change Mitigation Activities and Determinants in the Rural Guinea Savannah of Nigeria. *Sustainable Agriculture Research*, 1:(2):170-177.

FAO (Food and Agricultural Organization). 2008. Climate Change Adaptation and Mitigation in the Food and Agriculture Sector: High - level conference on food security: the challenges of climate change and bioenergy. P,56.

Folke, C., Carpenter, S., Elmqvist, T., Gunderson, L., Holling, C., Walker, B., . . . Ohlsson, L. (2002). *Resilience and Sustainable Development: Building Adaptive Capacity in a World of Transformation.* Environmental Advisory Council. Stockholm, Sweden.: Scientific Background Paper for the Process of the World Summit on Sustainable Development.

Francis, O., Wasonga, O., Nyangito, M., Schilling, J., and Munang, R. (2015). Drought Adaptation and Coping Strategies Among the Turkana Pastoralists of Northern Kenya. *International Journal of Disaster and Risk Science*, 6:295–309.

Frank, L. and Christine, A. (2009). *Migration, Environment and Climate Change: Assessing the Evidence.* Internal Organization for Migration, Geneva. (http://www.iom.int) Accessed on 9th of January, 2015.

Franklin, S. (2007) Dolly Mixtures: The Remaking of Genealogy, Duke University Press.

Fratkin, E., and Roth, E. (2005). *As pastoralists Settle:Social,Health and Economic Consequences of the Pastoral Sedentarization in Marsabit District* . Kenya: Kluwa Academic.

Gbegeh, B., & Akubuilo, C. (2013). Socioeconomic determinants of adoption of yam minisett by farmers in Rivers state, Nigeria. *Wudpecker Journal of Agricultural Research*, 2(1):033 - 038,.

Gbetibouo, G. (2009). *Understanding Farmers' Perceptions and Adaptations to Climate Change and Variability: The Case of the Limpopo Basin, South Africa.* . Washington DC: IFPRI.

Gbetibouo, G. A. (2009). *Understanding farmers' perceptions and adaptations to climate change and variability. The case of the Limpopo basin, South Africa.* IFPRI Discussion.

GCSI (2004). *Executive Summary of five multi sector surveys on Nigeria's vulnerability and adaptation to climate change. A joint project of NEST, Nigeria and GCSI, Canada* . Abuja,Nigeria. pp 16: under the auspices of Canada-Nigeria Climate Change Capacity Development Project, Canadian International Development Agency and Federal Ministry of Environment .

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

Hatfield, J. (2008). *The Effects of Climate Change on Livestock Production.* Retrieved from USDA online:http://www.thepigsite.com/articles/2296/the-effects-0f-climate-change-on-livestock-production

Helena, K., and Reimund, R. (2009). *Implications of and possible responses to Climate Change.* Helsinki Discussion Papers No.39: Department of Economics and Management, University of Helsinki.

Heltberg, R., Siegel, P. B., and Jorgensen, S. L. (2009). Addressing human vulnerability to climate change: toward a 'no-regrets' approach. *Global Environmental Change*, 19(1): 89-99.

Herlocker, D. and Dolan, R.A. (1980) *Primary Productivity of the Herb Layer and its relation to rainfall.* IPAL Tech. Rep. No. A-3. Proc. of a scientific seminar, Nairobi 24-27 November, 1980. UNEPMAB Integrated Project in Arid Lands, Nairobi.

Hoffmann, I. (1998). Zamfara Reserve-Past and Present. In I. Hoffmann, *Prospects of Pastoralism in West Africa.* 25: 1-9.

Houerou, H.N. and Hoste, C.H (1977) Rangeland Production and annual rainfall relations in the Mediterranean Basin and in the African Sahelo-Sudanian Zone. *Journal of Range Management* 30(3):181-189

Ibrahim, K. and Mohammed, B.M. (2015). Rising Temperature: Evidence of Global Warming in Northern Nigeria. *Journal of Global Environment and Earth Science*,5(22): 50-55

Idrisa1, Y. L. (2012). Analysis of Awareness and Adaptation to Climate Change among Farmers in the Sahel Savannah Agro-ecological Zone of Borno State,Nigeria. *British Journal of Environment and Climate Change*, 2(2): 216-226.

IFAD. (2008, May 9).*Climate change and the future of smallholder agriculture: How can rural poor people be part of the solution to climate change?* Retrieved from Discussion paper prepared for the Round Table on Climate Change at the Thirty-firstsessionofIFAD'sGoverningCouncil:http://www.ifad.org/climate/roundtable/indexhtm

Ifeanyi-obi, C., Etuk, U., & Jike-wai, O. (2012). Climate Change, Effects and Adaptation Strategies; Implication for Agricultural Extension System in Nigeria. *Greener Journal of Agricultural Sciences*, 2(2):053-060.

Iona, D. (2011). *A Study on the Challenge of Climate Change and Pastoralists' livelihoods among the Waso Boran in Northern Kenya.* Roskilde University pp1-8: Unpublished Msc thesis, International Development Studies, Department of Society and Globalisation.

IPCC. (2001). *Climate Change 2001:The Scientific Basis. Report edited by Houhton, J.T. et al., contribution of Working Group 1 to the Third Assessment Report of the IPPC.* Cambridge, UK: Cambridge University Press.

IPCC. (2007). *Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the IPPC.* Cambridge: Cambridge University Press.

IPCC. (2007). Impacts, Adaptation, and Vulnerability.Contribution of Working Group II to the Third Assessment Report of the Intergovernmental Panel on Climate Change . In M. Parry, & O. P. Canziani. United Kingdom: Cambridge University Press.

IPCC.(2007a). *Climate Change 2007 Synthesis Report:Contribution of Working Groups I,II and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change.* Cambridge: Cambridge University Press.

IPCC. (2007b). *Impacts,Adaptation and Vulnerability.* Cambridge: Cambridge university press.

Ishaya, S., and 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.

Jon, K., and Greg, S. (2012). *From Conflict to Coping: Evidence from Southern Ethiopia on the contribution of peace building to drought resilience among pastoralists' group.* Addis Ababa, Ethiopia: Mercy corps.

Joshi, S., Jasra, W., Ismail, M., Shrestha, S., and Wu, N. (2013). Herders' perception of and responses to climate change in Northern Parkistan. *Environmental Management*, 52 (3):639-648.

Juana, J., Kahaka, Z., & Okurut, F. (2013). Farmers' perceptions and adaptations to climate change in sub-Sahara Africa: a synthesis of empirical studies and implications for public policy in African agriculture. *Journal of Agricultural Science*, 5:121–135.

Kamruzzaman, M. (2015). Farmers' Perceptions on Climate Change: A Step toward Climate Change Adaptation in Sylhet Hilly Region. *Universal Journal of Agricultural Research*, 3(2): 53-58, 2015.

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

Kehinde, E. (2014). Conflict Management Strategies to reduce consequences of livelihoods of fulani cattle herds and farmers in Kabba Bunnu,Kogi State,Nigeria. *Nigerian Journal Of Rural Sociology*, 14(2):15-21.

Kgosikoma, O. (2006). *Effects of Climate Variability on Livestock Population Dynamics and Community Drought Management in Kgalagadi, Botswana.* Norway: M.sc Thesis, Norwegian University of Life Sciences.

Kirimi, N., John, G. M., and Agnes, O. N. (2013). Climate Change Challenges and Adaptation Strategies among the Pastoralits of Laikipia county Kenya.*International Journal of Agricultural Extension*, 1(1):20-30.

Knowler, D., and Bradshaw, B. (2007). Farmers' adoption of conservation agriculture: a review and synthesis of recent research. . *Food Policy* , 32 (1), 25–48.

Krejcie, R.V. and Morgan, D.W. (1970). Determining Sample Size for Research Activities*Educational and Psychological Measurement*, 30: 607-610.

Ladan, S.I. (2014). Assessment of Sewage Disposal Method and Environmental Health Impacts in Katsina Metropolis, Northern Nigeria. Journal *of Life Sciences and Technologies*,2(1):38-43

Lanyasunya, T., Musa, H., Yang, Z., Mekki, D. and Mukisira, E. (2005). Effects of Poor Nutrition on Reproduction of Dairy Stock on Small holder Farms in the Tropics. *Pakistan Journal of Nutrition* , 4(2): 117-122.

Leister, A., Paarlberg, P. and Lee, J. (2015). Dynamic Effects of Drought on the U.S. Livestock Sectors. *Journal of Agricultural Applied Economics*, 47(2):261-284.

Leserogol, C. (2008). *Contesting the Commons: Privatizing Pastoral Lands in Kenya.* Ann Arbor: University of Michigan Press.

Lobell, D., Burke, M., Telbaldi, C., Manstranda, M., Fakon, W., & Naylor, R. (2008). Priortizing Climate Change Adaption Needs for Food Security in 2030. *International Journal of Science* , 31((9):60-71.

Maddison, D. (2007). *The perception of and adaptation to climate change in Africa.* Washington D.C., USA: The World Bank.

Maddison, D. (2006). *The perception of and adaptation to climate change in Africa. CEEPA* . University of Pretoria, South Africa: CEEPA Discussion Paper No. 10. Centre for Environmental Economics and Policy in Africa.

Mahmud, Y., Salvatro, D., Temesgen, D., Claudia, R., and Gunnar, K. (2008). *The Impact of climate change and Adaptation on food production in low income Countries.Evidence from the Nile Basin, Ethiopia.* Pretoria,South Africa:University of Pretoria.: IFPRI.Discussion paper NO 00828.Centre for Environmental Economics and Policy in Africa.

Marenya, P., & Barrett, C. (2007). Household-level Determinants of Adoption of Improved Natural Resources Management Practices among Smallholder Farmers in Western Kenya. . *Food Policy*, 32:515 – 536.

Max Lox Group (1978). Survey and Development Plans. Kaduna State Government. from Adamu (1993). Katsina State, Nigeria. Giant in the Tropics. *States Surveys*Vol.2.Gabumo Publishing Co. Ltd.

Maxwell, D., and Cardwell, R. (2008). *The coping strategies Index Field Methods Manual, Second Edition,*. CARE USA.

Mcbe, J., Lesile, P., and Deluca, L. (2010). Adopting Cultivation to Remain Pastoralists: The Diversification of Maasai Livelihoods in Northern Tanzania. *Human Ecology*, 38(3):321-334.

McCabe, J. (2003). Sustainability and Livelihood Diversification Among the Maasai of Northern Tanzania. . *Human Organization.*, 62(3):100–111.

McCabe, J. (2006). Cattle bring us to our enemies. Turkana ecology,politics, and raiding in a disequilibrium system. *Human Ecology*, 34(1): 147–149.

McGuire, B., Macon, I., and Kilburn, C.R.J. (2002). *Natural Hazards and Environmental Change.* London: Arnold.

Mertz, O., Mbow, C., Reenberg, A., and Diouf, A. (2009). Farmers' Perceptions of Climate Change and Agricultural Adaptation Strategies in Rural Sahel. *Environmental Management*, 43:804–816.

Meze-Hausken, E. (2004). Contrasting Climate Variability and Meteorological Drought with Perceived Drought and Climate Change in Northern Ethiopia. *Climate Research*, 27:19-31.

Mohammed, I. .. (2011). The Future of Pastoralism in the Sahel Zone of West Africa-Climate Change: Impacts and Consequences on pastoralism. *A paper presented at the International Conference on the Future of Pastoralism organised by the Future Agricultures Consortium at the institute of Development Studies* (pp. pp 1-20). University of Sussex and Feinstein: International Centre of Turfs University,21-23,March.

Mohammed, I., Muazu, E., Yahaya, S. and Midat, J. (2014). Food Insecurity Looms as Cattle Thieves Roam Free. *Leadership Newspapers* (leadership.ng/news/food-insecurity looms-cattle-thieves-roam-free) Accessed on 15th July, 2014.

Montle, B., and Teweldemedhin, M. (2014). Assessment of farmers' perceptions and the economic impact of climate change in Namibia:Case study on small-scale irrigation farmers (SSIFs) of Ndonga Linena Irrigation project . *Journal of Development and Agricultural Economics*, 6(11):443-454.

Moran, E.F. (2000). Human adaptability (2nd edition). Boulder, CO: Westview Press, 446 p.

Moretimore, M. (1989a). Livestock production. In J. Oguntoyibo, and M. Filani, *A Geography of Nigerian Development* (pp. 275-298). Ibadan: Heineman Educational Book Ltd.

Moretimore, M. (1989b). *Adapting to drought.* London: Cambridge Press Ltd.

Moretimore, M.J. and Adams, W.M. (2001). Farmer Adaptation, Change and Crisis in the Sahel. *Global Environmental Change.*11 (1):49-57.

Mortimore, M. (1998). *Roots in African Dust: Sustaining the Sub-Sahara Drylands*, London: Cambridge University Press.

Moser, S., & Ekstrom, J. (2010). A framework to diagnose barriers to climate change adaptation. *Proceedings of the National Academy of Sciences*, 107(51): 22026-22031.

Muhammed, I., Belel, A. I. and Muhammed, U. B. (2015). An assessment of farmer-pastoralist conflict in Nigeria using GIS. *International Journal of Engineering Science Invention*, 4(7):23-33.

Musa, J., Baba, K. M., and Beli, S. (2013). Economic Analysis of Crop Production under Jibiya Irrigation Project, Katsina State, Nigeria. *Nigerian Journal of Basic and Applied Science*, 21(4): 283-290.

Musembi, C., and Kameri-Mbote, P. (2013). Mobility, marginality and tenure transformation in Kenya: Explorations of community property rights in law and practice. *Nomadic Peoples*, 17(1):5-32.

Mustapha, S., Sanda, A., & Shehu, H. (2012). Farmers' perception of climate change in central agricultural zone of Borno state, Nigeria. . *Journal of Environment and Earth Science.* , 2:21–28.

Mwang'ombe, A., Ekaya, W., Muiru, W., Wasonga, V., Mnene, W., Mongare, P., and Chege, S. (2011). Livelihoods Under Climate Variability and Change: An Analysis of the Adaptive Capacity of Rural Poor to Water Scarcity in Kenya's Drylands. *Journal of Environmental Science and Tecnology*, 4(4):403-410.

Ndambiri, K., Ritho, C., Mbogoh, G., Ng'ang'a, I., Muiruri, J., Nyangweso, M., . . . Cherotwo, H. (2012). Analysis of farmers' perceptions of the effects of climate change in Kenya: the case of Kyuso district. . *Journal of Environment and Earth Science*, 2:74-83.

Nhemachena, C., & Hassan, R. (2007). *Micro-Level Analysis of Farmers Adaption to climate change in Southern Africa.* Washington DC: International Food Policy Research Institute, Washington.

Nhemachena, C., and Hassan, R. (2008). Determinats of African farmers' strategies for adapting to climate change.Multinomial choice analysis. . *African Journal of Agriculture and Resource Economics*, 2(1):83-140.

Niamir, M. (1991) Traditional African Range Management Techniques: Implications for Range land Development. ODI Pastoral Development Network Paper.

Niamir-Fuller, M. (2000). Managing mobility in African rangelands. In N. McCarthy, B. Swallow, M. Kirk, and P. Hazell, *property rights,risks, and livestock development in Sub-Saharan Africa* (pp. 102–131). Washinton,DC: International Food Policy Research Institute,.

Nicholas, O., Maduke, M., Enete, A., Amaechina, E., Onokala, P., and Eboh, E. (2012). A Framework for Agricultural Adaptation to Climate Change in Southern Nigeria. . *International Journal of Agriculture Sciences*, (5):243-252.

Nigerian Environmental Study/Action Team (NEST) and Global Strategies International (GCSI) (2004). *Executive Summary of five multi sector surveys on Nigeria's vulnerability and adaptation to climate change*. A joint project of NEST, Nigeria and GCSI, Canada under the auspices of Canada- Nigeria Climate Change Capacity Development Project, Canadian International Development Agency and Federal Ministry of Environment Abuja, Nigeria. pp 16

Nkonya, E., Pender, J., Kaizzi, C., Kato, E., Mugarura, S., Ssali, H., & Muwonge, J. (2008). *Linkages Between Land Management, Land Degradation, and Poverty in Sub-Saharan Africa: The Case of Uganda.* Wasington D.C.: International Food Policy Research Institute.

Nomadism. (2009). *Encyclopedia Britannica,2009 Student and Home Edition* . Chicago.

Nouhoun, Z., Luc, H., and Eva, S. (2013). Climate Change and Variability:Perception and Adaptation strategies of pastoralists and agro-pastoralists across different Zones of Burkina Faso. *Regional Environmental Change*, 13:(5):1-17.

NRC (2002). *Abrupt climate change inevitable surprises.* Washington, Dc.: National Academy press.

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

Nyanga, H., Johnsen, F., and Aune, J. (2011). Smallholder Farmers' Perceptions of Climate Change and Conservation Agriculture: Evidence from Zambia. *Journal of Sustainable Development*, 4(4): 73-85.

O'Brien, K., Pelling, M., Patwardhan, A., Hallegatte, S., Maskrey, A., Oki, T., . . . Yanda, P. (2012). Towards a sustainable and Resilient Future. In C. Field, V. Barros, T. Stocker, D. Qin, D. Dokken, K. Ebi, . . . P. Midgley, *Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation (A special Report of Working Groups I and II of the Intergovernmental Panel on Climate Change-IPCC)* (pp. 437-486). Cambridge,UK, and New York,USA: Cambridge University Press.

O'Malley, M. (2000). *Cattle and Cultivation: Changing Land Use Patterns in Pastoral Maasai Livelihoods, Loliondo Division, Ngorongoro District. Tanzania.* PhD dissertation. Department of Anthropology, University of Colorado.

O'Brien, K. L., S. Eriksen, L. P. Nygaard and A. Schjolden (2007): Why different interpretations of vulnerability matter in climate change discourses. *Climate Policy*,7: 52-68

Odekunle, T., Andrew, O., and Aremu, S. (2008). Towards a wetter Sudano-Sahelian ecological zone in twenty-first century Nigeria. *Weather*, 63(3):66-70.

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

Odjugo, P. A. (2010). Adaptation to Climate Change in the Agricultural Sectorin the Semi-arid Region of Nigeria. *2nd International Conference: Climate, Sustainability and Development in Semi-arid Regions*, (pp. 1-14). Fortaleza - Ceará, Brazil.

Odjugo, P. A. (2013). Analysis of climate change awareness in Nigeria. *Scientific Research and Essays*, 8(26): 1203-1211,.

Odjugo, P., and Ikhuoria, A.I. (2003). The Impact of Climate Change and Anthropogenic Factors on Desertification in the Semi-Arid Region of Nigeria. *Global Journal of Enviromental Science*, 2(2):118-126.

Odjugo, P.A.O. (2010). General overview of climate change impacts in Nigeria. *Journal of Human Ecology.*29(1): 47-55

Odoh, S., and Chilaka, F. (2012). Climate Change and Conflict in Nigeria: A Theoretical and Empirical Examination of the Worsening Incidence of Conflict between Fulani Herdsmen and Farmers in Northern Nigeria. *Arabian Journal of Business and Mangement Review(OMAN),* 2(1):1-15.

Olagunju, T.E. (2015). Drought, Desertification and the Nigerian Environment. A review. *Journal of Ecology and the Natural Environment*,7(7):196-209.

Ojo, O. (1985). Drought Persistence in Tropical Africa since 1969. *Proceedings on long-range forcasting research,WMO,workshop on the diagnosis and prediction on monthly and seasonal atmospheric variations over the Globe College Park: WMO Report Series.* I(6):73-85.

Okumu, F. (2013). *Small-Scale Farmers' Perceptions And Adaptation Measures To Climate Change In Kitui County, Kenya.* University of Nairobi: M.Sc. Thesis submitted to the Centre for Advanced Studies in Environmental Law and Policy (CASELAP),.

Oladipo, E. (2011). The challenge of climate change for Nigeria: An overview. In E. O. Iguisi, O. F. Ati, R. O. Yusuf, and A. E. Ubogu, *Climate Change Impacts: Risks and Opportunities* (pp. 22-44). Zaria: Proceedings of the International Conference of the Nigerian Meteorological Society held held at Ahmadu Bello University,Nigeria, 13th-17th November,2011.

Olaniran, J. (2002). *Rainfal Anomalies in Nigeia:The Contemporary Understanding. Paper presented at the 55th inaugural lecture.* University of Ilorin,Nigeria. pp. 55.

Oluwasusi, J., & Tijani, S. (2013). Farmers Adaptation Strategies to the Effect of Climate Variation on Yam Production: A case study in Ekiti State,Nigeria. *Agrosearch*, 13(2):20-31.

Onubuogu, G. and Esiobu, N. (2014). Trends, perceptions and adaptation options of arable crop farmers toclimate change in Imo State, Nigeria: A logit multinomial model approach . *World Journal of Agricultural Sciences*, 2 (5): 108-122,.

Onubuogu,G., Chidebelu, S., and Eboh, E. (2013). Enterprise Type, Size and Allocative Efficiency of Broiler Production in Imo State, Nigeria. *International Journal of Applied Research and Technology*, 2(6): 10 – 19.

Opiyo, F., Wasonga, O., Nyangito, M., Schilling, J., and Munang, R. (2015). Drought Adaptation and Coping Strategies Among the Turkana Pastoralists of Northern Kenya. *International Journal of Disaster Risk Science*, 6 (3):295–309.

Opole, O. (2013). *The Impact Of Climate Variability on Pastoralism:Forage Dynamics and Trends in Cattle Population in Kajiado County, Kenya.* M.Sc Thesis, Department of Geography and Environmental Studies, University of Nairobi.

Osotimehin, K. O., Tijani, A. and Olukomogbon, E. (2006).An economic analysis of small scale dairy milk processing in Kogi State, Nigeria *Livestock Research for Rural Development*,18(117)Retrieved:November14,2015,fromhttp://www.lrrd.org/lrrd18/11/osot18157.htm.

Ovuka, M., & Lindqvist, S. (2000). Rainfall variability in Murang'a District, Kenya: Meteorological Data and Farmers' Perception. *Geogr Ann Ser A Phys Geogr*, 82:107-119.

Ozor, N. (2009). Understanding Climate Change. Implications for Nigerian Agriculture,Policy and Extension. *National Conference on Climate Change and the Nigeria Environment.* Nsukka: Department of Geography,University of Nigeria.

Patil, D., Meena, H. R., Tripathi, H., Kumar, S., and Singh, D. (2012). Socio Economic Profile of Sheep Reared Dhangar Pastoralists of Maharashtra, India. *Journal of Recent Advances in Agriculture*, 1(3):84-91.

Patrick, S. (2012). *An Assessment of forest Resource Utilization and Management:A study of Katsina fuel wood Plantain Number 2 forest reserve in Katsina Local government Area of Katsina State.*

Patt, A., & Schröter, D. (2008). Perceptions of climate risk in Mozambique: implications for the success of adaptation strategies. . *Global Environmental Change*, 18:458–467.

Pauw, P. (2013). The role of perception in subsistence farmer adaptation in Africa-enriching the climate finance debate. *International Journal of Climate Change Strategies and Management.* , 5(3):3.

Philip, A., Andrew, J. D., & Lindsay, C. (2013, June 20). *Barriers to climate change adaptation in sub-Saharan Africa: evidence from northeast Ghana and systematic literature review*. Retrieved from Centre for Climate Change Economics and Policy: http:www.see.leeds.ac.uk/sri

Pittock, B. A., and Jones, N. R. (2009). Adaptation to What and Why? . In L. E. Schipper, and I. Burton, *Adaptation to Climate Change* (pp. 35-62). London: Earthscan.

Pius, Z., and Christopher, W. (2010). Livelihood Diversifications and Implications on Food Security and Poverty Levels in the Maasai Plains:The Case of Simanjiro District,Northern Tanzania. *African Journal of Environmental Science and Technology*, 4(3):154-166.

Posthumus, H., Gardebroek, C., and Ruerd, R. (2010). From Participation to Adoption: Comparing the Effectiveness of Soil Conservation Programs in the Peruvian Andes. *Land Economics*, 86(4):645-667.

Pouliotte, J., Smit, B., and Westerhoff, L. (2009). Climate Change and Development. *Adaptation and development: Livelihoods and climate change in Subamabab, Bangladesh*, 1:31-46.

Prager, K., and Posthumus, H. (2010). Socio-Economic Factors Influencing Farmers' Adoption of Soil Conservation Practices in Europe. In T. Napier, *Human Dimensions of Soil and Water Conservation* (pp. 203-223). Nova science publishers.

Pugliese, A., and Ray, J. (2009, Novemnber 19). *Awareness of Climate Change and Threat Vary by Region.* Retrieved from Adults in Americas, Europe most likely to be aware, perceive threat.:http://www.gallup.com/poll/124652/awareness-climate-change-threat-vary-region.aspx

Rogers, E. M. (2003). *Diffusion of Innovations (5th ed.).* London: Free Press.

Salawu, K.; Owolarafe, T.A.; Barau, M.M.; Lawal, T.A.; Abubakar; M.A.; Fadilu, M. and Nwachukwu, F.C. (2014). Determination of selected Heavy metals in seasonal river

in Maru Town, Zamfara state, Nigeria. *Journal of Environmental and Earth Science,*4(21):11-15

Sangeda, A., Maleko, D. and Mtengeti, E. (2013). Socio-economic and ecological dimensions of climate variability and change for agro-pastoral communities in Central Tanzania . *Livestock Research for Rural Development*, 25:(12)1-19.

Sawa, B. (2010). Climate Change and Spatio-Temporal Variability in occurence of wet dry Spells in Northern Nigeria. *The Zaria Geographer,Geography Department,A.B.U., Zaria,* Vol.18.

Scheffran, J., Marmer, E. and Sow, p. (2012). Migration as a contribution to resilience and innovation in climate adaption: social networks and co-development in northwest africa. *Applied Geography*, 33,119-127.

Shafiq, M. and Kakar, M. (2007). Effects of Drought on Livestock Sector in Balochistan Province of Parkistan. *International Journal of Agricultural and Biology*, 9(4):657-665.

Schilling, J., Opiyo, F. and Scheffran, J. (2012). Raiding pastoral livelihoods: Motives and effects of violent conflict in north- western Kenya. *Pastoralism: Research, Policy and Practice*, 2(25): 1–16.

Sejian, V. and Knaqvi, S. (2012). Livestock and Climate Change: Mitigation and Strategies to Reduce Methane Production. In G. Liu, *Green House Gases Capturing UtilizationandReduction.*Availablefromhttp:www.intechopen.com/books/greenhouse-gases-capturing-utilization and reduction .

Singh, S. K., Meena, H. R., Kolekar, D. V. and Singh, Y. P. (2012). Climate Change Impacts on Livestock and Adaptation Strategies to Sustain Livestock Production. *Journal of Veterinary Advances*, 2(7): 407-412.

Smith, J. and Lenhart, S. (1996). *Climate change adaptation policy options in vulnerability and adaptation of African ecosystems to climate change.* CR special,6(2) book version.

Smit, B. and Olga, P. (2001). *Adaptation to Climate Change in the Context of Sustainable Development and Equity.* In: McCarthy, J. J., O. F. Canziani, N. A. Leary, D. J. Dokken and K. S. White (eds.): 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.

Smithers, J., and Smit, B. (2009). Human Adaptation to Climatic Variability and Change. In L. E. Schipper, and I. Burton, *Adaptation to Climate Change* (pp. 15-33). London: Earthscan.

Sofoluwe, N. A., Tijani, A. A., and Baruwa, O. I. (2011). Farmers' perception and adaptation to climate change in Osun State, Nigeria. *African Journal of Agricultural Research*, 6(20):4789-4794,.

Solomon, D. (2001). *Cattle Population Dynamics in the Southern Ethiopian Rangelands.* Utah State University, Logan, Utah, USA.: Research Brief 01-02.The GL-CRSP Pastoral Risk Management Project (PARIMA).

Tamer, A., Radha, G., Patrick, S., and Koko, W. (2012). *Climatic Change, Vulnerability and Human mobility: Perspectives of Refugees from the East and Horn of Africa.* United Nations University, Institute for Environmental and Human Security Report No.1,June.

Tanner, T., and Mitchell, T. (2008). Entrenchment or Enhancement: Could Climate Change Adaptation Help to reduce chronic poverty?(4th September). *Institute of Development studies Bulletin Volume*, 39:6-15 .

Temesgen, D., Claudia, R., Mahmud, Y., Rashid, M., and Tekie, A. (2008). *Analysing the determinants of farmers' choice of Adaptation methods and perceptions of climate change in the Nile Basin of Ethiopia.* Washington,DC : IFPRI.Discussion paper NO 00798.

Temesgen, D., Yahualashet, H., & Rajan, D. (2014). Climate change Adaptations of smallholder farmers in south-eastern Ethiopia. *Journal of Agricultural Extension and Rural Development*, 6(11)354-366

Tizale, C. (2007). *The dynamics of soil degradation and incentives for optimal management in the Central Highlands of Ethiopia.* University of Pretoria; Pretoria, South Africa.: PhD thesis. Faculty of Natural and Agricultural Sciences.

Tenge De Graff, J. and Hella (2004) Social and Economic Factors Affecting the Adoption Of Soil and Water Conservation in West Usambara Highlands, Tanzania. *Land Degradation And Development*, 15 (2), 99–114.

Terrence, M., Paul, W., & Laura, D. (2010). Adopting Cultivation to Remain Pastoralists:The diversification of Maasai livelihoods in Tanzania. *Human Ecology*, 38(3):321-334.

Tol, R. (1998). Adaptation to climate change in the context of sustainable development and equity. *Global Environmental Change*, 8(2): 109-123.

Udo, R., and Mamman, A. (1993). *Nigeria Giant in the sun Vol.2 state surveys.* Lagos: Gabumo Press.

(UNFCCC) United Nations Framework Convention on Climate Change (1992) *Article1http*://unfccc.int/essential_background/convention/background/items/256.php Accessed on 02/07/10

UNFCCC. (2012, November 13). *United Nations Framework Convention on Climate change*. Retrieved from www.unfccc.int/adaptation/items/2973.php.

Umar, B.F. (2010). *The Pastoral-Agricultural Conflict in Zamfara State,Nigeria.* North Central Regional Centre For Rural Development. Iowa State University,Ames.

Usman, U., Yelwa, S., Gulumbe, S., & Danbaba, A. (2013). An Assessment of the Changing Climate in Northern Nigeria Using Cokriging. *American Journal of Applied Mathematics and Statistics*, 1(5):90-98.

Ward, D., Saltz, D., and Ngairorue, B. (2004). Spatio-temporal rainfall variation and stock management in arid Namibia. *Journal of Range Management* , 57: 130–140.

Weber, E. U. (2010). What shapes perceptions of climate change? *Wiley Interdisciplinary Reviews: Climate Change*, 1(3):332-342.

Whyte, A. (1977). *Guidelines for Field Studies in Environmental Perception.MAB Technical Notes.* Paris: UNESCO.

WU, N., and Yan, Z. (2002). Climate Variabilty and social vulnerability on the Tibetan Plateau:Dilemma on the road of Pastoral Reform. *Erdkunde*, 56:2-14.

Yesuf, M., Falco, S., Deressa, T., Ringler, C., & Kohlin, G. (2008). *The impact of climate change and adaptation on food production in low-income countries, .* Washington, Washington DC.

Yirga, C. (2007). *The dynamics of soil degeradation and incentives for optimal management in Central Highlands of Ethiopia.* Pretoria,South Africa: Unpublished PhD. Thesis. University of Pretoria.

Yohannes, G., Wolfang, B., and Ann, W. (2010). Emerging Responses to Climate Change in Pastoral System. *Rural Development News*, 2:1-8.

APPENDIX

DEPARTMENT OF GEOGRAPHY

AHMADU BELLO UNIVERSITY, ZARIA.

Dear respondents,

I am a PhD student of the above university undertaking a research on the ANALYSIS OF NOMADIC PASTORALISTS' COPING STRATEGIES TO CLIMATE VARIABILITY IN KATSINA AND ZAMFARA STATES, NIGERIA. Please help fill this questionnaire. This exercise is purely academic; hence information provided would be treated confidentially and used only for the purpose of research. Thank you.

Please tick [✓] where appropriate.

SECTION A: RESPONDENTS' PERSONAL BIODATA

1.Community of respondent: _____

2. Sex Male [ ] Female [ ]

3. Age (years) <15 [ ] 15-19 [ ] 20-24 [ ] 25-29 [ ] 30-34 [ ]
35-39 [ ] 40-44 [ ] 45-49 [ ] > 50 [ ]

4. Marital Status: Married [ ] **Single** D[illegible]rced [ ]

5. Political Status: Community head [ ] Family head [ ] Religious head [ ]

6. Occupation: Animal rearing [ ] Arable farming [ ] Trading [ ]
Civil servant [ ]
Artisan [ ] Others (Specify) [ ]

7. Level of Income: <1[illegible]000 10[illegible]0-200,000 20[illegible]00-300,000 [ ]
[illegible]300,000-400,000 [illegible]400,000

8. Level of Education [ ] Tertiary [ ] Secondary [ ] Primary [ ] Islamic [ ] Informal

9. Household Size: [ ] ≤ 5 [ ] 6-10 [illegible]11-15 [illegible]6-20 [illegible]21-25 [ ] 26

10. Religion: Christianity [ ] Islam [ ] Traditional [ ]

11. Ethnic group: Hausa [ ] Fulani [ ] Yoruba [ ] Igbo [ ] Others (specify)

12. Country of Origin_____

13. For how long have you been rearing animals? _____

14.What type of pastoralist are you? Settled ☐ Transhumance ☐ Nomadic ☐

15.What is the size of your cattle? Less than100 ☐ 100-500 ☐ 500-1000 ☐

1000-5000 ☐ 5000 & above ☐

SECTION B: PASTORALISTS' PERCEPTION OF CLIMATE VARIABILITY AND CAUSES

Please attempt to answer all the statements in your best possible manner and tick once for astatement.

3 = Agree, 2=Disagree, 1= Undecided

Pastoralists' Perception of changes in Rainfall, Temperature, Drought, flood, pests and diseases

S/N0.	Perceptions	Rainfall intensity			Temperature variability			Drought occurrences			Flood occurrences			Pests and Diseases incidence		
		1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
16	Increased															
17	No change															
18	Decreased															
19	I don't know															
20	Is likely to increase in our life time															
21	Others (Specify)															

3 = Agree, 2 =Disagree, 1 = Undecided

Pastoralists' Perception of changes in the onset and offset of seasons

S/N0.	Perceptions	Cold season			Hot season			Rainy season		
		1	2	3	1	2	3	1	2	3
22	Comes early									
23	Delays									
24	No change									
25	Don't know									
26	Others (Specify)									

3 = Agree, 2 =Disagree, 1 = Undecided

Perception of changes in the duration of seasons

S/N0.	Perceptions	Cold season			Hot season			Rainy season		
		1	2	3	1	2	3	1	2	3
27	Increased									
28	Reduced									
29	No change									
30	Others (Specify)									

3 = Agree, 2 =Disagree, 1 = Undecided

Pastoralists' perceived causes of climate variability

S/N0.	Perceptions	1	2	3
31	God			
32	Ancestral spirit and gods			
33	Deforestation			
34	Industrial Pollution			
35	Combustion of fossil fuel			
36	Scientists and Modernization			
37	Don't know			
38	Others (specify)			

3 = Agree, 2 =Disagree, 1 = Undecided

Pastoralists' perceived impacts of climate variability

S/N0.	Perceptions	1	2	3
39	Decreased animal productivity			
40	Increase in animal mortality			
41	Decreased forage availability and quality			
42	Reduction in income from livestock			
43	Reduction in water quality and availability			
44	Exacerbated conflicts over scarce resources			
45	Increased incidence of pests and diseases			
46	Shift in range land vegetation structure or boundaries			
47	Others (specify)			

SECTION C: PASTORALISTS' INTEGRATED VULNERABILITY

48. Frequency or number of occurrences of climate related natural disaster for the period of 17years (1996-2013) in the study area.

Extreme Climate Events	96	97	98	99	00	01	02	03	04	05	06	07	08	09	10	11	12	13
Flood																		
Drought																		
Storms																		
Whirlwind																		

49. Damages done to lives and properties due to climate related hazards for the period of 17 years in the area of study (1996-2013)

Damages	96	97	98	99	00	01	02	03	04	05	06	07	08	09	10	11	12	13
No. of Deaths of family members																		
Total no. of livestock deaths																		

50. Average number of livestock per species owned by households

Livestock	Cattle	Donkey	Goat	Sheep	Camel	Poultry
Number						

Livelihood Diversification

Agree=3, Disagree=2, Undecided=1

What other sources of income do you have aside from rearing of animals?

S/N0.	Sources of income	1	2	3
51	Trading			
52	Sale of firewood			
53	Mat making			
54	Traditional house building			
55	Digging of well			
56	Remittances			
57	Casual job			
58	Gifts			

59. Income Structure

Income	Percentage
Share of income from livestock to total income	
Share of income from non-farm job to total income	

SECTION D: PASTORALISTS' COPING STRATEGIES

5=strongly agree, 4=agree3=undecided, 2=disagree and 1=strongly disagree

Pastoralists' adopted strategies to curb the impact of climate variability on livestock keeping

S/N0.	Strategies	1	2	3	4	5
60	Move long distances to find pasture and water					
61	Use of crop residues as animal feeds					
62	Diversification of livelihood activities					
63	Herd splitting					
64	Herd destocking					
65	Herd diversification					
66	Concentrate feeding					
67	Water harvesting					
68	Praying to God					

SECTION E: BARRIERS TO ADAPTATION STRATEGIES

5=strongly agree, 4=agree3=undecided, 2=disagree and 1=strongly disagree

What are your challenges to the adopted strategies?

S/N0.	challenges	1	2	3	4	5
69	Conflicts over scarce resources-pasture and water					
70	Limited market accessed					
71	Inadequate knowledge and information on climate variability					
72	Inappropriate policy					
73	Minimal extension services					
74	Undefined regional boundaries					
75	poverty					
76	Agricultural expansion limiting livestock movement					
77	Limited skills to engage in new income					

SECTION F: PASTURE MANAGEMENT PRACTICE

How do you provide your animals with fodder? Tick as appropriate

S/N0.	Items	
78	Natural pasture	
79	Crop residue	
80	Purchase of fodder concentrates	
81	Growing of hay or other fodders	
82	Others(specify)	

83. Do you move longer distance now for grazing than before? Yes ☐ or No ☐

84. What is the average distance covered in grazing?

S/N0.	Items	
85	1-5km	
86	6-10km	
87	11-15km	
88	16-20km	
89	21-30km	
90	30 and above	

1 = strongly agree2 = Agree3 = Undecided4 = strongly disagree5 = Disagree

What is the trend of natural fodder availability around your community?

S/N0.	Items	1	2	3	4	5
91	Gradual decline in quantity available					
92	Steady increase in quantity available					
93	Remains the same					
94	Total decline					
95	Fast increase in quantity available					
96	Others					

97. What factors resulted in the trend observed above? _____

_____

98. What action did the trend necessitate? _____

SECTION G: WATER SUPPLY

1 = strongly agree2 = Agree3 = Undecided4 = strongly disagree5 = Disagree

What is your source for portable water for human and livestock consumption and use? Tick as appropriate

S/N0.	Items	
99	Bore hole	
100	Family well	
101	Dam	
102	River	
103	Public well	
104	Others	

105 Is the quantity of water from the above sources sufficient for the animals? Yes ☐ or No ☐

106 If No, why? _____

_____

_____

_____

_____

Which member of the family (household) usually fetches water for family need?

S/N0.	Items	
107	Household head	
108	House wives	
109	Female Children	
110	Male children	
111	Others	

1 = strongly agree2 = Agree3 = Undecided4 = strongly disagree5 = Disagree

What is the trend of availability of water?

S/N0.	Items	1	2	3	4	5
112	Gradual fall in the quantity of water available					
113	Steady increase in the quantity of water available					
114	Remains the same					
115	Fast drying off					
116	Others					

117. What factors resulted in the trend above?_____

_____

1 = strongly agree2 = Agree3 = Undecided4 = strongly disagree5 = Disagree

What actions did the trend necessitate?

S/N0.	Items	1	2	3	4	5
118	Pond widening					
119	Well deepening					
120	Developing new sources of water					
121	Rain water harvesting					
122	Others					

SECTION H: ENVIRONMENTAL MANAGEMENT ACTIVITIES

1 = strongly agree2 = Agree3 = Undecided4 = strongly disagree5 = Disagree

What is your usual source of cooking energy?

S/N0.	Items	1	2	3	4	5
123	Firewood					
124	Kerosene					
125	Animal dung					
126	Crop residue					
127	Charcoal					
128	Others					

1 = strongly agree2 = Agree3 = Undecided4 = strongly disagree5 = Disagree

If the source is fire wood from where do you get it?

S/N0.	Items	1	2	3	4	5
129	Bushes around					
130	Purchases from firewood sellers					
131	Others					

1 = strongly agree2 = Agree3 = Undecided4 = strongly disagree5 = Disagree
If from surrounding bushes, who is responsible for collection?

S/N0.	Items	1	2	3	4	5
132	Household head					
133	Male children					
134	House wives					
135	Female children					
136	Others					

1 = strongly agree2 = Agree3 = Undecided4 = strongly disagree5 = Disagree
What is the trend of firewood availability within your village in terms of quantity?

S/N0.	Items	1	2	3	4	5
137	Readily available					
138	Situations remain the same					
139	Getting scarce					
140	Becoming increasingly scarce					
141	Others					

SECTION I: GOVERNMENT PROJECT/DROUGHT CONTROL MEASURES

127. Did you know of any government climate change control agency?

Yes ☐ No ☐

1 = strongly agree2 = Agree3 = Undecided4 = strongly disagree5 = Disagree
How did government assist you after the last drought?

S/N0.	Items	1	2	3	4	5
128	No help					
129	Food relief					
130	Seedlings					
131	Credit facilities					
132	Others					

1 = strongly agree2 = Agree 3 = Undecided4 = strongly disagree5 = Disagree
How would you rate government's attitude to your community generally when droughts occur?

S/N0.	Items	1	2	3	4	5
133	Concerned and helpful					
134	Not sensitive					
135	Government's help did not reach us					
136	I don't know anything about government					
137	Others					

FOCUS GROUP DISCUSSION

Illustrative Focus Group Discussion Guides and Probes

Core questions	**Related Probe Questions**
General Questions 1. How much do you know about climate Change? 2. How will you describe the climatic situation in your community? 3. Why do you think climate is critical to nomadic activities? 4. Are there species of livestock that withstand the climatic condition in your Community than others?	**Related Probe Questions** 1. Probe for comments on awareness of the Issue of climate change. 2. Probes for comments on trends of weather conditions in the Area of Study. 3. Probe for comments on pastoral-climate Relationship in the study area. 4. Probe for coping strategy/adaptive capacity in the study area.
Questions on Vulnerability	
1. How has climate change affected livestock production activities in your community? 2. What are the socioeconomic implications of climate change on livestock?	1. Probe for comments on biophysical Vulnerability. 2. Probe for comments on socioeconomic Vulnerability.
Questions on pastoralists' coping strategy	
1. What techniques have pastoralists devised to curtail climate change? 2. What forms of support do pastoralists receive from the government? 3. What other sources of assistance do pastoralists benefit? 4. How regular are these support 5. Do you think pastorals in your community have been empowered enough to overcome the limitations set by climate change. ?	1. Probe on the use of traditional and modern coping strategies by pastoralists. 2. Probe for comments on whether there are any organized forms of support rendered by the government. 3. Probe for comments on other forms of assistance aside from the government. 4. Probe for comments on the frequency and reliability of supports offered. 5. Probe for comments on the adequacy of governments' intervention.
Questions on constraints to mitigation	
1. How effective are the curbing strategies adopted. 2.What are the perceived barriers to adopted strategy 3. How can the problem of climate change be effectively tackled?	1. Probe for comments on efficacy of adaptation method. 2.Probe for comments on hindrances to adaptation 3. Probe for comments on recommendations for the best strategy.

INTERVIEW

Illustrative Interview Guides

Name……...…Position/profession.....…….....
..... Village .....

General Questions

1. How much do you know about climate Change?

2. How will you describe the climatic situation in your community?

3. Why do you think climate is critical to nomadic activities?

4. Are there species of livestock that withstand the climatic condition in your Community than others?

Questions on Vulnerability

1. How has climate change affected livestock production activities in your community?

2. What are the socioeconomic implications of climate change on livestock?

Questions on pastoralists' coping strategy

1.What techniques have pastoralists devised to curtail climate change?

2. What forms of support do pastoralists receive from the government?

3. What other sources of assistance do pastoralists benefit?

4. How regular are these support

5. Do you think pastorals in your community have been empowered enough to overcome the limitations set by climate change.?

Questions on constraints to mitigation

1. How effective are the curbing strategies adopted.

2.What are the perceived barriers to adopted strategy

3. How can the problem of climate change be effectively tackled?