ASSESSMENT OF HOUSEEHOLD LEVEL OF ADAPTATION TO DROUGHT AMONG RURAL COMMUNITIES IN JIGAWA STATE, NIGERIA

BY

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A PHD THESIS SUBMITED TO THE SCHOOL OF POSTGRADUATE STUDIES AHMADU BELLO UNIVERSITY ZARIA, IN FARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF THE DOCTOR OF PHILOSOPHY DEGREE IN GEOGRAPHY

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DECLARATION

I declare that the work in the project thesis entitled ASSESSMENT OF HOUSEEHOLD LEVEL OF ADAPTATION TO DROUGHT AMONG RURAL COMMUNITIES IN JIGAWA STATE, NIGERIA in Department of GEOGRAPHY and ENVIRONMENTAL MANAGEMENT under the supervision of Prof. E.O Iguisi., Dr. B. A. Sawa and Dr. A. A. Ibrahim. The information derived from the literature has been duly acknowledged in the text and a list of references provided. No part of this thesis was previously presented for another degree or diploma at any university.

_____ _____

YAKUBU, Hassan Gwangwan ***Date***

CERTIFICATION

This project thesis entitled ASSESSMENT OF HOUSEHOLD LEVEL OF ADAPTATION TO DROUGHT AMONG RURAL COMMUNITIES IN JIGAWA STATE, NIGERIA by YAKUBU, Hassan Gwangwan PhD/SCI/39103/2012/2013 meet the regulations governing the award of Degree of Doctor of Philosophy (PhD) in Geography of the Ahmadu Bello University, and is approved for its contribution to knowledge and literary presentation.

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Prof. A. Z. ABUBAKAR Dean, School of Postgraduate Studies	_____ **Signature**	_____ **Date**

DEDICATION

I dedicate this work to my late father Muhammad Nasur Mikhael for his positive parental care,

May his soul rest in perfect peace Ameen

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ABSTRACT

This study assessed households' level of adaptation to drought among rural communities in Jigawa state. Rainfall data spanning a period of 35 years (1980-2014) was obtained from Jigawa State Agricultural and Rural Development Authority (JARDA) and Kano State Agricultural and Rural Development Authority (KNARDA) Offices in Dutse and Kano respectively. Normalized Rainfall Index (NRI) was used in depicting drought frequency and magnitude. Results show that the study area suffered fifteen drought episodes of different magnitudes representing about 42.86% of the entire period under study. Both frequency and magnitude declined especially in the last decade coinciding with the periods of annual rainfall increase. Results obtained from the questionnaire administered shows that households suffered numerous drought impacts. To assess the most pressing drought impact, drought impacts were ranked using Weighted Average Index (WAI) ranking. Famine, high food prices and poverty were the most impacting drought effects in the study area; ranking first, second and third respectively. Households through experience developed various adaptation strategies to mitigate the impact of drought. To assess the most effective adaptation strategy, Weighted Average Index ranking was used. Among the fifteen ranked adaptation practices, fatting, fertilizer and cash crops ranked first, second and third respectively. Problem Confrontation Index (PCI) was used in assessing households' constraints against effective adaptation. Respondents rated lack of fertilizer as the most problematic constraints against effective adaptation. Federal government should improve accessibility to, and affordability of fertilizer and other farm inputs. Governments and nongovernmental organizations should intensively exploit abundant underground water resources to enhance and increase irrigation activity; as of now, it is limited to the very scarce river banks and some low land terrain.

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CHAPTER ONE

INTRODUCTION

1.1 Background to the Study

Drought is an insidious hazard of nature. It is often referred to as a "creeping phenomenon" and its impacts vary from region to region. Drought can therefore be difficult for people to understand. It is equally difficult to define, because what may be considered a drought in one place would certainly not be considered a drought in another. In the most general sense, drought originates from a deficiency of precipitation over an extended period of time usually a season or more, resulting in water shortage for some activities. Its impacts result from the interplay between the natural event (less precipitation than expected) and the demand people place on water supply and this can exacerbate the impacts of drought (NDMC, 2014).

There is, however, no universal definition of drought due to the wide variety of sectors affected by drought, its diverse geographical and temporal distribution and the demand placed on water supply by human-used systems (Loukas and Vasiliades, 2004). Oladipo (1990) defined drought as “a pervasive climatic hazard resulting from precipitation deficit, which adversely affects established human activities and causing negative ecological changes in the affected areas over time”. Based on the nature of the water deficit, four types of drought are defined, namely: meteorological drought; agricultural drought; hydrological drought and socio-economic drought. The meteorological drought is defined by a precipitation deficiency over a pre-determined period of time. The agricultural drought (dry spells) is defined as a period when soil moisture is inadequate to meet the demands for crops to initiate and sustain plant growth. The hydrological drought is normally defined by deficiencies in surface and sub-surface water supplies relative to average conditions at various points through the seasons. The socio-economic drought occurs when the demand for an economic good exceeds supply as a result of a weather related shortfall in water supply (Wilhite, 2000; Loukas and Vasiliades, 2004; UNISDR, 2007).

Drought is caused by a number of factors which results in failure of effective precipitation. The underlying

cause of most droughts can be related to changing weather patterns manifested through excessive build up of heat on the earth surface, meteorological changes which result in a reduction of rainfall and reduced cloud cover, all of which results in greater evaporation rates. Drought is exacerbated by activities such as poor cropping methods, which reduce water retention of the soil, and improper soil conservation techniques which lead to soil degradation (Economic Commission for Africa [ECA], 2007).

However, since the 1960s, human-induced climate change has been increasingly contributing to extreme events in the form of rising temperatures (such as warmer spells and heat waves), changing precipitation patterns (e.g., flash floods) and sea storms (IPCC, 2013). The increased frequency and intensity of extreme weather conditions; such as droughts, floods, heat/cold waves, cyclones, delayed or early onset of rains, long dry spells, early withdrawal, during the last two decades, have been attributed to global warming (NDMG, 2010).The World Meteorological Organisation showed that the warmest 13 years of average global temperatures have all occurred in the 15 years since 1997, contributing to more frequent extreme weather events (Christian Science Monitor, 2011). However, rainfall is projected to become more variable with fewer rainy days but heavier rainfall events in most regions, consequently causing a greater risk of both droughts and floods (Watson, Zinyowera and Moss, 1998; McCarthy, Osvaldo, Canziani, Leary, Dokken and White, 2001).

The probability of drought at the on-set and towards the end of the rainy season is usually very high in Northern Nigeria (ICRISAT, 1984; Adeoye, 1986; Tenkouano, Chantereau, Sereme and Toure, 1997). Analyses conducted by the Nigerian Meteorological Agency (NIMET), have found that drought disasters are significantly more probable in recent times (Nnaji, 2001; Nnoli, 2004). The Director-General, Nigerian Meteorological Agency highlights that analysis of rainfall data (1911 -2000) in three 30 year intervals - 1911-1940; 1941-1970; 1971- 2000 show that many more places are recording late onset of rains, early cessation of rain, shortened length of the rainy season and reduced annual amount of rain especially in the northern part of the country. He also observed more frequencies of drought, more persistent harmattan haze and increasing temperature trends (Mohammad, 2009).

Dry spells (consecutive days with precipitation amount less than thresholds) at the beginning of the season usually result in multiple plantings and low or no yields leading to low food security index. In the

same vein, early cessation of rains could bring about water stress at critical periods of need during the reproductive stages of most crops thus resulting in crop failures and shrinking of yields (Abubakar and Yamusa, 2013). In Nigeria, the drought of the early 1970s caused a lot of economic disruptions. It was responsible for the drastic falls in GDP of 18.4% in 1971-1972 and of 7.3% in 1972-73 (Oladipo, 1993a, 1993b). It was also seen as causing the rapid rise in price index for foodstuff and relative decline in non-oil exports. It also resulted in the death of over 300,000 animals, representing about 13% of the total livestock population of the northeastern part of Nigeria (Jaiyeoba, 2002; Ati, 2006), while crop yield dropped by about 60% (Okorie, 2003; Alatise and Ikumawoyi, 2007). In addition to obvious losses in yields in crop and livestock production, drought is also associated with increases in insect infestations, plant diseases e.t.c. (FRN, 2000; ONRG, 2004a; Ayoade, 2005).

Many ways of coping with drought have been institutionalized over the years, and are now permanent features of the agricultural and social system at global, national, regional, community and individual level. According to Inter- Governmental Panel on Climate Change (IPCC, 2001), adaptation are actions taken to help communities and ecosystems moderate, cope with, or take advantage of actual or expected changes in climatic conditions. Various studies have revealed a number of indigenous adaptive measures being used by farmers to mitigate the effects of drought in the Sudano-Sahelian zone in general and the study area in particular these include changes in planting dates, changes in harvesting dates, multiple cropping (cropping of many crops on same piece of land), intensive manure application, intercropping main crops planted with subsidiaries at low densities, use of wetland/river valley (e.g. Fadama), evolving contingency cropping systems when rains are delayed, use of early maturing crop varieties or shifting to other crops grown instead of millet, use of early maturing dwarf sorghum variety (*Mace da kunya in Sokoto*) migration of pastoralists and their animals out of the community in search of feed and water e.t.c. (Gashua, 1991; Ariyo, Gashua and Oladipo, 1996; Ayeni, 2001; Nyong, Adesina and Elasha, 2007; Sanni, Oluwasemire and Nnoli 2012; Abubakar and Yamusa, 2013; Joshua and Ekwe, 2013)

Poor and marginalized households tend to be less resilient and face greater difficulties in absorbing and recovering from disaster impacts. Recurrent events also lead to compounding losses for many households, leading them to organize livelihoods in such a way that their overall risks are reduced in the

face of uncertainty, even if it means a reduction in income and an increase in poverty (UNISDR, 2009b). In the absence of effective adaptation, food insecurity and ill-health will deepen poverty and affect livelihoods, assets, infrastructure, environmental resources and economic growth thereby slowing poverty reduction and sustainable development strategies (Shemdoe, 2011).

However, local communities as well as individual farmers are continuously adjusting to environmental stress. These community adjustments are critical to the success of any new program introduced by government and they are tangible bases for innovations (Wisner and Mbithi, 1974). Lack of incorporation of indigenous adaptation strategies by government in its adaptations strategies may be the reasons why in Nigeria most programs aimed at mitigating the impact of drought failed as reported in literature (Joshua and Ekwe, 2013), a situation termed as institutional lapses by Mortimore (1989). For these reasons, it is of paramount importance to assess effectiveness of existing adaptation strategies of local farmers of Jigawa state in improving resilience to droughts.

Nigeria is likely to suffer increasing levels of climate change impacts because of its geographical location and weak institutional, human, economic, technological and financial capacity to cope with the multiple impacts of these disruptions. Vulnerability to climate change is compounded by the over dependence on climate sensitive sectors, especially agriculture. Millions of Nigerians experience food and water shortages and have to deal with inadequate crop harvest, crop failures, animal diseases, lack of water and pasture for animals (Sanusi, Apampa and Sotinrin, 2013).

1.2 Statement of the Research Problem

Africa and Nigeria in particular, appears to be particularly vulnerable to increasing water scarcity. Farmers in northern Nigeria perceived that the seasons have become less predictable than in the past (Ekpoh and Nsa, 2011; Farauta, Egbule, Agwu, Idrisa and Onyekuru, 2012; Joshua and Ekwe, 2013). Droughts are frequent about 3 in every 10 years; with high incidence of dry spell after the onset of rains (Sanni, Oluwasemire and Nnoli, 2012). While droughts are frequent, the rate of growth in agriculture has been one of the slowest in terms of production and productivity (FAO, 1998; Okorie, 2002). Recent food crises in countries such as Nigeria are remainder of the continuing vulnerability of the region to the vicissitude of

climatic condition. This is in large measure due to weak institutional capacity, limited engagement in environmental and adaptation issues, and a lack of validation of local knowledge (Adams *et al,* 1998; Spore, 2008; BNRC, 2008). A localized drought that occurred in Yobe state in 2004 resulted in a high degree of crop failure; especially millet, sorghum and rice together with locust and Quella bird invasion were recorded. Total tonnage of grains lost was estimated to about 330 metric tons (FME, 2004).

In northern Nigeria, Irrigation is one of the most effective ways of coping with and reducing the risk of drought. However, the overall performance of major public irrigation schemes in Northern Nigeria was reported to be generally poor due to improper maintenance, unreliable water delivery as well as technical deficiency in the infrastructure (Abubakar, 2008; Othman, Arab, Ibrahim and Kallah, 2010). Today, Nigeria has less than 9% of the total cropped area under irrigation (Sanni, Oluwasemire and Nnoli, 2012). Jigawa State Ministry of Agriculture (2013) indicated that less than 15% of the irrigable land in Jigawa state is under irrigation. Therefore, the rural population is very vulnerable to rainfall fluctuations

Apart from irrigation schemes, a number of measures have been taken by the Nigerian authority in collaboration with national and international research institutions in providing various adaptation strategies to mitigate drought such as; drought tolerant and early maturing crop varieties, reduction in post-harvest crop losses, increase in livestock and fisheries production, national strategic grain reserve, National Emergency Management Agency and weather forecasting. However, most of the drought interventions by Nigerian government in the region have failed to provide effective mitigation strategies to drought **(**Ariyo, Gashua and Oladipo, 1996; Oladipo, 2010; Joshua and Ekwe, 2013).This is because the policy framework to align human development and climate change response efforts through adaptation is largely undeveloped in the country and the country‘s institutional capacity to respond effectively to climate change is weak (Oladipo, 2010). Indeed, lack of incorporation of indigenous knowledge also poses a serious problem to adaptation of recommended amelioration measures by the people (Ijeoma, 2012; Nyong, Adesina and Elasha, 2007). However, education and awareness campaigns are considered among the most potent adaptation strategies to climate change impacts in general and drought in particular. Recent study in the region shows low educational and awareness campaign among rural farmers (Abaje, Sawa, Iguisi and Ibrahim, 2016).

Over 80% of the total land mass of Jigawa State is considered arable and about 90% of the State's population are predominantly farmers, making agriculture the major source of livelihood, food security and poverty reduction (Jigawa State Ministry of Agriculture, 2013). However, according to the 2015 Nigerian Poverty Assessment, the incidence of poverty in Jigawa State is 88.4%. Making it third only above Zamfara and Yobe (Osewa, 2015). Literature also revealed an increase in the occurrence of drought event in terms of frequency and intensity in the study area (Nsa and Ekpoh, 2011; Sanni, Oluwasemire and Nnoli, 2012; Abaje, Ati, Iguisi and Jidauna, 2013; Kayode and Francis, 2013) and this may pose serious challenges to the existing adaptation practices. However, most researches in the study area dwelled on drought occurrence, frequency and intensity as well as adaptation and management strategies but none have attempted to assess effectiveness of these generic strategies in meeting the basic needs of rural household in the study area. This is the gap in knowledge that the study intends to bridge as the livelihood of majority of households in the state is heavily reliant upon rainfall and the use of traditional implements highlighted by high poverty index of the study area. The research questions that this study addressed are:

1. What are the characteristics of drought in the study area between1980 and 2014?

2. What are the impacts of drought on households among rural communities in the study area?

3. What are the drought adaptation strategies adopted by the households in the study area?

4. How effective are these adaptation strategies in meeting basic needs of households in the study area?

5. What are the challenges against effective adaptation to drought impact among rural households in the study area?

1.3 Aim and Objectives of the Study

The aim of this study is to assess the level of adaptation to droughts among rural households in Jigawa State. The specific objectives to achieve this aim are to:

i. Assess the frequency of occurrence and intensities of drought in the study area between 1980 and 2014,

ii. identify the effects of drought on households of the rural communities in the study area,

iii. identify the various household indigenous drought adaptation strategies practiced by farmers in the study area

iv. examine the effectiveness of the various adaptation strategies in meeting households' basic needs among rural Communities in the study area.

v. examine the challenges against effective adaptation to drought among rural communities in the study area.

1.4 Scope of the Study

This study focused on household level of adaptation to drought among rural communities in Jigawa state. It covered extreme northern part of the state where drought impacts is more pronounced. However, the study covered a period of 35 years (1980-2014) as the Sahelian droughts of the 1970s and the 1980s ravaged this zone and left farmers impoverished (Ati *et al*., 2007). The Intergovernmental Panel on Climate Change Fourth Assessment Report (IPCC, 2007) states that the world indeed has become more drought-prone during the past 25 years, and that climate projections for the 21st century indicate increased frequency of severe droughts in many parts of the world. In Northern Nigeria literature reveals an increase in the frequency and more intense droughts in the 1980_s (Nsa and Ekpoh, 2011; Sanni, Oluwasemire and Nnoli, 2012; Abaje, Ati, Iguisi and Jidauna, 2013; Kayode and Francis, 2013).The scope also covers drought impacts, adaptation strategies and effectiveness of these strategies in minimizing the impacts. This is because it has been noted that the frequent occurrence of drought in this zone is responsible for the social backwardness and general poor quality of life; especially among the less privileged ones (Alatise and Ikumawoyi, 2007). The situation is being aggravated by increase in human population, which appears to be stressing natural support system (FRN, 2005).

1.5 Justification of the Study

Nigeria is experiencing unfriendly climate conditions with negative impacts on the welfare of millions of people. Persistent drought, delay in onset of rains, early cessation of rains and short rainy season; including pronounced dry spells, have caused low agricultural productivity for a country that is mostly dependent on rain fed agriculture. In recent years, concern has grown worldwide that droughts may be increasing in frequency, severity and duration given changing climatic conditions and documented increases in extreme climate events (Sivakumar, 2012; Peterson, Hoerling, Stott and Herring, 2013). Analyses conducted by the Nigerian Meteorological Agency (Ni MET), have found that drought disasters are significantly more probable in recent times (Adger, Huq, Brown, Conway and Hulme, 2015). While droughts are frequent, the rate of growth in agriculture has been one of the slowest in terms of production and productivity (IPCC, 2001)

CHAPTER TWO

CONCEPTUAL FRAMEWORK AND LITERATURE REVIEW

2.1 Introduction

This chapter explained the basic concept of drought, characteristics, impacts and adaptation. It also reviewed previous researches covering above mention drought parameters.

2.2 Conceptual Framework

2.2.1 Drought

Drought is a water supply and demand issue, which results from precipitation deficiency (rainfall) over a marked period of time (season, year), its onset or end, is rather difficult to predict (Oyebande and Balogun, 1990). However, drought is more than just a moisture deficit; it is the result of a complex interplay between natural precipitation deficiencies on varying time and space scales and can be exacerbated by human water demand (American Meteorological Society, 2004).

Drought is a natural part of climate, although many people erroneously consider it a rare and random event. It occurs in virtually all climatic zones, but its characteristics vary significantly from one region to another. Drought is a temporary aberration; it differs from aridity, which is restricted to low rainfall region and is a permanent feature of arid and semi-arid environment (Okorie, 2003; National Drought Mitigation Centre, 2006a; UNISDR, 2007). However, there is no universally accepted definition of drought due to the wide variety of sectors affected by drought, its diverse geographical and temporal distribution and the demand placed on water supply by human-use systems (Loukas and Vasiliades, 2004). Oladipo (1990) defined drought as a "pervasive climatic hazard resulting from precipitation deficit, which adversely affects established human activities and causing negative ecological changes in the affected areas over time".

2.2.2 Type of Drought

Based on the nature of the water deficit, many authorities defined four types of droughts thus;

(a) The meteorological drought which is defined as a lack of precipitation over region for a period of time.

(b) The hydrological drought which is related to a period with inadequate surface and subsurface water resources to supply established water uses of a given water resources management system, (c) The agricultural drought, which, usually, refers to a period with declining soil moisture and consequent crop failure without any reference to surface water resources.

(d) The socio-economic drought which is associated to the failure of water resources systems to meet the water demands and thus, associating droughts with supply of and demand for the economic good (Ayoade, 2004; Barry and Chorley, 2003; Okorie, 2003; AMS, 2004; Loukas and Vasiliades, 2004; NDMC, 2006; Trenberth, 2007; Wilhite, 2000 and UNISDR, 2007).

Apart from these types, other scholars categorized drought according to intensity into invisible, mild, moderate, severe and extreme (Shuaibu and Oladipo, 1993).Therefore, drought has many attributes. Other attributes apart from those mentioned earlier are; on-set, duration, persistency, return period and termination. However, out of these attributes, the important one is the intensity. This is because it shows the severity degree of the drought. The various intensities mentioned earlier have effects on the environment, agriculture, water availability and human beings in the area of occurrence. Drought effects vary with intensity. Therefore, the degree of impact of extreme drought on the environment for example will be greater than that of invisible or mild drought. The study focused on rural communities where agriculture is the main source of livelihood to most households. So concerns are mainly on agricultural drought and its impacts.

2.2.3 Causes of Drought

Drought is one of the most important climate-related disasters which climate change is set to exacerbate (ECA, 2007). In Nigeria, some areas like the Niger Delta regions receive more than normal rainfall, while some areas in the Northern region receive almost no rainfall as a result, growing seasons are changing, ecological zones are shifting, and rainfall is becoming more unpredictable and unreliable both in its timing and its volume (Brett, 2009). The crop water regime may be affected by changes in seasonal precipitation, within- season pattern of precipitation and inter annual variation of precipitation (IPCC,

2007).

Drought is caused by a number of factors which results in failure of effective precipitation. The underlying cause of most droughts can be related to changing weather patterns manifested through excessive build up of heat on the earth surface, meteorological changes which result in a reduction of rainfall and reduce cloud cover, all of which results in greater evaporation rates. When there is high air pressure, air falls instead of rising. With the air pressing down in a high pressure zone, no current of water vapour are carried upward. As a result, no condensation occurs, and little rain falls to the earth. In addition, high-pressure areas push clouds and currents downward and away, resulting in sunny, cloudless weather. It is normal for a high pressure system to pass over an area and move on, being replaced by a low pressure system. However, when a high pressure system is stalled, the sunny weather can drag on for days. If it keeps on going, the result is a drought (OEF, 2000).

The persistence of drought in parts of northern Nigeria during the 1970s, 1980s and 1990s were attributed to the prevalence of a stagnated anti-cyclonic circulation of tropical atmosphere over areas that normally should be exposed to rising arm of tropical Hadley Cell circulation by mid-summer (Kalu, 1987; Kamara, 1986). These conditions are themselves related to the tropical component of global general circulation system. Tropical circulation patterns are particularly influenced by heat inputs from such sources as warm ocean surfaces acting through latent heat released in deep cumulus convection (Lockwood, 1988). Related heat sources which also have important bearing on tropical circulations are high plateaus and equatorial rainforests (Nicholson and Tucker, 1998). These heat sources display visible latitudinal and longitudinal variations, and also a marked tendency to vary on both annual and in case of oceans, non-annual scales. One of the consequences of these circulation patterns is that rainfall patterns in West Africa, including northern Nigeria, show both annual and greater than annual variations and also marked tele-connections with distant locations (Nicholson, 1985).

Most of the droughts that occur in this region have been found to be associated with a late start of rainy season and early cessation of rains, resulting in drastic reductions of the length of the rainy season. For instance, a number of studies within the Sudano-Sahel region have shown significant trend towards false onset, late or delayed onset and early cessation of the summer rains over a 30-year period from 1969 to

1998 (Houndenou and Hernandez, 1998; Ekpoh, 1999a; Camberlin and Diop, 2003; Abubakar and Yamusa, 2013). In addition, long- term rainfall analysis for the area has revealed frequent appearances of false onsets, as well as, a trend towards a pronounced decrease in annual rainfall amounts (Ekpoh, 1999a; Floyd and Ekpoh, 2007).

Drought can occur virtually anywhere in the world during ENSO events, though researchers have found the strongest connections between ENSO and intense drought in Australia, India, Indonesia, Philippines, Brazil, parts of east and south Africa, the western pacific basin islands (including Hawaii), central America and various parts of the United States. Drought occurs in each of the above regions at different times (seasons) during an event and in varying degrees magnitude (NDMC, 2006a). In a study conducted by Kpripalani and Kulkami (1997) recognized that the ENSO phenomenon is the single most important cause of year to year climatic variability. According to them, majority of the warm extremes (El Nino events) cause below–normal rainfall over Indonesia, while cold extremes (La Nina events) cause above normal rainfall over India. Since the late 1960s, Sahelian drought has been shown to have tele-connections with El Nino Southern Oscillation (ENSO); a phenomenon that is associated with periodic fluctuation in intensity of inter-tropical atmospheric and oceanic circulations that is usually coincident with anomalous warming of the Eastern Tropical Pacific Ocean (Nicholson, 1993; Foland, Palmer and Parker, 1986; Ekpoh, 1991; Akonga, 2001).

Giannini, Saravanan and Chang, (2003) further identified Sea Surface Temperature (SST) as the principal driver of Sahelian rainfall variability, which they modeled successfully for the period 1930-200 0, using a model that also represents land-atmosphere interaction, via moisture feedbacks. Other studies that similarly used long-term data from a number of synoptic stations in Nigeria also yielded some very useful information on the recurrence, persistence and periodicity of severe droughts in Nigeria (Adefolalu, 1985, 1986; Tarhule and Woo, 1998).

Empirical studies conducted over the past century have not shown that drought is exclusively the result of a single cause. It typically results from a synergistic interaction between regional and remote influences (AMS, 1997). Studies on the causes of drought according to Oladipo (1993b) fall into four main categories. First are the studies which regard droughts as local manifestations of anomalies in the large-

scale atmospheric circulation. Second are studies that have elaborated on the dynamical teleconnections between the dominant drought time scales and those of global sea- surface temperatures (SST) and other tropical phenomena such as the ENSO. Others have attributed droughts to land surface feed- back process and increase in green house gases resulting largely from human activities. Finally, droughts have been explained as naturally occurring non- linear interactions in the atmosphere. Similarly, Barry and Chorley (2003) stated that causes of drought conditions to include: (a) increase in size and persistence of the sub- tropical high pressure cells; (b) changes in summer monsoon circulation; (c) lower ocean surface temperatures produced by changes in currents or increased upwelling of cold waters; and (d) displacement of mid-latitude storm tracks.

Today, there is sufficient evidence of rising global temperatures due to increased emission of greenhouse gases (Carbon dioxide, Nitrous oxide, Methane and Chlorofluorocarbons) into the atmosphere. The increased global warming has the capacity to trigger large-scale climatic disturbances, which ultimately may have significant impact on the Sahel rainfall (Biasutti and Giannini, 2006). Analysis of the climate of north-western Nigeria for the period 1915-2008 confirms that the rainfall of that region has fluctuated substantially. Such fluctuations affect both inter-annual and intra-annual rainfall patterns. Fluctuations in inter-annual rainfall totals are not confined to the mean-state conditions but also affect the standard deviation and the coefficient of variation. With regard to intra-annual rainfall, the study has shown that rainfall between 1967 and 2007 has fluctuated enormously not only in terms of total receipts, but also in the dates of rainfall onset and cessation, as well as in the length of the rainy season. Further, there is evidence of incessant “false onset” in recent rainfall characteristic.

2.2.4 Drought Impacts

Man depends on the environment as life-supporting system. With population increase and rapid urbanization process coupled with man’s technological advancement to exploit the environmental resources of air, water, fauna and biota, the delicate ecological balance between man and environment must be maintained if man must survive on this plant (Nick, 2012). Therefore impacts of drought on the community are due both to the physical nature of the hazard as well as to the community’s ability to manage associated risks.

The probability of drought at on-set and towards end of the rainy season is usually very high in Northern Nigeria (ICRISAT, 1984; Adeoye, 1986; Tenkouano *et al.,* 1997). Dry spells at the beginning of the season usually result in multiple plantings and low or no yields leading to low food security index. In the same vein, early cessation of rain could brings about water stress at critical periods of need during reproductive stages of most crops, thus resulting in crop failures and shrinking of yields. Large areas of Northern Nigeria falling within the Sahel and Sudan ecological zones between latitude 9-14^{0}N are prone to recurrent droughts in one form or the other (Glantz and Katz, 1987; Apeldoorn, 1981; Adeoye, 1986; Nyong, *et al.,* 2007). The 20th century started in the region with droughts and the resultant famines of 1903 and 1911-1914, respectively (Kolawole, 1987). Other droughts included those of 1919, 1924, 1935, 1951-1954, 1972-1973, 1984-1985, 2007 and 2011 (Apeldoorn, 1978, 1981; Kolawole, 1987; Mortimore, 1989). Droughts have a multi-dimensional effect on humanity in terms of several socio-economic parameters like agriculture, human health, sea level rise, scarcity of labor, disease prevalence (Adger and Kelly, 1999). Droughts are expected to impact livelihood and their occurrence will further aggravate poverty levels and sustainability of livelihood means in the years to come.

The impacts of drought in general include mass starvation, famine and cessation of economic activity especially in areas where rain fed agriculture is the main stay of the rural economy. It is common knowledge that drought is the major cause of forced human migration and environmental refugees, deadly conflicts over the use of dwindling natural resources, food insecurity and starvation, destruction of critical habitats and loss of biological diversity, socio-economic instability, poverty and climatic variability through reduced carbon sequestration potential.

It has also been noted that the frequent occurrences of drought in the Sudano-Sahelian zone is responsible for the social backwardness and general poor quality of life, especially among the less privileged ones (Alatise and Ikumawoyi, 2007). The situation is aggravated by the increase in human population, which appears to be stressing natural support system (FRN, 2005).The widespread poverty, the fact that Nigeria's economy depend on climate-sensitive sectors mainly rain fed agriculture, poor infrastructure, heavy disease burdens, high dependence on and unsustainable exploitation of natural resources and conflicts render the country especially vulnerable to impacts of drought.

2.2.5 Adaptation to Drought

Drought hazard affects agriculture and determine the adequacy of food supplies (Ayoade, 2004); hence, the need for adaptive and coping strategies. According to Inter- Governmental Panel on Climate Change (IPCC, 2001), adaptations are actions taken to help communities and ecosystems moderate, cope with, or take advantage of actual or expected changes in climatic conditions. Adaptation could be proactive also referred to as planned. This requires assessing the vulnerability of natural, man-made systems as well as costs benefits of actions versus inactions and planning alternatives accordingly. Adaptation could also be reactionary which means actions are taken to reduce the impact of drought or take advantage of opportunities presented (Omolola, 2009).

There are both traditional (indigenous) and technological approaches to reducing the risk of drought and building resilience to its effects. The most common approach, and the one most often followed by both developing and developed nations, is post-impact government (or nongovernment) interventions. These interventions are normally relief measures in the form of emergency assistance programs aimed at providing money or other specific types of assistance (e.g., livestock feed, water, food) to the victims (or those experiencing the most severe impacts) of the drought. This reliance on government for relief is contrary to the philosophy of encouraging self-reliance through investments in creating improved coping capacity (UNCCD, 2013).

Another type of drought policy approach is the development of pre-impact government programs that are intended to reduce vulnerability and impacts. In natural hazards field, these types of programs or measures are commonly referred to as mitigation measures. These types of measures are numerous but appear to be less obvious to many when associated with drought since impacts are generally non-structural. The final type of policy response is the development and implementation of preparedness plans and policies, which would include organizational frameworks and operational arrangements developed in advance of drought and maintained in between drought episodes by government or other entities. This approach represents an attempt to create greater institutional capacity focused on improved coordination and collaboration within and between levels of government and with stakeholders in the plethora of private organizations with a vested interest in drought management (i.e., communities, natural

resource districts or managers, utilities, agribusiness, farm organizations, and others) (UNCCD, 2013).

A common understanding of droughts is essential for its comprehensive management in an integrated approach, addressing the over-all development goals and well-being of the people living in drought prone areas and involving the different sectors and stakeholders affected (WMO, 2011). Droughts have often been dealt with in a reactive manner through drought relief programmes rather than by applying a pre-emptive management approach that reduces vulnerability, making the effective use of scientific knowledge and all available relevant information. Policies related to national and regional management of drought are generally unsatisfactory and even lacking in most countries (WMO, 2011). The adversities resulting from droughts emphasize the importance of strategies needed to cope with the impacts. Unless well-thought strategies are implemented, they can result in a far reaching consequence and cause severe impacts on societies and livelihood especially among the natural resource dependent communities (Tompkins and Adger, 2004; Thomas and Twyman, 2005). Managing vulnerability and enhancing resilience against drought are the major pressing issues particularly among developing tropical countries of the continent.

2.2.6 Challenges against Effective Adaptation

Responses to drought by governments throughout the world are generally reactive, poorly coordinated and untimely and are typically characterized as “crisis management” (Wilhite and Pulwarty, 2005). In addition, the provision of drought relief or assistance to those most affected has been shown to increase vulnerability to future drought episodes by reducing self- reliance and increasing dependence on government and donor organizations. Thus, it is imperative that emergency relief be provided in such a manner that it provides a safety net for those elements of society that are most vulnerable while promoting self-reliance and the principles of a national drought policy based on the concept of risk reduction **(**Wilhite, Mannav, Sivakumar and Pulwarty, 2014**).**

2.3 Literature Review

Drought is an inherent characteristic of Africa. One-third of the people in Africa lives in drought-prone areas and are vulnerable to the impacts of droughts (Bates, Kundzewicz, Wu, and Palutikof, 2008). Since

the devastating Sahelian drought of the early 1970s, drought has reoccurred in many parts of Africa (Oladipo, 1993). In West Africa, a decline in annual rainfall has been observed since the end of 1960s, with a decrease of 20–40% in the period 1968–1990 as compared with the 30 years between 1931 and 1960 (Nicholson, Some, and Kone, 2000; Chappell and Agnew, 2004; Dai *et al*., 2004). Droughts of various intensities have been reported in the Sudano- Sahelian region (Mortimore, 1973; James, 1973; Adefolalu, 1986; Oladipo, 1993; Abaje, Ati and Iguisi, 2011; Aremu, 2011).

Most droughts that occur in this region have been found to be associated with a late start of rainy season and its early cessation, resulting in drastic reductions of the length of the rainy season. For instance, a number of studies within the Sahel region have shown a significant trend towards false onset, late or delayed onset and early cessation of the summer rains over a 30-year period from 1969 to 1998 (Houndenou and Hernandez, 1998; Ekpoh, 1999a; Camberlin and Diop, 2003). False onset is a situation where the rainy season starts normally and then ceases abruptly, creating a dry period between the false onset and the true onset. Late or delayed onset is a situation where the expected start of the rainy season is delayed. Early cessation is a situation where the rainy season stops far ahead of the expected time. In addition, long- term rainfall analysis for the area has observed frequent appearances of false onsets, as well as, a trend towards a pronounced decrease in annual rainfall amounts (Ekpoh, 1999a, Floyd and Ekpoh, 2007).

Oladipo (1993a) studied the spatial characteristics of drought in northern Nigeria and the result revealed that mean probabilities of moderate drought for the Sahel, mid land and the guinea savanna zones were 0.31, 0.26, and 0.24 respectively, with a recurrent interval of between 3 and 4 years. The occurrence of drought is, therefore, one of the conditions that also speed up desertification process in the Sudano-Sahelian zone of Nigeria. Also Iwegbu (1993) investigated the areal extent of drought for the whole of Nigeria for the period 1921 – 1987. It was revealed that drought does not cover the entire country and no particular areas were persistently affected by drought until 1970s and 1980. Since the beginning of 1970s, areas affected by drought have increased in extent with a consequence decrease in near normal and wet conditions particularly in the Sahelian and midland zone.

Drought incidence is not new in the sub-Saharan regions in Nigeria considering the fact that the entire

Sahel region is susceptible to climatic anomalies (Okorie, 2003). Oladipo (1993a) examined some aspects of spatial characteristics of drought in northern Nigeria using a long period instrumental data set (1916-1987) of monthly growing season (April-October) rainfall totals for 34 stations in order to quantify drought. It was established that there were remarkable seasonal changes in the pattern of wetness and dryness over the regions with no consistent recurrent patterns in moisture anomalies.

Similarly, Tarhule and Woo, (1997) analyzed both historical information on sub-Saharan drought/famines and measured rainfall data from northern Nigeria. It was found that drought duration was related to magnitude, that is, the maximum cumulative rainfall deficit. This relationship confirms that longer drought recorded in the chronicles were more severe than the shorter ones. Both chronicles and rainfall records shows that drought of short duration less (<3years) tend to be less severe, more frequent and spatially more viable than long droughts. Droughts lasting over 3 years were regional in extent and were separated by long intervals between occurrences.

Otun and Adewumi (2009) proposed anew drought index (DI) based on several precipitation parameters to quantify drought hazard in semi arid region. In addition to the practice of using only rainfall volume for indexing drought, the proposed index verifies the potentials of nine (9) other precipitation effectiveness variables (PEV_s); namely (onset of rain, cessation of rain, length of rainy and dry season, wet days and dry days within the wet season, dry days within the year, maximum dry spell length within the wet season and mean seasonal rainfall depth (MAR); in quantifying drought conditions over a place. The Conjunctive Precipitation Effectiveness Index (CPEI), as proposed in the study, utilizes a mathematical model that algebraically combines “standardized seasonal PEV difference or deficit in each prevailing PEV” and terms of their sequent higher powers to define a single numerical value for this “at site” drought index approach.

The result shows that the set of PEV_s for indexing drought varies with location. The trends observed in drought values obtained using the CPEI models employing the optimum PEV_s also clearly earmarks the 1970-73 and 1983-87 historical drought years within the study area. Similarly Abaje (2010) carried out a study on the occurrence of droughts in the Sudano-Sahelian Zone of Nigeria (1949- 2008). The result revealed that 1980s is a decade of consecutive years of large scale drought that reached a peak.

Similarly Abaje, Ati, Iguisi and Jiduana (2013) evaluated the extent and degree of severity of droughts in the Sudano- Sahelian Ecological Zone of Nigeria using Normalized Rainfall Index technique. The results revealed that the zone was characterized by larger extent of severe drought since the beginning of 1968 through early 1970s, then the 1980s in which the drought was so severe than any other decade in the study period.

In Nigeria, drought has severe impacts on food security, livelihood, and economic, social and cultural activities of the affected people. This has aggravated food situation in the area resulting in low food security index. Drought of the early 1970s in Nigeria caused a lot of economic disruptions. For example, it was held responsible for the drastic falls in GDP of 18.4% in 1971-1972 and of 7.3% in 1972-73. It was also seen as causing the rapid rise in price index for foodstuff and relative decline in non-oil exports (FRN, 2000). Many economic impacts occur in agriculture, livestock and related sectors, including forestry and fisheries, because of the reliance of these sectors on surface and subsurface water supplies (ONRG, 2004a). For example the drought that occurred between 1972 and 1973 in Northern Nigeria resulted in the death of over 300,000 animals, representing about 13% of total livestock population of the northeastern part of Nigeria (Oladipo, 1993a, 1993b; Jaiyeoba, 2002; Ati, 2006), and crop yield dropped by about 60% (Okorie, 2003; Alatise and Ikumawoyi, 2007). In addition to obvious losses in yields in crop and livestock production, drought is also associated with increases in insect infestations, plant diseases (ONRG, 2004a; Ayoade, 2005). In Nigeria, crop losses due to insect pest have been estimated to be of order of 50 to 60% of total crop production (Ayoade, 2005). The incidence of forest and range fires increases substantially during extended drought, which in turn places both human and wildlife population at higher levels of risk (NDMC, 2006c).

The impacts of droughts are well known and have been analyzed and elucidated by several authors (Apeldoorn, 1978; 1981; Kolawole, 1987; Mortimore, 1989). Jibrin (2010) highlighted the effects of drought in the Sudano-Sahelian zone as follows: low or no crop yields resulting in low food security index; mass famine; death of livestock; low groundwater levels resulting in dry wells (which needed to be dug deeper and deeper to obtain water for drinking); drying of lakes and dams; loss of biodiversity and impoverishment of ecosystem; acute shortage of water for domestic use and for livestock; decline in

GDP; migration into urban areas; separation of families; and increased indebtedness.

Drought hazard affects agriculture and determines the adequacy of food supplies (Ayoade, 2004), hence, the need for adaptive and coping strategies. The Intergovernmental Panel on Climate Change Fourth Assessment Report (IPCC, 2007) stated that the world indeed has become more drought-prone during the past 25 years, and that climate projections for the 21st century indicate increased frequency of severe droughts in many parts of the world. Studies show that without adaptation, climate change is generally detrimental to the agriculture sector; but with adaptation, vulnerability can largely be reduced (Easterling *et. al.,* 1993; Rosenzweig and Parry 1994; Reilly and Schimmelpfennig 1999; Smit and Skinner, 2002).

Large numbers of inhabitants of drought prone areas are smallholder farmers, who depend mostly on the highly variable rainfall for crop cultivation and maintenance of their herds (Abubakar and Yamusa, 2013). In Uganda, income diversification, digging of drainage channels, and the use of drought-tolerant varieties have been reported (Okonya, Syndikus, and Kroschel, 2013). In dry land areas of West Africa, for example, complex migration patterns have emerged as rural populations adapt to both seasonal variability in precipitation and extended periods of drought. Pastoralist population modify their movements during extreme dry periods by moving larger numbers of animals into wetter parts for longer periods of time, a practice that may bring them into conflict with sedentary farmers (Apata, 2011). More importantly will degrade the area and further aggravate drought occurrence. Studies in Ghana have reported adaptation practices in agriculture, including crop diversification, change of planting date, hybrid varieties, and soil moisture conservation techniques (Okorie, 2002; Dietz, Ruben, and Verhagen, 2001).

Joshua and Ekwe, (2013) analyzed indigenous mitigation and adaptation strategy to drought and environmental changes in Nigerian section of Lake Chad using questionnaires, field interview and group discussion. In his findings, Indigenous techniques of mitigating drought includes; mixed farming, delayed farmland clearance, rain fed and dry season farming, fishing and hunting of wild life, buying and selling of agricultural and non agricultural goods, handcraft such as weaving and mat making, selling of fuel wood among others. The single farming production is not adequate to face drought as a result the local farmers diversified their socioeconomic activities which include supplementing their major economic activity with other activities as a mitigation plan to cope with changing environmental conditions and the continued

fluctuation of fresh water resources which mostly affect their socio-economic activities in the area.

Adeaga (2002) examined the occurrence, impact and adaptation strategies to drought in Sudano-Sahelian zone. Drought indices, namely drought magnitude, severity and duration, were analyzed using rainfall variability index indicator. In his findings, the periods 1980-1990 as well as the two 4-year periods of 1970-1973 and 1992-1995 were times with low annual water storage which greatly affected agricultural practices in the Sudano-Sahelian region of Nigeria. These led to loss of flood plains; as noted in the Chad basin and the Hadejia-Nguru with a shorter growing season of wetland species and crops, widespread crop failures, loss of livestock and over-cultivation of available productive lands (flood plains) with a lot of economic, health and environmental hardship, as well as a higher dependency on rainfed agricultural practices; failure of water resources systems designed in the 1970s-pre- and post-designed socio-economic benefits were not met. The knock on effect included shortage of food, unemployment and underemployment, resulting in a highly reduced purchasing power. Famine, starvation and death of both animals and man were rampant. Other demographic processes were also affected, such as the migration of people from rural areas to urban centres in search of non-agricultural based jobs and livestock farmers moving southward to better-watered areas, in search of water and pasture for their cattle.

Responses to drought by governments throughout the world are generally reactive, poorly coordinated and untimely and are typically characterized as “crisis management” (Wilhite and Pulwarty, 2005). In addition, the provision of drought relief or assistance to those most affected has been shown to increase vulnerability to future drought episodes by reducing self- reliance and increasing dependence on government and donor organizations. Thus, it is imperative that emergency relief be provided in such a manner that it provides a safety net for those elements of society that are most vulnerable while promoting self-reliance and the principles of a national drought policy based on the concept of risk reduction **(**Wilhite, Mannav, Sivakumar and Pulwarty, 2014**).** A study carried out by Gashua (1991) on evaluation of indigenous techniques of coping with drought in Bade Local Government Area, Borno State. The result revealed that farming community of Bade perceives drought as the most serious ecological problem and measures for its mitigation have also been evolved to reduce its effects. Several indigenous techniques of drought mitigation in the face of recurrent droughts were adopted by the farmers over the

years (Mortimore, 1989; Kunda and Chibuike, 2013).

Traditionally, drought management has been reactive, relying largely on crisis management. However, this approach has been ineffective because of its untimely response, poor coordination and poor reach in drought-affected groups or areas. In Nigeria the list of farmers' innovations is impressive, most of these responses are no more than temporary stop-gap measures until normal rainfall returns. In extreme cases, traditional responses proved to be inadequate when the severity and intensity of drought stretch traditional responses beyond their absorptive capacities, the results are often disastrous as witnessed in 1973 in the region (Oladipo, 1992).

However, uncertainties in sustainable development with the current indigenous adaptation strategies among rural communities in the study area are growing stronger as poverty indices indicate increase annually. In the absence of effective adaptation, food insecurity and ill-health will deepen poverty and affect livelihoods, assets, infrastructure, environmental resources and economic growth, thereby slowing poverty reduction and sustainable development strategies (Shemdoe, 2011).The degree to which an agricultural system is affected by climate change depends on its adaptive capacity. Enhancing the adaptive capacity and increasing resilience can accelerate the pace of progress towards sustainable development (Farauta, Egbule, Agwu, Idrisa, and Onyekuru, 2012). Therefore, poor marginal rural communities confronted with the vagaries of climate change, will need to become more resilient if they are to survive and thrive.

CHAPTER THREE

THE STUDY AREA

3.1 Introduction

This chapter explained geographical location of the study area, climate, relief and drainage, Soil and Vegetation, Population and People as well as Economics Activities of the populace**.**

3.2 Location of the Study Area

Jigawa State is situated in the north-western part of Nigeria located between latitudes 11.00°N and 13.00°N and longitudes 8.00°E and 10.15°E (figure 3.1). Kano and Katsina states bordered Jigawa to the west, Bauchi State to the east and Yobe State to the northeast. To the north, Jigawa shares an international border with Zinder Region in the Republic of Niger. The state has a total land area of approximately 22,410 square kilometres (Dangel, 2008).

3.3 Climate

The climate of Jigawa state is semi arid, characterised by long dry season and short wet season. The wet season is roughly four months (June to September) and dry season is seven to eight months (October to May). The rainy season may start in May but early rains in April are not unusual. The bulk of the rainfall comes in June through September. Violent dust storms followed by tornadoes and lightning usually herald the onset of rains in May/June and their retreat in September or early October. The total annual rainfall ranges from 600mm in the north to 1000mm in southern part of the state.

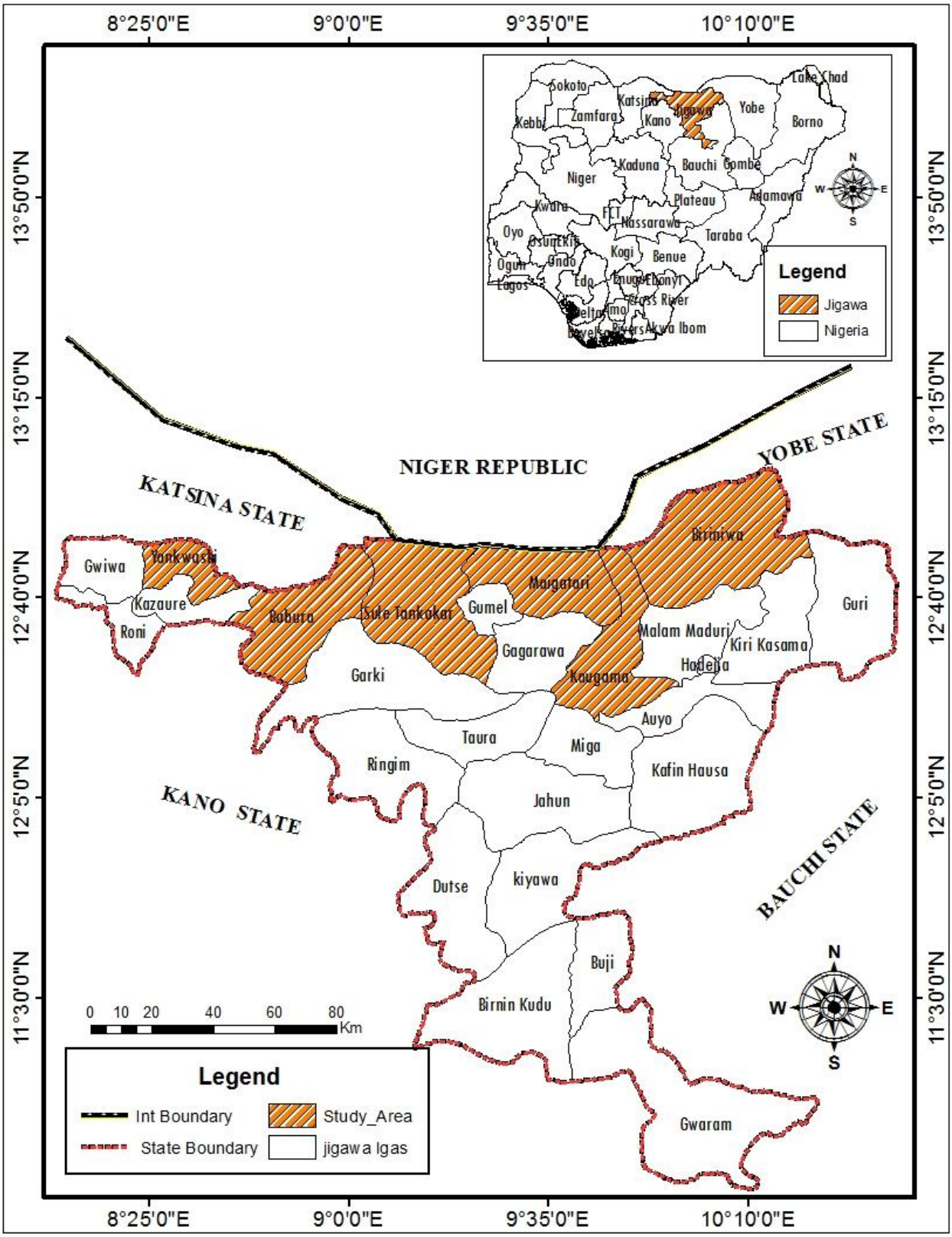

Figure: 3.1.The Study Area

Source: Modified From Administrative Map of Jigawa State (2015).

Great variations occur in the annual rainfall total and may result in severe and prolong dry spell which

causes crop failure, death of livestock and overall human sorrow (Olofin, 1987; Onlinenigeria, 2003).

The temperature regime is warm to hot. The mean annual temperature is about 25^0C but the mean monthly values range between 21^0C in the coolest month and 31^0 C in the hottest month. However, the mean daily temperature could be as low as 13^0C during the month of December and January when cold harmattan winds blow from the Sahara desert. Evapotranspiration is very high and relative humidity is highest in August (up to 80%) and very low in January through March (twenty three to thirty per cent) when it is moderated by the harmattan. The year is characterized by well marked dry and wet seasons.

3.4 Relief and Drainage

Jigawa state is characterized by undulating land, with sand dunes of various sizes spanning several kilometres in parts of the State. The southern part of Jigawa is comprised of Basement Complex while the northeast is made up of sedimentary rocks of the Chad Formation. The main rivers are Hadejia, Kafin Hausa and Iggi Rivers with a number of tributaries feeding extensive marshlands in north-eastern part of the State. Hadejia – Kafin Hausa River traverses the State from west to east through Hadejia-Nguru wetlands and empties into Lake Chad Basin (Olofin, 1987 and Dangel, 2008).

3.5 Soils and Vegetation

The southern part of the state is underlain by Basement Complex rocks, the soils are latosols of ferruginous type. They are not strictly zonal soils because of the strong influence of parent material and topography on them. A variety of immature soils also occur in this area. These soils include Lithosols at the foot slopes of hills and rock outcrops, hydromorphic soils in floodable areas of low terrace and in inactive channels of major rivers and Regosols (sandy waste) in the active channels of all rivers. The northern part of the state comprises Chad formation and the soils consist mostly of unconsolidated sediments which are predominantly sandy. Consequently, the soils are mostly sandy, silty or sandy loams which occur on the well drained interfluves. The silty loams occur on the lower slopes and the outer rim of depression. At the bottom of the depressions, especially those associated with swamps formed by ‘disappearing’ streams, hydromorphic soils occur. In dune fields, Lithosols occupy the interdunes depressions. Soils in the dune fields are brown to dark brown in color (Olofin, 1987).

Vegetation of the state falls within the Sudan savanna belt, but traces of Guinea savanna are found in part of the southern district. Extensive open grasslands, with few scattered stunted trees are characteristics of the vegetation. The original vegetation has since been removed, giving rise to farm parkland. Due to annual cultural land clearing, almost all the original tree species were removed. For most part of the state, only few trees; mostly of the Mimoceae and Ceselpinaceae families existed. Despite deforestation, there still exist remnants of former climatic climax. Vegetation in some sparsely scattered districts, especially near water courses; acacia species tend to be plentiful in such areas (Olofin, 1987 and Onlinenigeria, 2003). The *Adonsonia digitata, Termarindus indica, Bytrospernum, Parkia bigglobosa, Ceiba pentandra, Vitex digitata* and various species from the acacia and *ficus* families are the common species. Grass becomes shorter and sparser, and the tree cover are less dense, with latitudinal declining precipitation northward (Directory of soil institution and experts in Africa, 2002).

3.6 People and Population

The socio-cultural situation in Jigawa State could be described as homogeneous. It is mostly populated by Hausa/Fulani, who can be found in all parts of the State. Kanuri are largely found in Hadejia Emirate, with some traces of Badawa mainly in its Northeastern parts. Though each of the three dominant tribes has continued to maintain its ethnic identity, Islam and a long history of inter-marriages have continued to bind them together.

About 3.6 million people inhabit Jigawa State. Life expectancy as at 2001 was about 52 years with a total fertility rate of about 6.2 children per woman of childbearing age (a little above the national average). Although population of the State is predominantly rural (90%), the distribution in terms of sex is almost equal between male (50.8%) and female (49.2%). This pattern of

population distribution is same across various constituencies in the State and between urban and rural areas. In terms of age distribution, the 2002 CWIQ Survey indicates that 45.2% of the population was made up of young people below the age of 15; 49.0% between the ages of 15 and 59 while 5.8% were people aged 60 and above. This survey reveals a dependency ratio of almost 1; meaning that there is almost one dependent to every economically active person in the population (Olofin, 1987; Onlinenigeria, 2003).

Average household size was about 6.7 almost all of which were headed by males. About 60% of household heads were self-employed with agriculture as their main occupation, and nearly two-thirds of these households were monogamous families. The overall literacy rate was about 37% in 2002 (22 percent for women and 51 percent for men). School enrolment ratio is fairly high with very good improvements in the last few years, though there is disparity between boys and girls (Onlinenigeria, 2003).

Basic indicators for water supply sector show that access to potable water is over 90%, which is among the highest in the country. The 2002 CWIQ Survey however, indicated that while access to high quality safe drinking water (pipe born, hand pump boreholes and protected wells) is low at about 63%, nearly two-thirds of households have good means of sanitation. In terms of health services, about two-fifths of the population have access to medical services which is, however, higher in urban areas where access was found to be about 55%. The CWIQ Survey found that an average of 70% of those who consulted a heath facility expressed satisfaction with the services provided (Olofin, 1987; Onlinenigeria, 2003).

3.7 Economics Activities

The Economy of Jigawa State is largely characterized by informal sector activities with agriculture as the major economic activity. Over 80% of the population is engaged in subsistence farming and animal husbandry. Trade and commerce are undertaken on small and medium scale, especially in agric goods, livestock and other consumer goods. Other informal sector activities include blacksmithing, leather-works, tailoring services, auto repairs, metal works, carpentry, tanning, dyeing, food processing, masonry etc. Though modern industrial sector is yet to gain a solid footing, the seed for their development was planted through establishment of small-scale industries particularly in areas of food processing and other agro-allied activities (Onlinenigeria, 2003). However, the Federal Office of Statistics(2001), classified Jigawa State among those with relatively high severity and incidence of poverty in the country, with a Gross Per Capita Income of N35, 000 per annum (US$290), which is below the National Average. However, the 2002 Core Welfare Indicators Questionnaire (CWIQ) Survey indicated that over two-fifths of the population do not consider themselves poor (Onlinenigeria, 2003).

CHAPTER FOUR

METHODOLOGY

4.1 Introduction

This chapter discussed the sources for the generation of required data and the statistical techniques used in analyzing the data generated.

4.2 Reconnaissance Survey

Reconnaissance survey was carried out to acquaint the researcher with the study area. The geographical extent of the state was examined. Brief discussion and observation of farming activities were held during the survey. Meteorological section of Jigawa State Agricultural and Rural Development Authority (JARDA)

and Kano State Agricultural and Rural Development Authority (KNARDA) Offices, in Dutse and Kano respectively were visited for the purpose of collecting rainfall data for the study.

4.3 Types and Source of Data

The study relied on both primary and secondary data in order to achieve the stated aim and objectives. The primary data include Farmer's perception of the impact of drought, adaptation strategies and effectiveness of those strategies as well as constraints against effective adaptation. Government agencies (JARDA) relevant to agricultural practice in the state were interviewed on the impact of drought, adaptation strategies as well as efforts they have made in helping rural households in mitigating the impact. The secondary data include daily rainfall records from 1980-2014 and literature from Journals, Magazines, Textbooks, Pamphlets and other relevant materials from various Government Agencies.

Daily rainfall data for the period of 35 years (1980-2014) were collected from Jigawa State Agricultural and Rural Development Authority (JARDA) and Kano State Agricultural and Rural Development Authority (KNARDA) Offices, in Dutse and Kano respectively. This is because rainfall is the variable that mainly determines the duration, magnitude and intensity of drought (Oladipo, 1985; Keyantash and Dracup, 2002). Therefore, it was used to determined years of drought occurrences in the study area. Jigawa State (Dutse) has rainfall records from 1993-2014 only due to recent establishment. Rainfall data from 1980-1992 were collected from the nearest meteorological station (Chalawa) in Kano Metropolis. Table 4.1 indicates the types, source and purpose of collecting the specified data.

Table 4.1 Type, Source and Purpose of collecting the data

Type of data	Source of data	Purpose of collecting the data
Daily rainfall data	KNARDA/JARDA	To Compute drought index in the study area i.e. frequency and magnitude.
Farmers' bio-data, drought impact, adaptation, effectiveness	Questionnaire	To analyze information on drought impact, adaptation, effectiveness of these adaptation as well as constraints to effective adaptation

and constraints

4.4 Sampling Design and Questionnaire Administration

According to the National Population Commission (2006) Jigawa state had a total population of 4,361,002 and a total number of 830,907 households. Table 4.2 shows distribution of population by household types in Jigawa State.

Table 4.2 Distribution of Population by Type of Household

Household Type	Total No. of Households	Males	Females	Total Population
Regular	310,310	2,093,948	2,099,081	419,3029
Institutional/Census Functionaries	7,551	69,674	33,345	103,019
Homeless Household	793	2,517	1,916	4,433
Homeless Person	840	2,003	897	2,900
Nomadic Household	10,797	27,666	26,225	53,891
Transient; Person/Household	445	1,639	1,026	2,715
Fishing & Hunting Persona/Household	161	579	436	1,016
Total	**830,907**	**2,198,076**	**2,162,926**	**4,361,002**

Source: NPC (2006)

Jigawa state projected population as at 2016 was 5820200 (Brinkhoff, 2017). The average household size was 6.7. Therefore the projected household was 868,686.57.To determine the sample size for this research, Krejcie and Morgan's (1970) method of determining sample size was adopted which states that

for an area with a population between 250,000 –1,000,000 the sample size would be 384, as tabulated by The Research Advisers, (2006). In this study the population here refers to the number of households which is 868686.57, and falls within this range; therefore the sample size to be used for this research is 384.

Multi-stage sampling technique was used in selecting the respondents. In the first stage, purposive sampling technique was used to select six Local Government Areas(LGA_s) mostly affected by drought episode representing about 22% of the entire Local Governments in the State. The selected local government areas are Babura, Birniwa, Kaugama, Maigatari, Sule-tankarkar and Yankwashi respectively. Purposive sampling, according to Bernard (2002) is the deliberate choice of an informant due to the quality the informant possesses. Considerations were also given to minimize urban or semi urban influence in the selection. Table 4.3 shows LGAs with villages selected in each.

Table: 4.3 Projected Population Distributions of the Six Selected Local Governments

Local Government Area	Population	Number and Name of Villages Selected
Babura	284500	Aduare, Batali, Giginya, Masko, Unguwar Gawo and Yar Kirya
Birniwa	189800	Birniwa Tasha, Kakori, Kasabur and Yarda Babba
Kaugama	172400	Dusare, Gareru, Turmi and Zaburan
Maigatari	236600	Bagware, Jobi Gari, Matoya and Matsatstsagi
Sule-tankarkar	180200	Asayaya, Daudu,Tsalle andYan Damo
Yankwashi	127800	Gangara Kuda and Zoto

Source: Brinkhoff (2017)

Second stage: Proportional sampling was used in selecting the number of villages in each of the selected LGA_S. The number of villages in each of the selected LGAs is proportional to the population size of those LGAs selected. The LGA with population of about 50,000 to 150,000 has two villages; 150,001-250,000 has four villages and 250001-350000 has six villages. Third stage: Random sampling was used in

selecting the villages from the six selected LGAs. A total of twenty four villages were selected for questionnaire administration. Number of respondents in each of the selected village is proportional to its population size. In the fourth stage: Purposive sampling technique was adopted with the help of key informants in each of the selected villages to help in identifying heads of households who have a lot of experience with respect to drought incidence and indigenous coping strategies whom to administer the questionnaire to.

For the purpose of administering the questionnaire, head of households (Male or Female) above thirty (30) years of age and who must have lived for at least, twenty (20) years within the study area was issued the questionnaire. The reason for this decision is that these are the people who have drought experience and the information required about drought, its impact, adaptation as well as effectiveness of those coping strategies.

4.5 Data Analysis

Data was analyzed using statistical package for the social sciences (SPSS). Frequencies, percentages, tabulation, drought index and rankings were the basic statistical tools used in presenting farmers' perceptions about drought, impacts, adaptations strategies and effectiveness of the adaptations as well as constraints militating against effective adaptation.

Objective i

To assess the frequency and intensity of drought researchers have formulated various techniques for computing drought index such as Conjunctive Precipitation Effectiveness Index (CPEI), Bhalme and Mooley Drought Index (BMDI) (1980), Standard Precipitation Index (SPI) etc. For this study, Normalized Rainfall Index (NRI) formulated by Turkes (1996) was used. Normalized rainfall index is a measure of magnitude of drought using annual rainfall totals and the standard deviation to indicate the shortage of water of any given season. This technique was chosen among others because of the following comparative advantages: the index has shown to perform comparatively well in depicting periods and magnitudes of drought; it is simpler and less intricate, as it does not use terms like soil water capacity and evapotranspiration for its calculation as these parameters were not available in the study area.

Normalized rainfall index for a given station as defined by Turkes (1996) is computed thus: -$A_{sy}= \frac{Rsy - \bar{R}s}{Ss}$

Where A_{sy}= the normalized rainfall index

R_{sy}= the rainfall total for the station during the year (or season).

$\bar{R}s$ = the long term mean (of the period specified for the station).

S_s =standard deviation of the annual (or seasonal) rainfall total for that station.

In this study, a modified classification of NRI was adopted. This is because extreme values that are greater than 1.76 and less than or equal to -1.76 are very infrequent throughout the period under study. This modified index was used by previous researchers in the region (Abaje, Ati, Iguisi and Jidauna, 2013). The modified classification is given in Table 4.4

Table 4.4 Modified Normalized Rainfall Index

Character of Rainfall	**Very wet**	**Moderately wet**	**Mildly wet**	**Near normal**	**Mild drought**	**Moderate drought**	**Severe drought**
Index	1.31 or more	0.86 to 1.30	0.51 to 0.85	0.50 to -0.50	-0.51 to -0.85	-0.86 to -1.30	-1.31 or less

Source: Abaje, Ati, Iguisi and Jidauna (2013)

Objective ii

To identify the effects of drought, frequencies and percentages were used to present data generated on the effects of drought. To determine the most impacting effect respondents ranked the effects on the order of their perceived influence based on a 0–3 Scale and the weighted average index (WAI) was computed as:

$$WAI = \frac{\sum FiWi}{\sum Fi}$$

Where *F* = frequency of response; *W* = weight of each score; and *i* = score (3 = highly affecting; 2 = moderately affecting; 1 = less affecting; 0 = not affecting).

Objective iii

To identify various adaptation strategies households adopted. Frequencies and percentages were used

to present data generated on various drought adaptation strategies to achieve this objective.

Objective iv

To assess effectiveness of the various adaptation strategies, respondents scored these adaptations in the order of their effectiveness in mitigating drought impact in the study area based on a 0–3 scale using weighted average index (WAI):

$$WAI = \frac{\sum FiWi}{\sum Fi}$$

Where *F* = frequency of response; *W* = weight of each score; and *i* = score (3 = highly effective; 2 = moderately effective; 1 = less effective; 0 = not effective).

Objective v

To identify the most critical constraints challenging effective adaptation to drought, respondents graded their perceived barriers based on a 0–3 Likert scale (*i.e.*, ranging from "not a problem" to "highly problematic"). The Problem Confrontation Index (PCI) value was estimated using the formula thus: PCI = *Pn* × 0 +*P*1 × 1 + *Pm* × 2 + *Ph* × 3

Where: PCI = Problem Confrontation Index;

Pn = Number of respondents who graded the constraint as no problem;

Pl = Number of respondents who graded the constraint as low;

Pm = Number of respondents who graded the constraint as moderate;

Ph = Number of respondents who graded the constraint as high

The values on the Likert scale indicating no problem, less problem, moderate and highly problematic are indicated on Table 4.5.

Table 4.5 Likert Scale of Problem Confrontation Index

Likert Scale (PCI)	Meaning
0	No Problem
1	Low
2	Moderate
3	High

CHAPTER FIVE

RESULTS AND DISCUSSION

5.1 Introduction

This chapter presents results of the research. It presents demographic characteristics of the respondents. Farmers' age, experience, gender and educational status are indispensible for taking appropriate adaptation measures. Farming activities, drought experience, adaptation strategies and effectiveness of those strategies as well as constrains militating against effective adaptation were analyzed.

5.2 Socio-Economic Characteristics of the Respondent in the Study Area

Respondents' socio-economic characteristics determined effectiveness or otherwise of drought adaptation. People with high literacy level showed greater and high level of efficiency in managing disaster in general whereas people with low educational status were very vulnerable to even manageable disaster and mostly the impact was very much higher whenever it strikes.

5.2.1 Distribution of Respondents by Age

The distribution of respondents by age group is given in Table 5.1. Farmers with age above 60 years category form 28.65 % followed by 30-40 years category with 27.86 %, 41-50 years category with 25.26% and the least category was 51-60 with 18.2% respectively. Over 80% of the respondents fall within the range of those that actively engage in farming.

Table 5.1 Age Distribution of the Respondents

Age (years)	Frequency	Percentage
30-40	107	27.87

41-50	97	25.26
51-60	70	18.23
above 60	110	28.65
Total	**384**	**100**

Source: Fieldwork (2017)

5.2.2 Sex of the Respondents

All the respondents were male indicating no participation of women folk in the business among rural communities in the study area due to cultural and religious influence. The low level of women participation in agricultural activities proved men's dominance in decision- making with regards to climate policy and implementation of adaptation practices, hence in general men's perspective are taken into account in planning processes (Genanet, 2007).

5.2.3 Marital Status of the Respondents

All the respondents are married and mostly polygamous. Absence of divorce, widow and single households in the respondents is because the entire respondents were above 30 years of age on one hand and they are rural communities were cultural values are adhered to strictly.

5.2.4 Household size of the Respondent

Household size of the respondents is presented on Table 5.2.

Table5.2 Family size of the Respondent

Family size of the Respondent	Frequency	Percentage
1-5	31	8.07
6-10	79	20.57

11-15	45	11.72
Above 15	229	59.64
Total	**384**	**100**

Source: Fieldwork (2017)

Findings show that household with more than fifteen person form the majority. Average family size of the rural households is much higher than the average of the state of 6.7 people per household. Family size is a source of pride and source of respect in the study area. Most household adhere to the tradition of *Gandu* family system in which an elderly person headed the household while his younger brothers and their children remained under him. This conforms to the tradition of most African rural agrarian societies. It has been observed that the number of person in the household is a very important consideration in determining the labour available for farm work (IAR, 2001). It also affects household income, farm size, household food requirement etc.

5.2.5 Educational Qualification of the Respondents

Respondents' educational qualification in the study area is shown on Table 5.3. Major literacy status of the respondents is Islamic education. The extremely low level of communities' attainment of western education may impair speedy diversification of new adaptation strategies as they may have little access to various information outlets as observed in the region (Abaje, Sawa, Iguisi and Ibrahim, 2016).

Table 5.3 Respondents Educational Qualification

Educational Qualification	Frequency	Percentage
Primary	62	16.15
Secondary	45	11.72
Tertiary	31	8.07
Islamic Education	246	64.06

Total	**384**	**100**

Source: Fieldwork (2017)

Education is an important factor that determines the ability of a person to understand policies or programmes that affects his or her profession. It also facilitates learning and helps acceptance and adoption innovations, decision on production, sale and enterprise selection, access to formal credits sources e t c. (Abdussalam, 1997; Adeputu and Barthe, 2007). This may be the reason for respondents' stubbornness to acceptance and incorporating new innovations introduced by government at first instance.

5.2.6 Respondents' Duration of Residency

Respondents' duration of residency is presented on Table 5.4. Most of respondents are indigenes of the study area that have lived above 25 years in the area with about 84.38% while the least percentage of 2.87% lived between 10-15 years and are mostly civil servants from neighbouring Local Government Areas of the state. The homogeneity of respondents and long duration of residency determined their potentials of experience and various adaptation practices in the area. The greater the experience of a farmer the higher the chances of knowing the techniques used in adapting with drought (Gashua, 1991).

Table 5.4 Respondents Duration of Residency

Years Lives in the Village	**Frequency**	**Percentage**
10-15years	11	2.87
16-20years	28	7.29
21- 25years	21	5.47
Above 25 years	324	84.37
Total	**384**	**100**

Source: Fieldwork (2017)

5.2.7 Respondents' Primary Occupations

The primary occupation of the respondents is indicated on Table 5.5.

Table 5.5 Respondents' Primary Occupations

Respondents' primary occupations	Frequency	Percentage
Farming	340	88.54
Business	1	0.26
civil service	42	10.94
others, specify	1	0.26
Total	**384**	**100**

Source: Fieldwork (2017)

Most of the respondents were farmers followed by civil servant with 10.94%. The extremely low skilled labour percentage as a means of livelihood of the respondents is attributed to low literacy level among rural communities in the study area which makes them not employable in government offices and companies.

5.2.8 Respondents Farming Type

All the respondents were subsistence farmers producing crops mostly for families needs. This indicates high level of vulnerability of most households to the impact of droughts because adaptation effectiveness is directly linked to poverty index. This conforms to the findings of Bello*, et. al.,* (2012) which states over 80% of farmers in northern Nigeria were subsistence farmers. The reason for this higher percentage was because the population for this study was drown entirely from rural communities.

5.2.9 Farm Size of the Respondents

Household's farm size in the study area is presented on Table 5.6.

Table 5.6 Household's Farm Size

Household's farm size	Frequency	Percentage
1-5 hectares	135	35.17
6-10 hectares	92	23.95
11-15 hectares	56	14.59
16-20 hectares	65	16.92
Above20hectares	36	9.37
Total	**384**	**100**

Source: Fieldwork (2017)

About 35% of the respondents have 1-5 hectares and 24% of the respondent having 6-10 hectares. Fourteen percent of the respondents have 16-20 hectares and 5.38% having above 20 hectares. Abundant arable land potentials of the study area are great asset capable of handling mechanized farming with necessary input available.

5.2.10 Respondents Farming Experience

Respondents farming experience in the study area is shown in Figure 5.1

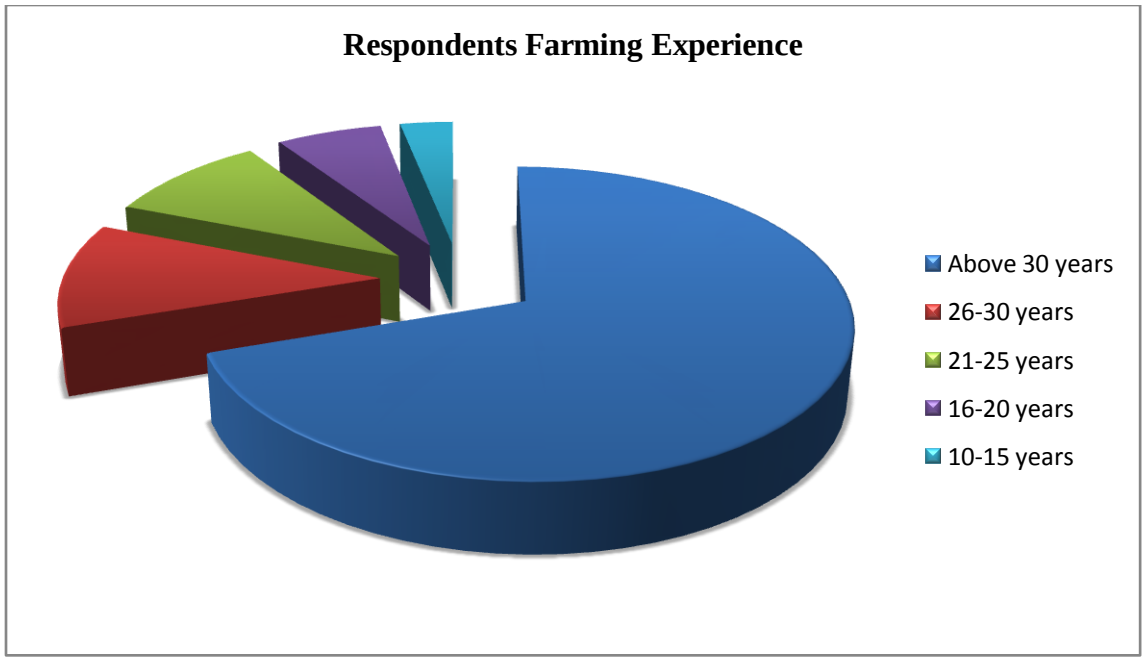

Figure 5.1 Respondents Farming Experience
Source: Fieldwork (2017)

Respondents with above 30 years farming experience have 69.71%, 26-30 years category has 11.29%, 21-25 years has 9.57%, while 16- 20 years has 6.21 and 10-15 years has 3.22% respectively. This finding shows that all the respondents have relevant information concerning drought as well as adaptation strategies and challenges facing agricultural activities in the region due to long duration of farming experience.

5.2.11 Crops cultivated in the Study Area

Crops cultivated by the respondents in the study area are presented on Table 5.7. Millet and sorghum are major food crops cultivated by the respondents in the study area while Sesame, Cowpea, Roselle and Groundnuts are the main cash crops universally cultivated.

Table 5.7 Crops cultivated

Food Crop	Frequency	Percentage
Millet	384	100
Sorghum	384	100
Maize	16	4.17

Sesame	371	96.62
Peanut	384	100
Rice	25	6.51
Wheat	3	0.78
Groundnut	248	64.58
Bambara Nut	154	40.10
Cassava	4	1.04
Bitter Melon	79	20.57
Melon	51	13.28
Rosella (Sobo)	284	74
Tomatoes	6	1.56
Pepper	7	1.82

Source: Fieldwork (2017)

However, intensive mixed cropping (about 4-6 crops on a piece of land) and mixed farming is the dominant practice. This was because farmers in the study area usually complement their food need with either cash crops produced or animal fattened even in normal years.

5.3 Drought Characteristics of the Study Area

5.3.1 Rainfall Characteristics of the Study Area (1980-2014)

5.3.2 Test for Normality

The result of standardized coefficients of Skewness (Z1) and kurtosis (Z2) for the station is presented in Table 5.8. The result shows the station conform to Gaussian normal distribution at 95% confidence limit. Based on these result there was no need to transform the data (Iwegbu, 1993).

Table 5.8 Normality Test for Annual Rainfall Value in Dutse for 35Years (1980-2014)

Mean	S/Dev	CV	Skew	Kurt

883.0609	299.0368	33.86367	0.592144	-0.33611

5.3.3 **Trends in Annual Rainfall in Dutse for 35 Years (1980-2014)**

The trends in annual rainfall value in Dutse for 35years (1980-2014) is shown in Figure 5.2.

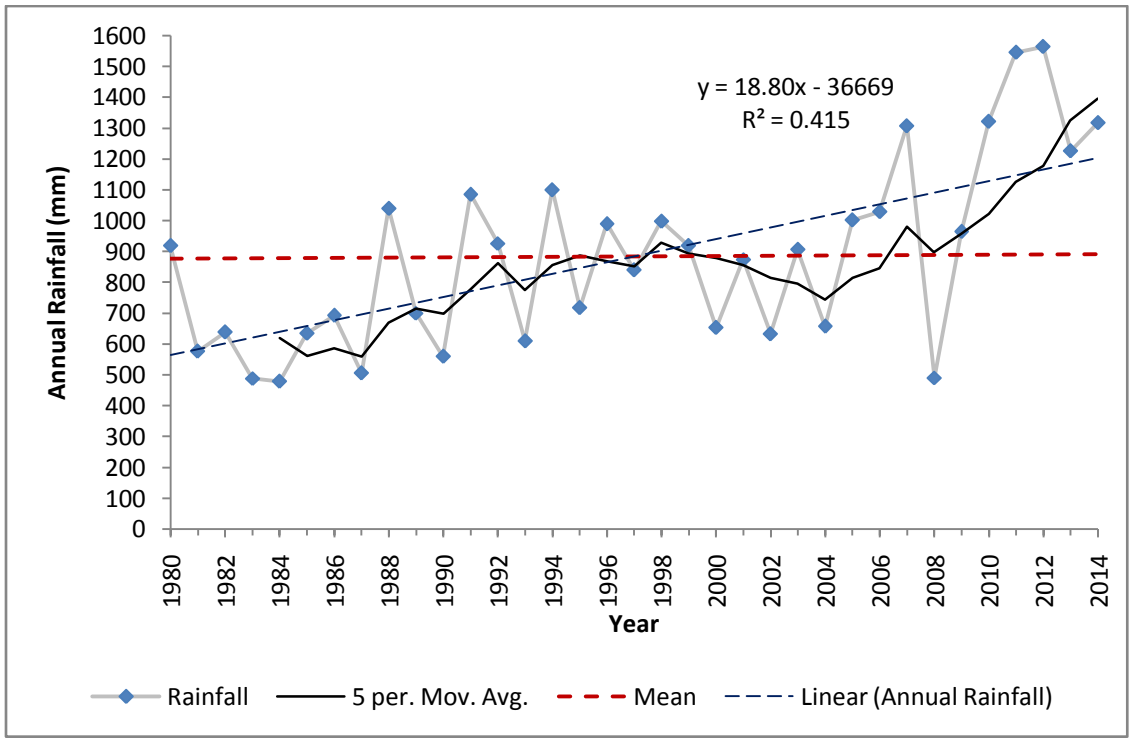

Figure 5.2 Trends in Annual Rainfall at Dutse for 35 Years (1980-2014)

The general patterns of annual rainfall shows frequent inter annual variability. Regression line indicates increasing trend. Five year running mean indicates low values below long term mean from 1980 to 2007 with a slight increase above long term mean between1997 and 2001. This coincides with the period of frequent drought episode in the region. From 2002 it rises above long term mean towards the end of the period under study. This finding conforms to earlier studies conducted in the Sudano- Sahelian zone with data of l990$_s$ upwards (Ibrahim, Yakubu, Ati and Iguisi, 2011). Low annual rainfall totals in the first twenty five years of the period under study coincides with periods of frequent drought episodes in the Sudano-Sahelian ecological zone as reported by Kayode and Francis (2012)

5.3.4 Drought Frequency and Intensity in the Study Area

The result of Normalized Rainfall Index (NRI) is presented in Figure 5.3.

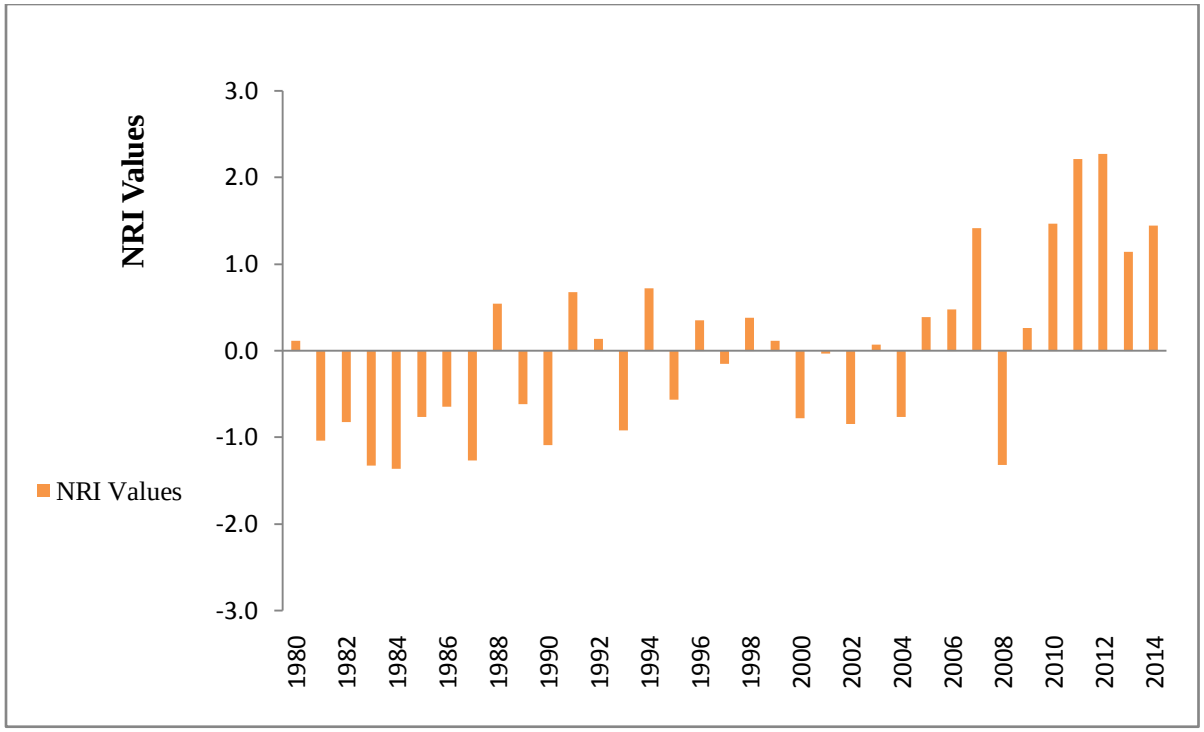

Figure 5.3 Normalized Rainfall Index Value for Jigawa State

The result showed that study area suffered frequent drought episode at varying intensities in the first decade under study (1980-1989). This decade was characterized by more severe and more persistent droughts. From then, both frequency and intensity of drought declined until 2008 when the area witnessed the most extreme drought throughout the period under study. This also conforms to the finding of Suleiman (2014). Out of the fifteen recorded drought events, eight occurred in the first decade representing about 53.3% of total drought events. Decline in drought frequency and intensity may not be unconnected with increase in annual rainfall amount recorded in the study area. This confirmed the earlier findings of decreasing drought events and increasing annual rainfall amount (Ati, 2006; Aremu, 2011; Ibrahim, Yakubu, Ati and Iguisi, 2011).

The most dominant drought intensity in the area was mild drought with 8 years occurrences representing 53.33% of total drought occurrences during the period of study (Table 5.9.).

Table 5.9 Drought Frequency Intensity and Percentage of Occurrence (1980-2014)

Drought Intensity	Drought Years	Frequency of Occurrence	Percentage of Total Occurrence
Mild Droughts	1982,1985,1986,1989,1995,2000,2002,2004	8	53.33
Moderate droughts	1981,1987,1990,1993	4	26.67
Severe Droughts	1983,1984,2008	3	20
Total		**15**	**100**

Source: Fieldwork (2017)

Moderate drought has 4 years of occurrences representing 26.67% and the least occurred intensity was severe drought with 3 years representing 20% of the total occurrences. The 15 years of all drought intensities occurrence represents about 42.86% of the entire period under study (1980-2014). This conforms to previous findings of rainfall characteristics in the region of highly variable and frequent drought episodes

5.4 Households' Drought Perception, Effects and Adaptation Strategies in the Study Area

5.4.1 Households' Drought Experience

All the respondents experienced drought or series of droughts depending upon the age and farming experience. Respondents' views agree with the statistical findings that the study area is ravaged by frequent drought events due to highly variable rainfall in both frequency of occurrence and amount characterizing the region.

5.4.2 Households' Drought Perception

Respondents' perception of what drought is in the study area is given on Table 5.10

Table 5.10 Respondents' Understanding (Perception) of Drought

Respondents' Meaning of Drought	Frequency	Percentage

An extension of dry season beyond its normal duration	361	94.01
Drying of crops	16	4.17
Persistence of moisture deficit condition through a series of years	7	1.82
Total	**384**	**100**

Source: Fieldwork (2017)

Most of the respondents consider drought to be an extension of dry season beyond its normal duration, while 4.1% see it as drying of crops and the least percentage of 1.82 % considered drought as persistence of moisture deficit through a series of years. The reason for higher percentage is because most respondents believed an extension in dry seasons affects the length of growing season as the rains comes late most crops grown are affected or the rain seized before the crops reach maturity. This is because most crops were not early maturing crops.

5.4.3 Respondent's Perception of Causes of Drought

Respondent's perceived causes of drought in the study area are presented on Table 5.11.

Table5.11 Respondent's perceived Causes of Drought

Causes of Drought	**Frequency**	**Percentage**
Act of God	379	98.7
Man	2	0.52
Climate change	3	0.78
Total	**384**	**100**

Source: Fieldwork (2017)

Almost all the respondent believed drought is an act of God with only 0.78% attributing it to climate change and 0.52% to man. This indicates low level awareness on the current environmental issues

especially climate change and weaknesses of most agricultural institutions in terms of information dissemination with regards to new farming techniques to rural farmers (Mortimore, 1989, Oladipo, 2010).

5.4.4 Respondents Perceived Drought Cycles of Occurrence

Respondents perceived drought circles of occurrence in the study area is shown in Figure 5.4

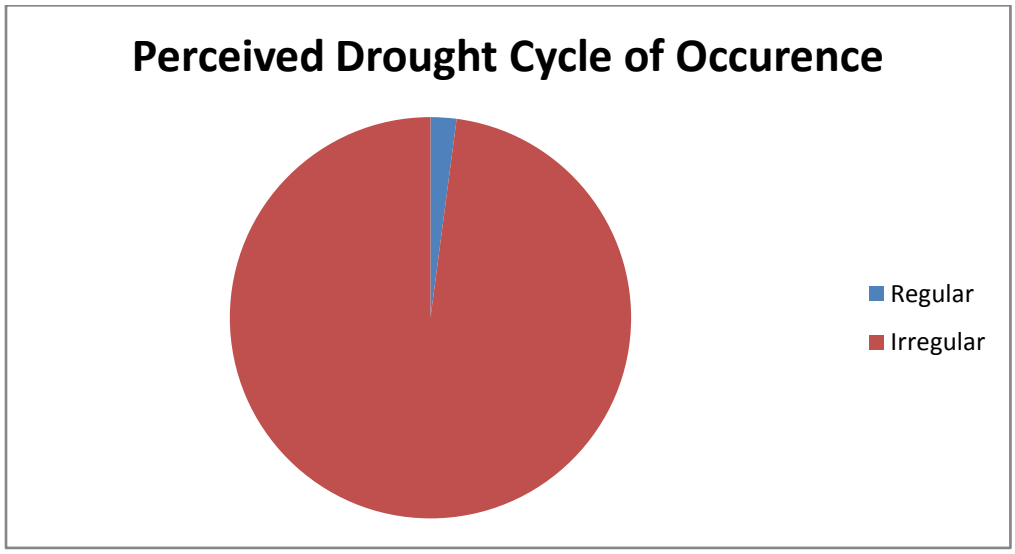

Figure 5.4 Perceived Drought Cycles of Occurrence
Source: Fieldwork (2017)

Almost all the respondents believed that drought has no definite circles of occurrence in the study area rather its occurrence is irregular without any cyclical patterns. Only about 2.18% agreed that drought followed cyclical pattern.

5.4.5 Respondents' Perceived interval of Drought Occurrence

Respondents' perceived interval of drought occurrence is presented on Table 5.12.

Table 5.12 Drought Interval of Occurrence

Drought interval	Frequency	Percentage
2 Years	3	0.78%
5 Years	4	1.04%
10 Years	1	0.26%
Irregular	376	97.92%

Total	**384**	**100**

Source: Fieldwork (2017)

Almost all the respondents' perceived drought occurs at irregular interval with no definite circle while 2.18% believed that drought followed definite patterns of intervals of 2, 5, and 10 years with a percentage of 0.78, 1.04 and 0.26 respectively. Perceived irregular pattern of drought occurrence by the majority of the respondents conforms to the statistical findings in the study area and the general perception of rainy season is usually characterized by the annual amount of rain received. Because annual amount mostly determine the length of growing seasons especially in the Sudano- Sahelian climatic belt (Adefolalu, 1986).

5.4.6 Respondents' Perceived Changes in the Frequency and Intensity of Drought

All the respondents experienced changes in terms of frequency and intensity drought occurrence in the study area. This conforms to the statistical findings of changing patterns of drought episodes especially in recent years.

5.4.7 Respondents' Perceived Trends of Drought Occurrence

Respondents perceived a trend of drought occurrence in the study area is shown on Table 5.13.

Table 5.13 Trends of Drought Occurrence

Trends of Drought Occurrence	Frequency	Percentage
Abrupt Rainfall onset and cessation on the increase	46	11.98
Decrease in rainfall amount annually	14	3.65
Reduction in number of rainy days/ months/ yearly	9	2.34
Decrease in Occurrence	315	82.03
Total	**384**	**100**

Source: Fieldwork (2017)

Most of the respondents believed drought events are on the decrease and annual rainfall amount is on the increase. This view is in conformity with the statistical findings as well as previous research findings (Ati, 2006; Aremu, 2011; Ibrahim, Yakubu, Ati and Iguisi, 2011). About 11.98% of the respondents viewed abrupt rainfall onset and cessation on the increase, 3.65% of the respondents experienced decrease in rainfall amount annually, while 2.34% experienced reduction in number of rainy days/months/yearly. All the three views were at variance with statistical findings especially those that encompass recent rainfall data.

5.4.8 Perceived Causes of Changes in Drought Occurrence

Respondents perceived causes of change in drought occurrence in the study area were presented on table 5.14.

Table 5.14 Causes of Changes in Drought Occurrence

Causes of changes in Drought occurrence	Frequency	Percentage
Climate change	1	0.26
Excessive cultivation	3	0.78
Desert encroachment	1	0.26
Act of God	379	98.07
Total	**384**	**100**

Source: Fieldwork (2017)

Almost all the respondents attributed causes of recent changes in drought occurrence (Decrease) to the act of God with less than 2% attributing it to other human factors like climate change, excessive cultivation and desert encroachment respectively. This view is at variance with statistical findings which attributed the current trends in drought frequency and intensity especially in dry tropical environment to anthropogenic climate change affects. This view is due to very low environmental awareness campaign from the authorities concerned through extension services and other media (Abaje, Sawa, Iguisi and

Ibrahim, 2016).

5.5 Effects of Drought in the Study Area

Drought impacts are complex as it cut across various sectors ranging from socio-economic to environmental sectors. The result obtained from the questionnaire administered revealed drought impact affecting the households in the study area cut across all the above mentioned sectors.

5.5.1 Impact of Drought on Farming Activities

Drought effects on farming activities in the study area were presented on Table 5.15.

Table 5.15 Drought Impacts on Farming Activities

Drought Impact on Farming Activities	Frequency	Percentage
Poor yield	382*	99.5
Poor soil fertility	370*	96.4
Short/stunted growth	370*	96.4
Pests/diseases	378*	98.4

Source: Fieldwork (2017) * Multiple Responses

Findings show drought impacts on on-farm activities are very serious in all the parameters asked. Almost all the respondents suffered decrease in crop yield which is the highest percentage. This was a resultant effect of over dependence on rainfed agriculture and low irrigation activities as reported in the study area (Jigawa State Ministry for Agriculture, 2013). Almost all the respondents suffered problem of poor yield pests/diseases, poor soil fertility and short/stunted growth. Very low accessibility and unaffordability of improved seed varieties, pesticides and fertilizer, result in high crop failure. Due to the fact that the local seeds used by most respondents have low immunity from various pest due to long period of being used and usually are low yield varieties that take long periods to mature. This affects yield as most crops are exposed to the effects of droughts in terms of diseases and water deficiency. It also indicates high vulnerability level of most households to the drought impacts in the study area and the fragile nature of the adaptation strategies coupled with very weak agricultural institutions as reported in the region (Oladipo, 1992 and 2010).

5.5.2 Households' Drought Socio-Economic Impacts

Table 5.16 indicates households' drought socio-economic impact. Famine and high poverty rate are the most serious drought impacts affecting the generality of respondents with about 98.44% and 97.66% respectively. Agriculture is the main source of livelihood of the rural households and is mainly rainfed in the study area.

Table 5.16 Drought Socio-economic impacts on household

Socio-economic impacts on household	Frequency	Percentage
High rate of poverty	375*	97.66
High food prices	265*	69.01
Famine (inadequate food)	378*	98.44
Conflict	142*	36.98

Source: Fieldwork (2017) * Multiple Responses

The variable rainfall experiences in the study area coupled by crude farming methods results in high crop failure. High failure in both food and cash crops leads most household to famine and decline in the household income. It also raises both the demand and price of food items. These necessitate the households in adapting other measures to complement their food needs that mostly results in depleting their economic base annually e.g. selling assets.

5.5.3 Environmental Impacts

Respondents' droughts environmental impacts are presented on Table 5.17.

Table 5.17 Drought Environmental Impacts

Drought Environmental Impacts	Frequency	Percentage
Soil degradation	246	64.06
Vegetative degradation	190	49.48

Water resources degradation	195	50.78

Source: Fieldwork (2017)

Soil degradation is the most serious environmental challenge caused by drought in the study area. About 64.06% of the respondent suffered problem of soil degradation. This is due to improper farm management techniques coupled with sandy nature of the soil in the study area. Respondents mostly own large arable land and the dominant soil fertility maintenance strategy is through manuring which is not adequate with continued soil tillage annually. About 50.78% experienced water resource degradation and the least was vegetative degradation with 49.48% respondent. Despite high underground water potentials most rural households depends on local source that hardly serve domestic needs year round. In quest for manuring the farmlands numerous shrubs are annually cuts to produce accelerated manure (Composting) which exposes most farm lands to serious soil erosion which in turn affects soil fertility.

5.5.4 WAI Drought Impacts Ranking in Jigawa State

To further assess the most impacting drought impact these drought impacts were ranked using WAI ranking and the most impacting variables were determined. Table 5.18 shows WAI drought impacts ranking in the study area.

Table 5.18 Drought Impacts Ranking Using WAI

Drought impact	Highly Impacting (3)	Moderate Impacting (2)	Less Impacting (1)	Not Impacting (0)	WAI	Ranking
Famine	215	59	23	5		2.60

1					
High food prices	70	126	55	12	1.97
2					
High rate of poverty	41	134	104	34	1.58
3					
Health problem	38	20	43	29	1.52
4					
Water resources degradation	12	5	24	19	1.17
5					
Pests and diseases	5	15	83	138	0.53
6					
Shortage of animal feeds	1	18	17	13	0.50
7					
Soil degradation	2	6	24	102	0.49
8					
Decreased yield	0	1	6	18	0.32
9					
Vegetative degradation	0	0	4	13	0.31
10					
Others (conflict)	0	0	1	1	0.24
11					

Source: Fieldwork (2017)

Famine, high food prices and poverty are the most impacting drought effects in the study area ranking first, second and third with WAI value of 2.56, 1.97 and 1.66 respectively. This is because respondents

traditional farming method is characterized with high failure in crop yield observed in the study area. These confirm to the findings of other research (Adeaga, 2002; Ayoade, 2005; Adeputu and Barthe, 2007). Majority of the rural household rely on agriculture for their livelihood and entirely engage in subsistence farming characterized by rain-fed production low fertilizer use, poor quality seeds and absence of appropriate and improved seed varieties result in very low yields per-hectare which turns in to low food security index as highlighted by Jibrin (2010).

In the study area farmers hardly produce adequate food year round even in normal year. When drought strikes food crops as well as other cash crops yield is lowered to the extreme marginal level. These results in increase in quantity demand which normally raises the food price. This contributes to the high poverty index reported in the study area (NBS, 2007). Health problem is the fourth impacted variable. This problem is aggravated by inadequate food that affect household members especially children and women who that suffered acute malnutrition and related diseases during rainy season when most households' food items might have finished. Pests and diseases though impacted moderately, they greatly affect the total harvest output as they damage crops at various stages of developments. Vegetation degradation and conflict are the least drought impacts according to the respondents. So deforestation is very minimal in the study area as respondent active participate in reforestation purposely to curtail the menace of desert encroachment. The least important impacts are conflicts and it is because of the short duration of the problems and authority's intervention before escalation.

5.6 Respondents' Drought Adaptation Experience in the Study Area

All the respondents have been using various adaptation strategies aim at minimizing the impacts of drought. This is highlighting the frequency of drought occurrence in the study area.

5.6.1 Respondents' Drought Adaptation Practices

Respondents' drought adaptation practices were presented on Table 5.19.

Table 5.19 Respondents' Drought Adaptation Practices

Adaptation Practices	Frequency	Percentage

Delayed Clearing	97	25.26%
Composting	275	71.62%
Dry-planting	51	13.28%
Inter Cropping	357	93%
Spacing	275	71.62%
Manure	384	100%
Fertilizer	54	14.06%
Pesticides	113	29.43%
Irrigation	50	13.02%
Fatting	303	78.9%
Trade	142	37%
Hand Craft	125	32.55%
Seasonal Migration	51	13.28%
Driving	33	8.59%
Civil Service	35	9.89%
Improved Seed	48	12.5%
Agro-Postural	31	8.07%
Storage	275	71.62%
Crop Rotation	152	39.58%
Local Seed Selection	60	15.63%
Off farm activities	25	6.51%

Source: fieldwork (2017)

Respondents use multiple adaptation practices to effectively sustain household basic needs. These adaptation strategies were developed by farmers through trial in response to the challenges faced chronically. This conforms to other research findings e.g. Smit, Burton, Klein and Wandel, (2000) who highlighted that adaptation in northern Nigeria are mostly autonomous (implemented without external intervention) and responsive (implemented in reaction to climatic events and impacts). Though relative effectiveness may be achieved with recorded decrease in drought events, adaptation strategies remained sensitive to a slight weather variation due to limited options to effective adaptation practices globally tested and used.

5.7 Effectiveness of Drought Adaptation Practices in the Study Area

The sole aim of adaption is to minimize the impact of any disaster if it cannot be prevented. The level of effectiveness of any adaptation depends on its ability to minimize the impacts and or take advantage of the drought events to improve upon social and environmental condition.

5.7.1 Drought Adaptation Effectiveness in Meeting the Respondents Basic Needs

Perceived effectiveness of drought adaptation practices in meeting respondents basic needs in the study area was given on Table 5.20.

Table 5.20 Drought Adaptation Effectiveness in Meeting Respondents' Basic Needs

Effectiveness of adaptation strategies in meeting basic needs of the households	Frequency	Percentage
Increase in yield per hectare	233	60.68
Normal yield per hectare	3	0.78
Increase in annual income	97	25.26
In effective(decrease in yield)	110	28.65

Source: Fieldwork (2017)

Mojority of the respondents recorded an increase in yield per hectare and an increase in annual income. The recorded increase in crops yield is attributable to increase in annual rainfall totals and decrease in drought frequency and intensity recorded in the study area. Increase in annual rainfall amount also affects its distributions and length of the growing season. An improved adaptive strategy through experience from the previous drought episode has contributed in achieving relative effectiveness as observed in the region (Sanni, Oluwasemire and Nnoli, 2012; Abubakar and Yamusa, 2013; Sulaiman, 2014). While 28% of the respondent considered various adaptation practices used as ineffective in meeting the household basic needs with continuous decrease in crops yield annually**.**

5.7.2 Perceived Environmental Effectiveness of Drought Adaptation Practices

Respondents' perceived environmental effectiveness of drought adaptation practices in the study area is given onTable 5.21

Table 5.21 Environmental Effectiveness of Drought Adaptation Practices

Strategies' effectiveness in maintaining environment	Frequency	Percentage
Improved soil fertility	261	67.97
Improved vegetative Resources	8	2.08
Improved water Resources	57	14.84
Ineffective(decrease in crops yield annually)	115	29.95

Source: Fieldwork (2017)

Majority of the respondents experienced improved soil fertility. Intensive manuring by most respondents in the study area annually relatively maintained soil fertility as observed in the region by Olofin (1987). However 26% rated various adaptation strategies as in effective because of decrease in soil fertility despite various adaptation strategies used.

5.8. Indicators of resilience of the Adaptation Strategies

Resilience level of the adaptation strategies in the study area is shown on Table 5.22

Table5.22 indicators of resilience of the Adaptation Strategies

Resilience level of these strategies	Frequency	Percentage
Increase in annual yield yearly	86	22.4
Increase in annual income	151	39.32
Diversified source of income	112	29.16

Not sustainable	35	9.12
Total	**384**	**100**

Source: Fieldwork (2017)

Almost all the respondents in the study area rated adapted strategies as sustainable based on the following fragmented views; 22.4% of the respondents experienced increase in annual yield; 39.32% of the respondent experienced increase in annual income and 29.17% of the respondents their source of income were diversified respectively. This conforms to the assertion of Mortimore and Adams (1999) that in the 1980s famines – better integration of livestock and secondary occupations were observed in the Sahelian region. However, these relative achievements are subjective to respondents' perceived meaning of sustainability as most of them limit it to basic family's food needs. Only 9.12% rated various adaptation strategies as unsustainable with decrease in annual yield despite various adaptation strategies adapted.

5.9. WAI Ranking of Drought Adaptation Effectiveness in the Study Area

To further determined the most effective adaptation strategies WAI ranking was used. The ranking of adaptation practices based on farmers' perceived importance is presented in Table 5.23.

Table 5.23 WAI Ranking of Effectiveness of Drought Adaptation Practices.

Adaptation Practices	Highly Effective(3)	Moderate Effective(2)	Less Effective(1)	Not Effective(0)	WAI	Ranking
Fatting	133	113	52	5	2.23	1
Use Fertilizer	28	14	2	10	2.11	2
Sales of Cash Crop	57	49	37	9	2.01	3
Irrigation	27	16	6	11	1.98	4

Trade	55	28	53	6	1.93
5					
Improved Seed	8	28	8	4	1.83
6					
Inter cropping	9	53	11	19	1.57 7
Manure	55	34	40	55	1.48 8
Dry- planting	9	20	2	20	1.35
9					
Use of Pesticides	1	21	52	39	0.86
10					
Local Seed Selection	0	3	40	17	0.77
11					
Crop Spacing	0	2	21	29	0.48
12					
Pre-Sawing Management	2	2	11	34	0.43
13					
Seasonal Migration	0	0	21	30	0.41
14					
Hand Craft	0	1	28	96	0.24
L5					

Source: Fieldwork (2017)

Among the fifteen ranked adaptation practices, fatting, Fertilizer and cash crops ranked first, second and third with WAI value of 2.23, 2.11 and 2.01 respectively. Respondents' dependency on buying some part of their food items to bridge shortages annually is the reason that makes fattening and cash cropping (for

income generation to buy foods) as the most important and effective adaptation strategies. Fertilizer comes second though not adequate and affordable to most respondents. Farmers considered fertilizer as paramount because it rapidly improved and maintained soil fertility and gives immediate results in crops yields increase. Seasonal migration and hand craft were ranked least importance adaptation. This is as a result of enhanced adaptive strategies and declined in drought frequency that prove most of the adaptations effective.

5.10 Access to Government Intervention in Drought

Government level of intervention in drought in the study area is presented on table 5.24.

Table 5.24 Access to Government Intervention to Drought

Access to Government Intervention to Drought	Frequency	Percentage
Benefited	97	25.26
Not benefited	287	74.74
Total	**384**	**100**

Source: Fieldwork (2017)

Majority of the respondents never benefited from any of the various government adaptations interventions. The low level of government commitment in strengthening adaptation strategies in the study area could increase the vulnerability of most rural household to the impacts of drought. Nigeria consistently spent less than 5% of its annual budget on agriculture which is extremely low compared to other African countries'10% on Maputo 2003 based agreement (Anselm and Taofeeq, 2010). Federal government also solely funded and manages all agricultural research institutes. The states and local governments which are closer to the rural farmers are not involved in decision on funding, direction and implementation of research activities (Agbamu, 2000). The consequences of this are low new agricultural technologies transfer to the smallholder farm families for adoption. This invariably could cause serious challenges for agricultural adaptation (Bello*, et. al*., 2012). Low level educational status among respondents in the study area compounded the problems.

5.10.1 Type of Support Government Offered in the Study Area

The type of support benefited from government by the respondents' is indicated on table 5.25.

Table 5.25 Type of Support Government Offered

Type of Support Offered	Frequency	Percentage
Extension Service	28	28.87
Improve Seed and Fertilizer	92	94.85
Pesticides	44	45.36

Source: Fieldwork (2017)

Most of the beneficiaries benefited improved seed and fertilizer. Though beneficiaries were satisfied with the effectiveness of the intervention especially fertilizer but complained about the amount given to them and inconsistency of the program. Considering the proportion of the beneficiaries and the amount of fertilizer given to them, the study area falls short of the Nigerian average. In Nigeria the average fertilizer application is 8kg/ha, and this is below the 200kg/ha world average (Atser, 2007). This could impede the development of new agricultural technologies like new improved seeds and animal varieties for adaptation in the study area.

5.11 Non Governmental Organization Drought Intervention

The level of nongovernmental organization drought intervention in the study area is extremely low. The most notable one is OLAM Company. Less than one percent have ever benefited and even then not consistent. This low intervention is as a result of exercised control by government that nongovernmental organizations must work with its agencies in any community they intend to work with (support).

5.11.1 Type of Support Non Governmental Organization Offered

All the beneficiaries have benefited from of all the type of support offered that is improved seed, fertilizer, farm implement (pesticide spryer) and buying of the crop they produced at higher price from the company offering the support. The small proportion of the beneficiaries and the condition for benefits (Specific crops) makes the intervention to be less effective as some willing farmers could not have access to the intervention program. This is because most of the respondents were unable to form associations due to

low educational attainment and poverty. Nongovernmental organizations seem not safe to work with individual farmer as it involves issuing of credits directly or indirectly.

5.12 Household resilience against Drought Impacts in the Study Area

To further assess the sustainability of the adaptation strategies household resilience against drought with current climatic trend was asked and respondents views is shown on Table 5.26 Findings show that most of the respondents are safe with current adaptations used despite changes observed in the climatic trends. This higher percentage of adaptation sustainability is as a result of increase in the annual rainfall and hence decreases in both drought frequency and intensity which enhances the adaptation practices.

Table 5.26 Household resilience against Drought

Household resilience against drought	Frequency	**Percentage**
Resilient	273	**71.09**
Not Resilient	111	**28.91**
Total	**384**	**100**

Source: Fieldwork (2017)

5.13 Constraints to Effective Drought Adaptation in the Study Area

Respondents' constraints to effective drought adaptation in the study area are given on Table 27**.**

Table 27 Constraints to Effective Drought Adaptation

Constraints	Frequency	Percentage
Inadequate Fertilizer	360	93.75
Scarcity appropriate pesticides	286	74.47
shortage improved seeds	201	52.34
In accessibility to credit	307	80
Shortage of capital	287	74.74

Problem of Security	125	32.55
Non existence of price regulatory body	79	20.57
Inadequate of genuine Farm implement	278	72.40
Shortage of Extension services	8	2

Source: Fieldwork (2017)

Inadequate fertilizer; shortage of capital; scarcity of appropriate pesticides; increased prevalence and emergence of new pest and diseases; inadequate farm implement; inaccessibility to credit are considered as universal constraints that affects majority of the respondents in the study area. More than fifty percent of the respondents stick to the indigenous seeds. This was because some of respondents believed their indigenous seed is preferable to them than the high breed one hand and non availability of the products on the other hands. Security, extension services and price control are the list constraints with least respondents. This was due to low level of respondents' educational attainment as they sees government intervention as privilege not their right on one hand and on the other it exposes the weaknesses of government institution designated for drought intervention or agriculture as a whole to effectively adhere to the underlain regulation governing the conduct of any program.

5.14 PCI Ranking of Constraints to Effective Drought Adaptation in the Study Area

To assess the most impacting constraints against effective adaptation to drought, these constraints were ranked according to their relevance as a barrier using PCI ranking techniques. Results on barriers to effective adaptation practice are presented on Table 5.28. Inadequate fertilizer is ranked first as the most critical barrier to effective adaptation with PCI value of 910. Non availability and high cost coupled with poverty of most of the respondents in the study area makes it to be the most pressing issue to adaptation. Household mostly depend on this subsidized commodity which is far below what they required leaving majority of them without such meager ratio. In general Nigeria's fertilizer average application per hacter is very low use averages 10–15 kg/ha (IFDC 2006), compared to 100–200 kg/ha in developed agricultural economies. So the level of fertilizers application in the study area is far below the country's average and this is a serious challenge in lessening the impact of drought. Because even with

improve seeds and pesticide agricultural diversification would hardly be possible without corresponding fertilizer application.

Table 5.28 Constrains to Effective Drought Adaptation Ranking

Constrains to Adaptation and their degrees	High (3)	Moderate(2)	Low (1)	No Problem (0)	PCI	Rank
Inadequate Fertilizer	239	83	27	11	910	1
In Accessibility of Credit	44	87	91	85	397	2
Shortage of Improved Seeds	46	86	69	0	379	3
Inadequate Farm Implement	54	35	73	116	305	4
Scarcity Appropriate Pesticides	3	80	110	93	279	5
Shortage of Extension Services	0	3	5	4	11	6
Shortage of Capital	0	4	0	0	8	7
Problem of Security	0	1	4	5	6	8
Shortage of Price Regulatory Body	0	0	1	7	1	9

Source: Fieldwork (2017

Shortage of credits to farmers ranked second. Jigawa state is ranked among the states with high poverty index and this poverty is more pronounced among rural households that have limited opportunities. Literature indicates that improved agricultural productivity is associated with reduced incidence of poverty (Thirtle *et al.* 2003). Therefore most respondents in the study area could not afford to purchase necessary farm inputs required. Lack of improved seeds and farm implements ranked third and fourth impediments to a successful adaptation to drought with PCI values of 397, 379 and 305 respectively. High cost and none availability of improved seeds at village levels make it unaffordable. Fear of buying non genuine seeds also makes it a serious problem to most of the respondents. High cost of most farm implements and respondents low purchasing power hinders them from using new implements. Lack of appropriate pesticides, extension services and lack of capital are considered as moderate constrains to effective drought adaptation. Security and price control were less pressing barriers to effective adaptation.

CHAPTER SIX

SUMMARY, CONCLUSION AND RECOMMENDATIONS

6.1 Introduction

This chapter presents summary, conclusion and recommendations of the research.

6.2 Summary

Drought is an extended period of deficient rainfall relative to the long term average rainfall for a region. The inability of rainfall to meet the evapotranspiration demands of crops results in general water stress and crop failures. Agriculture is one of the immediate sector where drought impact is felt especially the study area, where rainfed agriculture is the major source of livelihood of the rural households. However, recently anthropogenic climate change is said to exacerbate the incidence of drought. With increased frequency or intensity of drought, impacts extend beyond the usual adaptation strategies, hence a significant fall in food production.

This study focused on assessing households' level of adaptation to drought among rural communities in Jigawa state. To achieve this, a total of 384 open and close ended copies of questionnaire were administered to respondents. The questionnaire assessed household awareness to drought, socio-economic characteristics, drought adaptation strategies, effectiveness of these adaptations and constraints against effective adaptation in the study area.

Rainfall data from 1980 to 2014 obtained from the Jigawa State Agricultural and Rural Development Authority (JARDA) and Kano State Agricultural and Rural Development Authority was subjected to linear trend analysis to analyze the rainfall characteristics. The Normalized Rainfall index (NRI) was used in depicting periods of different drought intensities in the study area. Regression line indicates increasing trend in annual rainfall amount, especially from 2005 towards the end of the period under study. Five year running mean indicates low values below long term mean until 2006. From then the value increased above the long term mean towards the end of the periods under study. Low annual rainfall totals in the first twenty five years of the period under study coincided with the periods of frequent drought episodes in

the study area.

Result of the Normalized Rainfall Index (NRI) showed that the study area suffered frequent drought episodes at varying intensities in the first decade under study (1980-1989). This decade was characterized by more severe and more persistent droughts. Out of the fifteen recorded drought events, eight occurred in the first decade representing about 53.3% of the total drought events. Decline in drought frequency and intensity in the last ten years under study resulted increase in annual rainfall amount recorded in the study area.

The result also revealed that households experienced series of droughts but have extremely low awareness of the scientific causes and changes in trend of occurrence of drought events in the study area. Households suffered various drought impacts ranging from socio-economic to environmental; however, famine, high food price and poverty were the most pressing impacts due to low yield of most crops produced and traditional farming system used by most respondents in the study area.

Numerous adaptation strategies were employed by respondents most of which are autonomous and responsive. These strategies include; fattening, fertilizer, cash-cropping, irrigation, trade, mixed cropping, manure, improved seeds, *binne* etc. However fattening, fertilizer application, cash-cropping and irrigation were the most effective adaptation strategies in the study area.

Rural households' main constraints against effective adaptation to drought according to respondents were unavailability and none affordability of fertilizer, improved seeds and pesticides, lack of access to the source of financial credits, lack of active extension services, high cost and non availability of farm implement, security and price control. However, out of these constraints fertilizer, credits to farmers and improved seeds were the most pressing constraints to most rural household in the study area.

6.3 Conclusion

Linear trend analysis of rainfall characteristics showed the study area enjoys increased annual rainfall amount in recent years. Increase in annual rainfall amount corresponds with decrease in drought occurrence in the study area. This enhanced the effectiveness of adaptation practices and adoptive

capacities of rural households in the study area.

The Normalized Rainfall Index was found to be relatively effective in describing drought characteristics as well as depicting wet condition in the area. Mild drought was the dominant drought events in the study area with about 53.33% frequency of occurrence. However, the first decade under study was characterized by frequent drought episode with more than 53% of the total occurrence. It was however the decade with more severe drought though the most severe events occurred in 2008.

Though, the study area experienced decrease in the frequency of drought occurrence, the fragile nature of the adaptation strategies of most household remained sensitive to a slight change in rainfall characteristics. Respondents solemnly rely on traditional adaptation strategies with little or no formal information on current climate issues. This information is vital tools for effective preparation and mitigation of droughts .The evidence of these was low farm output and high crop failure as reported in the study area.

6.4 Recommendations

1. Federal government should improve accessibility to, and affordability of fertilizer by making it pro-poor. While formulating input subsidy policy, it should include access, which is aimed at improved volume, varieties, and quality of agricultural inputs. Important also is affordability; agricultural inputs must be priced within reach of rural farmers.

2. State government should improve upon extension services by establishing effective relationship between farmers and extension workers, providing necessary working environment and or needed inputs. It should also incorporate various enlightenment agencies in promoting effective information delivery and feedback especially rural communities.

3. State and local governments should intensify effort on adult literacy as it is among the major problems extension workers face in delivering modern agricultural adaptation strategy; especially with current climatic trends. Adult literacy will also reduce vulnerability of rural household to drought as statistical analysis confirms that those with contingency plans are less vulnerable. Therefore, the extent of one's

preparedness affects the impacts of droughts when they occur.

4. The rural communities in the study area have higher poverty index rate and this hinders most of them from purchasing modern farm inputs which are usually high priced especially during farming season. Most household have no access to agricultural credits. Therefore Federal government and financial agencies should improve upon accessibility and affordability to agricultural credit to farmers. Lack of capitals is a serious constrain to adaptation sustainability.

5. Irrigation in the study area is limited to the very scarce river banks and some low land terrain despite the study area is being underlain by sedimentary Chad formation which is a good aquifer. Federal, state, local governments and nongovernmental organizations should intensively exploit abundant underground water resources to enhance and increase irrigation potentials.

6. Some of the respondents' adaptation practices proved effective. Research institutions should research in to these practices, enhance them and re-introduce them to farmers. This will encourage active participation and speedy assimilation of modern techniques introduced to rural households who have often characterized with stubbornness in accepting new ideas.

7. With regard to computing drought index, researchers conducting similar or related research should try other method that encompasses other drought indicators like vegetation index, soil water capacity, evapotranspiration etc. This may reveal further information about drought characteristics in the study area as rainfall is not the only indicator.

REFERENCES

Abaje, I.B. (2010). Occurrence of Drought in the Sudano Sahelian Zone of Nigeria. Unpublished M.Sc. Thesis Submitted to the Post Graduate School, Ahmadu Bello University, Zaria, Nigeria.

Abaje, I. B., Ati, O. F. and Iguisi E.O., (2011). Drought in the North-Eastern Part of Nigeria and the Risks on Human Health, in E.O. Iguisi, O. A. Ati, R.O. Yusuf and A.E. Ubogu (eds) NiMet Zaria 2011 Proceedings of the International Conference of the Nigerian Meteorological Society, pp 527-538.

Abaje, I.B., Ati, O.F., Iguisi, E.O. and Jidauna, G.G. (2013). Droughts in the Sudano-Sahelian Ecological Zone of Nigeria: Implications for Agriculture and Water Resources Development. *Global Journal of Human Social Science Geography, Geo-Sciences and Environmental Volume 13 Issue 2 pp1-11.*

Abaje, I. B., Sawa, B. A., Iguisi, E. O. and Ibrahim, A. A. (2016). Impact of Climate Change and Adaptation Strategies in Rural Communities of Kaduna State, Nigeria. *Journal of Environmental Studies and Management Vol. 9 (1) pp.96-108.*

Abdussalam, Z. (1997). Socio-economic analysis of the production of selected main crops involved in cross-border grain trade in Katsina state. An unpublished M Sc. Thesis. Department of Agricultural Economics and Rural Sociology, A B U Zaria

Abubakar, I. U. (2008). Issues on Crop Production in Northern Nigeria: Poor Crop Yields and Irrigation. Paper presented at *the first northern Nigeria submits on Agriculture*: *Policy and Finance imperatives for vision 2020* held on 28-30July, 2008 at Kaduna. Pp. 18

Abubakar, I.U. and Yamusa, M.A. (2013). Recurrence of Drought in Nigeria: Causes, Effects and Mitigation; International. *Journal of Agriculture and Food Science Technology, Volume 4, Number 3*.http://www.ripublication.com/*iJARS*.pp169-180

Adams, R. M., Hurd, B. H., Lenhart, S. and Leary, N. (1998). Effects of Global Climate Change on Agriculture and Interpretative Review. *Climate Research 11* pp19-30

Adeaga, O, (2002). Management of Drought Risk in the Sudano-Sahelian region of Nigeria, *FRIED* 2002, ed.pp.157-162

Adefolalu, D. O. (1985). Further aspects of the Sahelian drought as evident from rainfall regime in Nigeria. *Archive of Meteorology, Geophysics and Bioclimatology*, 36, 277-295. doi:10.1007/BF02263134,http://dx.doi.org/10.1007/BF02263134

Adefolalu D.O. (1986). Further aspects of Sahelian drought as Evidence from rainfall regime of Nigeria. *Archives for Meteorology Geophysics Bioclimatology Ser. B 36, pp* 277-295.

Adeoye, K.B. (1986). An Evaluation of Drought Incidence and Hazard in Northern Nigeria. Paper Presented at the 22nd Annual Conference of the *Agricultural Society of Nigeria, Zaria* 1st – 3rd September, 1986.

Adeputu, A. F. and Barthe, A., (2007). Vulnerability of Rural Sahelian Household to A Final Submitted to Climate Change (AIACC), Project the International START Secretariat 2000 Florida Avenue. NW Washington, DC.20009, USA.www.start.org pp 1-88

Adger, W.N. and Kelly, P.M. (1999). 'Social Vulnerability to Climate Change and the Architecture of Entitlements' *Mitigation and Adaptation Strategies for Global Change* 4(3/4) pp253–266

Adger, W.N., Huq, S., Brown, K., Conway, D., Hulme, M. (2015). Adaptation to Climate Change in the Developing World. 1-http://www.glerl.noaa.gov/seagrant/ClimateChangeWhiteboard/Resources/Uncertainty/climatech/adger03PR.pdf. pp. 1-7

Agbamu, J. U. (2000). Agricultural Research-extension Linkage System: An International Perspective, Agricultural Research and extension Network (AgRE). *Network Paer No. 106,* pp1-24

Akonga, A. Z. (2001). The Causes and Impacts of Drought. *ANIS Monograph No. 3*.pp.1-16

Alatise, M.O. and Ikumawoyi, O.B. (2007). "Evaluation of Drought from Rainfall Data for Lokoja" A confluence of Two Major Rivers, *Electronic Journals of Polish Agricultural Universities (EJPAU).Vol.10, Issue, 1***.** http://www.ejpau.media.pl/volume10/issue1/art-05.html

American Meteorological Society [AMS] (1997). AMS Policy Statement on Meteorological Drought .http://www.ametsoc.org/policy/drought/2.html

American Meteorological Society, [AMS] (2004). Meteorological Drought. *Bulletin of American Meteorological Society, 85* .ttp://www.ametsoc.org/policy/drought statements final 0304.html

Anselm, A. E. and Taofeeq, A. A. (2010). Challenges of Agricultural Adaptation to Climate Change in Nigeria: A Synthesis from the Literature.http://factsreports.revues. org/ index678.html.pp1-12

Apata, T., G. (2011). Factors Influencing the Perception and Choice of Adaptation Measures to Climate Change among Farmers in Nigeria. Evidence From farm Households in Southwest Nigeria http://businessperspectives.org/journals_free/ee/2011/ee_2011_04

Apeldoorn, G. J. Van. (1978). Drought in Nigeria Volume2: Lessons of the 1972-74 Disaster. *Center for Social and Economic Research,* Ahmadu Bello University, Zaria.

Apeldoorn, G. J. Van., (1981). Perspectives on Drought and Famines in Nigeria. *George Allen and Unwin Ltd,* London. pp.184

Aremu J. K. (2011). Combating and mitigating drought and desertification in Northern Nigeria, *JEHETR* 1(2), University of Benin, Benin City, Nigeria.

Ariyo, J. A., Gashua, M. A. and Oladipo, E. O. (1996). Indigenous o- farm Techniques of Coping with Drought in the Sahel Region of Nigeria; *Malaysian Journal of Tropical Geography, Volume 27, No.1.*

Ati, O.F., (2006). Rainfall Characteristics in Draught-prone Sudano-Sahelian zone of Nigeria, PhD Thesis, Department of Geography, Ahmadu Bello University, Zaria,

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 Resources.,* 993(12): pp.1746-1751. http://www/insinet.net/jasr/2007/1746-1751.pdf

Atser, G. (2007). Stakeholders demand scrutiny of 2007 budget. http://www.Budget monotoring.ng.org/ pp.181-188

Ayeni, A. I. (2001). Adaptation Opportunities, Barriers and Strategies in Developing Countries: Focus on Drought Management in Nigeria. Drought and Desertification Department Federal Ministry of Environment, Abuja Nigeria pp 1-7.

Ayoade, J.O. (2004). *Introduction to Climatology for the Tropics (*2nd eds).Spectrum Books Limited, Ibadan

Ayoade, J. O. (2005). *Introduction to Agroclimatology* (2nd eds) University press plc, Ibadan

Barry, R.G. and Choley, R.G. (2003). *Atmosphere, Weather and Climate (8th eds).* Routlege Taylor and Francis Group, London.

Bates, B. C., Kundzewicz, Z. W., Wu, S. and Palutikof, J. P. (2008). Climate Change and Water Technical Paper of the Intergovernmental Panel on Climate Change, IPCC Secretariat, Geneva. pp. 210 http:// www.ipcc.ch/

Bello, O. B., Ganiyu, O. T., Wahab, M. K. A., Afolabi, M. S., Oluleye, F., Ig, S. A., Mahmud, J., Azeez, M. A. and Abdulmaliq, S. Y. (2012). Evaluation of Climate Change Impacts on Agriculture and Food Security in Nigeria. *International journal of Agriculture and Forestry 2 (2)* pp 49-55

Bernard, H.R., (2002). *Research Methods in Anthropology Quantitative Methods, 3rd Edition,* Altamira Press Walnut Creek, California.

Biasutti, M. and Giannini, A. (2006). A robust Sahel drying in response to late 20th century forcing *Geophysics Resource Letters*, 11, L 11 706.

Brett, H. (2009). Food and Agriculture, Features, Climate Change Threat to Food Security .http:// www.people and planet. Net/doc.

Brinkhoff, T. (2017). Jigawa (state, Nigeria)-population statistics, chat, map. Source: National Population Commission of Nigeria (web), National Bureau of Statistics (web) .https: www.city population .de .php. (Accessed on march14th, 2018)

Building Nigeria's Response to Climate Change [BNRC] (2008). Climate Change Information on Nigeria: Agriculture, Food Security, Land Degradation Forestry and Biodiversity.http://www.landcareonline.com.au/wp.content/uploads/2012/08/LIF-August2012.pdf.

Camberlin, P. and Diop, M. (2003). Application of daily rainfall principal component analysis to the assessment of the rainy season Characteristics in Senegal. *Climate Research*, 23, pp.159-169.http://dx.doi.org/10.3354/cr023159

Chappell, A. and Agnew, C.T. (2004). Modeling Climate Change in West African Sahel Rainfall (1931–90) as an Artifact of Changing Station Locations. *International Journal of Climate, 24* (5), pp.547–554.

CSM [Christian Science Monitor] (2011). "Climate Change, 2011 Temperature the hottest ever during La Nina" http://www.csmonitor.com/Science/2011/1129/Climate-change-2011-temperatures-the hottest-ever-during-La-Nina**)**

Dai, A., Lamb, P. J., Trenberth, K. E., Hulme, M., Jones, P. D., and Xie, P., (2004): 'The recent Sahel drought Israel'. Submitted to *International Journal of Climate Change,* http://www.cgd.ucar.edu/cas/adai/publication-dai.html pp 1323-–1331

Dangel, C., (2008). "Jigawa State physiography". *CGIDD.*http://en.wikipedia.org/w/index.php?title=Jigawa_State&oldid=553650117

Dietz, A. J., Ruben, R., and Verhagen, A., (2001): Impacts of climate change on Drylands with a focus on West Africa. *Dutch National Research Program on Global Air Pollution and Climate Change, Report No. 410 200 076*. Wageningen: ICCD.

Directory of soil institution and experts in Africa, (2002). www.FAO.org/ag/agl/sw/wpnr/reports/y-sf/z-ng/ng.htm

Easterling, W. E., Crosson, P. R., Rosenberg, N.J., McKenney, M.S., Katz, L.A. and Lemon, K. M. (1993). 'Agricultural Impacts of and Responses to Climate Change in the Missouri-Iowa-Nebraska-Kansas Region', *Climate Change* 24(1–2), pp.23–62

Economic Commission for Africa [ECA], (2007). "Drought *and Desertification"* Fifth Meeting of the Africa Committee on Sustainable Development (ACSD-5/ Regional Implementation Meeting (RIM) for CSD – 16 Adis Ababa

Ekpoh, I. J. (1991). The Effects of Climatic Variability on Agriculture in Northern Nigeria PhD Dissertation, University of Birmingham, Birmingham B 15 2TT, United Kingdom.

Ekpoh, I. J. (1999a). Rainfall and Peasant Agriculture in Northern Nigeria.*Global Journal of Pure and Applied Sciences*, 5(1) pp.123-128

FA O (1998). Report on the development of food insecurity and vulnerability*. Committee on world food security, Rome*http://www.fao.org/docrep/meeting/w84970.htm

Farauta, B. K., Egbule, C. L., Agwu, A. E., Idrisa, Y. L. and Onyekuru, N. A. (2012). Farmers' Adaptation Initiatives to the Impact of Climate Change on Agriculture in Northern Nigeria. *Journal of Agricultural Extension Vol. 16 (1),* pp 132-144 http://dx.doi.org/10.4314/jae.v16i1.13

FME (2004). National Biodiversity Strategy and Action Plan. pp114

Federal Republic of Nigeria [FRN] (2000). National Action Program (NAP) to Combat desertification and Mitigate the Effect of Drought. Towards the Implementation of the United Nations Convention to Combat Desertification and Mitigate the Effect of Drought in the Country.

Federal Republic of Nigeria [FRN] (2005). Combating Desertification and Mitigating the Effects of Drought in Nigeria. The Revised National Report on the Implementation of the United Nations Convention to Combat Desertification (*UNCCD*) in those Countries Experiencing Serious Drought and/or Desertification, Particularly in Africa.

Floyd, B. N. and Ekpoh, I. J. (2007). Transforming traditional agriculture. *Global Journal of Social Sciences*, 6(2).pp.97-102

Folland CK, Palomer TN, Parker DE (1986). "Sahel rainfall and worldwide sea temperatures" *Nature, 320:*pp 602-607

Gashua, M. A., (1991). An evaluation of indigenous techniques of copping with drought in Bade local government area of Borno state, Nigeria. Unpublished M.Sc thesis, department of Geography, Ahmadu Bello University, Zaria

Genanet, U. R. (2007). Gender, Climate Change and Adaptation. Introduction to Gender Dimensions. Background Paper Prepared for the both ENDS BRIEFING PAPER "Adapting to Climate Change: How Local Experiences can Shape the Debate" *c/o LIFE e.VDircksenstr. 47,* D- 10178 Berlin

Giannini, A., Saravanan, R. and Change, P. (2003). Ocean forcing of Sahel Rainfall on inter-annual to inter-decadal timescales. *Science*, 302, 1027-1030. doi:10.1126/science.1089357 .http://dx.doi.org/10.1126/science.1089357

Glantz M. H. and Kartz, R. W. (1987) "African drought and its impacts: Revised interest in a recurrent phenomenon. *Desertification Control Bulletin 14*: pp 22-30.

Houndenou, C. and Hernandez, K., (1998). Climate of the Sahel 1961-1990 Benin. *Secheresse, 9,* pp.23-34

IAR [Institutes of Agricultural Research] (2001). The Adoption of Improved Cowpea Technologies In The Savannah Of Nigeria. A Report of Survey Conducted On PEDUNE/PRONAF Project In Nigeria, April

Ibrahim, A. A., Yakubu, H. G., Ati, O. F. and Iguisi, E. O. (2011). An Assessment of Monthly Rainfall profile for Kano from 1946-2005, *Brazilian Geographical Journals Vol.2 No.2,* 2011pp.354-368

ICRISAT, (1984) Agrometeorology of sorghum and millet in the semi-arid tropics, *Proceedings of an International Symposium*, 15-20 November 1982, ICRISAT Center, Pantancheru, India. pp.322

IFDC [International Fertilizer Development Corporation] (2006). Nigerian company re-opens only bureau fertilizer plant In Sub-Saharan Africa to meet summit call for African Green Revolution.www.ifdc.org/New_Design/Whats_New/Notore%20Release%20Final%206%20 13%202006.pdf

Ijeoma, S. (2012). Nigeria and Climate Change Adaptation; *ISSP Insight, International Society of Sustainability Professionals pp. 1-6*

Intergovernmental Panel on Climate Change (IPCC): 2001, Summary for Policymakers. *Climate Change 2001:* Impacts, Adaptation, and Vulnerability*,* a Report of Working Group II of the IPCC, Geneva, IPCC pp 870

IPCC (2007). *The AR4 Synthesis Report* IPCC Fourth Assessment Report: Climate Change 2007 (AR4) *Intergovernmental Panel on Climate Change, Geneva Switzerland*. Pp.104 .http://www.ipcc.ch/pdf/assessment-report/ar4/syr/ar4_syr.pdf

IPCC (2013). Climate Change 2013: 5th Assessment Summary for Policy makers. *Intergovernmental Panel on Climate Change* .http://www.climatechange2013.org/ images/uploads/WGIAR5-SPM_Approved27Sep2013.pdf pp.36

Iwegbu, I. A. (1993). Some Aspects of the Spatial and Temporal Characteristics of Drought in Nigeria. A Statistical Approach, PhD Dissertation, Department of Geography

Jaiyeoba, I. A. (2002). Environment. In: Okafafor, S., Osaghae, E., Ikporukpo, C., and Abumere, S. (Eds), *Africa Atlas of Nigeria,* Les Editions J.A, Paris, France, pp122-123

James A. R. (1973). Drought condition in the pressure water zone of North- Eastern Nigeria: Some provisional observations, *Savanna 2* PP. 108-114.

Jibrin, M. J. (2010). Coping with Droughts in Nigeria's Sudano-Sahelian Zone. *Paper Presented at the US-Nigeria International Workshop*: Exploring Strategies for Managing Drought Using Climate Forecasts and Indigenous Knowledge Nov 13-16, Bauchi Nigeria

Jigawa State Ministry of Agriculture (2013). Medium Term Sector Strategy (MTSS) 2014-2016 Prepared by Ministry of Agriculture; Supported *SPARC* pp1-36

Joshua. J. K. and Ekwe, M. C. (2013). Indigenous Mitigation and Adaptation Strategy to Drought and Environmental Changes in Nigerian Section of Lake CHAD Basin *International Journal of Applied Research and Studies (iJARS) ISSN: 2278-9480 Volume 2,* Issue 5 (May- 2013) www.ijars.in pp 1-14

Kalu, A. E. (1987). The recurrence of severe droughts in northern Nigeria. Proceedings of the 1985 Commonwealth Meteorologists Conference. Meteorological Office College, Reading

Kamara, S.I., (1986). The origins and types of rainfall in West Africa. *Weather, 41*: pp48-56

Kayode, A. J. and Francis, O. A. (2012). Drought Intensities in the Sudano-Sahelian Region of Nigeria. *Journal of Sustainable Society Vol. 1, No. 4, 2012, pp.88-95*

Kayode, A. J. and Francis, O. A., (2013). Temporal Analyses of Drought Intensities Occurrence within Recent Decades in Some Stations in Northern Nigeria. *Journal of Sustainable Development Studies, Volume 2, Number 1, pp.1-9*

Keyantash, J. and Dracup, J. (2002). The Quantification of Drought: An Evaluation of Drought Indices. *Bulletin of the American Meteorological Society, 83* (8) pp 1176-1180

Kolawole, A. (1987). Responses to Natural and Man-made Hazards in Borno, Northeast Nigeria. Disasters ?: pp.59-66

Krejcie, R.V and Morgan, D.W., (1970). Determining Sample Size for research activities, *Journal of Educational and Psychological Measurement30 pp.*607-610

Kripalani, R.H and Kulkami, A. (1997). India, Indonesia Experiencing Opposite Effects from the 1997 El Nino. Drought Network News. *A News Letter of the International Drought Information Center and The National Drought Mitigation Center. 10 (1):* Pp6

Kunda, J. J., and Chibuike, E. M., (2013). Indigenous Mitigation and Adaptation Strategy to Drought and Environmental Changes in Nigerian Section of Lake CHAD Basin. *International Journal of Applied Research and Studies (iJARS) ISSN: Volume 2, Issue 5* pp.2278-9480 www.ijars.in

Lockwood, J. G. (1988). *Climate and Climatic Variability in semi-arid regions at low latitudes*. M. L.Parry, T.R.Carter and N.T.Konijn (eds), The impact of climate variations on Agriculture: Assessments in semi-arid region. Kluner Academic Publishers, Dordrecht.

Loukas, A. and Vasiliades, L. (2004). Probabilistic Analysis of Drought Spatio-temporal Characteristics in Thessaly Region, Greece. *Natural Hazards and Earth System Sciences.* European Geo-Sciences Union. http://hal.achieves-Ouvertes.f r/docs/00/29/92/22/PDF/ nhess–4–719–2004.pdf

McCarthy, J. J., Osvaldo F., Canziani, N., Leary, A., Dokken, D. J. and White, K. S. (2001). Climate Change 2001: Impacts, Adaptation, and Vulnerability (eds.).*Working Group II, Intergovernmental Panel on Climate Change.* New York: Cambridge University Press

Mohammad R. A. (2009). *Nigeria: Stemming the Impact of Climate Change,* Daily Trust, 21st July, 2008

Mortimore, M., (1973). Famine in Hausa land. *Savanna* 2, pp 103-107

Mortimore, M. (1989). *Adapting to Drought: Farmers Famine and Desertification in West Africa.* Cambridge University Press, Cambridge. pp 299

Mortimore, M. and Adams, W. M. (1999). *Working the Sahel.* London Rout edge.

National Bureau of Statistics, 2007

National Drought Mitigation Centre, [NDMC] (2006a). What is Drought? Understanding and Defining Drought .http://drought.unl.edu/what is/concept.htm

NDMC [National Drought Mitigation Centre](2006c). Impacts of Drought. .http://drought.unl.edu/login.aspx?ReturnUrl=%2fDroughtBasics%2fWhatisDrought.aspx

NDMC, [National Drought Mitigation Center], (2014). What is Drought? .http://drought.unl.edu/login.aspx?ReturnUrl=%2fDroughtBasics%2fWhatisDrought.aspx

NDMG, [National Disaster Management Guidelines](2010. Management of Drought *A publication of the National Disaster Management Authority*, Government of India, New Delhi.www.ndma.gov.in pp.1-108

Nich, I. O. (2012). Desertification and Drought Risk Vulnerability: Potentials of Desertification and Drought Risk Management in Northern Nigeria (A case of Sokoto, Kano and Kaduna) *Journal of Environmental Management and Safety* .www.cepajournal.com p.1-14

Nicholson, S. E. (1985). Sub- Saharan rainfall, 1976-1984. *Journal of Applied Meteorology*, *24,* 1388-1391. http://dx.doi.org/10.1175/1520-0450(1985)024<1388:SSR>2.0.CO;2

Nicholson, S. E. (1993). 'An Overview of African rainfall fluctuations of the last decade'. *Monthly Weather Review*, *111,* 1646-1654. http://dx.doi.org/10.1175/1520-0493(1983)111<1646:SSRITY>2.0.CO;2

Nicholson, S. E., and Tucker, C. J. (1998). Desertification, drought, and surface vegetation: an example from the West African Sahel. *Bulletin of the American Meteorological Society*, 79(5), 815-829. Doi. http://dx.doi.org/10.1175 /1520-0477(1998)079 <0815: DDASVA >2.0.CO;2

Nicholson, S.E., Some, B. and Kone, B. (2000): An analysis of recent rainfall condition in West Africa, including the rainy seasons of the 1997 El Nino and the 1998 La Nina years. *Journal of Climate, 13(14),* pp 2628-2640

Nnaji, A.O. (2001). Forecasting seasonal rainfall for agricultural decision-making in northern Nigeria, *Agricultural and Forest Meteorology*, 107, 193-205.doi:10.1016/S0168-1923 (00)00239-pp 193-205

Nnoli, N.O. (2004). Variability and change in mean onset and cessation dates of rainy season in Nigeria, *Nigerian Meteorological Journal*, 4, pp 36-49

National Population Commission [NPC] (2006). 2006 Population and Housing Census of the Federal Republic of Nigeria Priority Tables (Volume I).www.population.gov.ng

Nsa, E. and Ekpoh, I. J., (2011). Extreme Climatic Variability in North-western Nigeria: An Analysis of Rainfall Trends and Patterns, *Journal of Geography and Geology Vol. 3, No. 1;* September 2011.www.ccsenet.org /jgg pp 1-12

Nyong, A., Adesina, F. and Elasha, B.O. (2007). The value of indigenous knowledge in climate change mitigation and adaptation strategies in the African Sahel, *Mitigation and Adaptation Strategies for Global Change*, **12**, 7. doi:10.1007/s11027-007-9099-0 pp 787-797

Ojos Negros Research Group, ONRG, (2004a). Impacts of Droughts. http://threeissues.sdsu.edu//threeissuesdroughtfacts04.html

Okonya, J.S.; Syndikus, K.; Kroschel, J., (2013). Farmers' perceptions of and copping strategies to climate change: Evidence from six agro-ecological zones of Uganda. *J. Agric. Sci.* **2013**, *5*, doi:10.5539/jas.v5n8 pp 252

Okorie, F.C. (2002). Studies on drought in Sub-Saharan region of Nigeria using satellite remote sensing and precipitation data.http://www.mathaba.net/gci/docs/research/nigeria-drought.htm

Okorie, F.C. (2003). Studies on Drought in the Sub-Saharan Region of Nigeria Using Satellite Remote Sensing and Precipitation Data .http://www.mathaba.net/gci/docs/research/nigeria-drought.html

Oladipo, E.O. (1985). A comprehensive Performance Analysis of Three Meteorological Drought Indices. *Journal of climatology, 5:* pp 655-664

Oladipo, E.O (1990). Drought in Africa: a synthesis of current scientific knowledge. *Journal of environmental and social sciences, Vol. 9, No. 2,* pp 64-82

Oladipo, E. O. (1992). Managing Drought for Development in Nigeria. Paper Presented at the 15th Annual Conference of the Africa Association of Australia and the Pacific, *Images of Africa*. Victoria University Wellington, New Zealand, 8-9 August1992

Oladipo, E.O. (1993). Some Aspects of the Spatial Characteristics of Drought in Northern Nigeria, *Natural Hazards 8,* pp 171-188

Oladipo, E. O. (1993a). Some Aspect of the Spatial Characteristics of Drought in Northern Nigeria, *Natural Hazards,* Kluwer Academic Publishers, Netherlands*, 8:* pp 171-188

Oladipo, E.O. (1993b). A Comprehensive Approach to Drought and Desertification in Northern Nigeria, *Natural Hazard.* Kluwer Academic Publishers, Netherlands*, 8:* pp 235-26

Oladipo, E. (2010). Towards Enhancing the Adaptive Capacity of Nigeria: A Review of the Country's State of Preparedness for Climate Change Adaptation: *Heinrich Böll Foundation Nigeria* pp 1-44

Olofin, E. A. (1987). *Some Aspect of Physical Geography of Kano Region and Selected Human Response.*BUK, Debis Standard Printers, Kano

Omolola, A. E. (2009). Climate Change and Adaptations. Staff/Post Graduate Seminar, Department of Geography University of Ibadan, pp7-8

Onlinenigeria**,** (2003). Nigeria: PHYSICAL SETTING-Jigawa State. http://www.onlinenigeria. Com/links/Jigawa-state

Oracle of Education Foundation, [OEF] (2000). Drought Causes of Droughts. Retrieved March 11, 2009 from http://www.library.Thinkquest.org/coo3603/English/droughts/causes of drought.shtml

Osewa, O. (2015). UNDP Ranking of state by poverty rates in Nigeria Politics-Naira land. The global multidimensional poverty index by UN .http//www.data for all.org/dashboard/poi/index.php/

Othman, M. K., Arab, A. I., Ibrahim, A. and Kallah M. S. (2010). Mitigating desertification through irrigation opportunities and challenges in Northern Nigeria, *In book of proceedings of the 10th International Conference of the Nigerian Institution of Agricultural Engineering,* 20-22nd October, 2010, pp 338-352

Otun, J. A. and Adewumi, J. K. (2009). Drought Quantification in Semi-Arid Regions Using Precipitation Effectiveness Variables: 18th World IMACS/ MODSIM Congress Cairn Australia 13-17 July 2009.htt:/mssanz.org.au/modsim09p. pp 1-7

Oyebande, L. and Balogun, I. (1990). Confronting the drought hazard through integrated policy and planning approach. In: *Proceedings of the 1st Biennial National Hydrology}' Symposium* (ed. by J. O. Sonuga; J. C. Umolu; L. Oyebande; F. Okoye; G. Oteze; O. Ajayi and V. Oke) (Maiduguri, Nigeria, 26-28 November 1990), pp.645-664 Nigeria National Committee for the International Hydrological Programme

Peterson, T.C., Hoerling, M.P., Stott, P. A. and Herring, S.C. (2013). Explaining Extreme Events of 2012 from a Climate Perspective (eds) Special Supplement *Bulletin of the American Meteorological Society 94 (9),* pp1-74

Reilly, J. and Schimmelpfennig, D. (1999). Agricultural impact assessment, vulnerability and the scope

for adaptation. *Climatic change 43*: pp 745–788

Rosenzweig, C. and Parry, M.C. (1994). Potential impact of climate change on world food supply. *Nature 307*: pp133-138

Sanni, S. A., Oluwasemire, K. O. and Nnoli, N. O. (2012). Traditional capacity for weather prediction, variability and coping strategies in the front line states of Nigeria *Agricultural Sciences Vol.3, No.4,* pp 625-630.http://dx.doi.org/10

Sanusi, A., Apampa, S. and Sotinrin, A. (2013). *socially inclusive sustainable development in a climate stressed northern Nigeria: a case study of Jigawa state;* with support from Chibueze Emenike, Project Manager, and Heinrich Böll Foundation Nigeria. Pp 1-45

Shemdoe, R. S. (2011)**.** Tracking Effective Indigenous Adaptation Strategies on Impacts of Climate Variability on Food Security and Health of Subsistence Farmers in Tanzania: *African Policy Studies Network; Working Paper Series |No 51.*AA pp1-34

Shuaibu, U. and Oladipo E.O. (1993) A Bhalme- Mooley – Type of Meteorological Drought Intensity Index for Northern Nigeria. *Zaria Geographer,* 14:18-27.

Sivakumar, M.V.K., (2012). High-level Meeting on National Drought Policy. CSA News, December. American Society of Agronomy, Madison, Wisconsin, USA

Smit, B., Burton, I., Klein, R. J. T. and Wandel, J. (2000) An Anatomy of Adaptation to Climate Change and Variability; *Climate Change45* pp 223-251

Smit, B. and Skinner, M. W. (2002). Adaptation options in agriculture to climate change: A typology. Mitigation and adaptation strategies for global change? Pp.85-114

SPORE (2008). Climate Change. Special Report pp.23

Suleiman, U. B. (2014). Farmers Adaptation Strategies to Drought In Katsina Band Its Environs. M. Sc. Thesis, Department Of Geography, Ahmadu Bello University, Zaria, Nigeria

Tarhule, A. and Woo, M., (1998). 'Changes in rainfall characteristics in northern Nigeria' *International Journal of Climatology 18(11),* pp 1261–1271

Tenkouano, A., Chantereau, J., Sereme, P. and Toure, A. B. (1997). Comparative response of a day-neutral and photoperiod-sensitive sorghum to delayed sowing or transplanting, *African Crop Science Journal 5(3)* pp 259-266

The Research Advisors, (2006). Sample Size Table. http://www.the research rdvisors.com/ tools /sample

Thirtle, C., Lin, L., and Piesse, J., (2003).The impact of research-led agricultural productivity growth on poverty reduction in Africa, Asia and Latin America, *World Development*, 31(12): pp 1959-1975

Thomas D, Osbahr H, Twyman C, Adger N and Hewitson B.(2005). Adaptations to Climate Change amongst Natural Resource-Dependant Societies in the Developing World: Across the Southern African Climate Gradient. *Technical Report 35,* Tyndall Centre for Climate Change Research

Tompkins,E.L., Adger,W.N.,(2004). Does adaptive management of natural resources enhances resilience to climate change? *Ecological Society .9(2),* 10–23.

Trenberth, K. E, Jones, P. D, Ambenje, P, Bojariu, R, Easterling, D, Klein Tank, A, Parker,D, Rahimzaden, F., Renwick, J.A. Rusticucci, M.,Soden, B., and Zhai, P. (2007). Observation:

Surface and Atmospheric Climate Change. In: Solomon, S., Quin, Manning, M, Chen , Z., Marquis, M,.Averyt, K.B, Tignor M., and Miller, H.L (Eds) . *Climate Change 2007: the Physical Science Basis,* pp 235- 336.Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panelon Climate Change. United Kindom and New york, N Y: Cambridge University Press. http://www.ipcc.ch/pdf/assessmentreport/ar4/wg l/ar4-wg l-chapter2.pdf

Turkes, M., (1996). Meteorological Drought in Turkey: A Historical Perspective, *Drought Network News, 89(3):* A Newsletter of the international Drought Information Center and the National Drought Mitigation Center, pp 1930-1993

UNCCD (2013). High Level Meeting on National Drought Policy (HMNDP) CICG, Geneva 11-15 March 2013; Science Document: Best Practices on National Drought Management Policy: World Meteorological Organization (WMO), United Nations Convention to Combat Desertification (UNCCD). Pp 1-12

UNISDR (2007). *Drought Risk Reduction Frame Work and Practice*: Contributing to the Implementation of the Hyogo Frame Work Action. United Nations Secretariat of the of the International Strategy for Disaster Reduction (UN/ISDR), Geneva, Switzerland, pp 98

UNISDR (2009b). Risk and Poverty in a Changing Climate, *Global Assessment Report on Disaster Risk Reduction.* United Nations Office for Disaster Risk Reduction, Geneva

Watson, R. T., Zinyowera, M. C. and Moss, R. H. (1998). *The Regional Impacts of Climate Change: An Assessment of Vulnerability, (eds).* Special Report of Working Group II, Intergovernmental Panel on Climate Change. New York: Cambridge University Press.

Wilhite, D. A. (2000). Drought as a Natural Hazard: Concepts and Definitions. In: Wilhite, D.A (eds.). Drought: *A Global Assessment,* Rougledge, pp3-18

Wilhite, D.A., and Pulwarty, R.S., (2005). *Drought and water crises: the road ahead* .In: Wilhite, D.A.(Ed.), Drought and Water Crises: Science, Technology and Management Issues. CRC Press, Boca Raton, Florida, pp 389–398

Wilhite, D. A., Sivakumar, M. V. K. and Pulwarty, R., (2014). Managing drought risk in a changing climate: The role of national drought policy. *Weather and Climate Extremes 3* pp4–13: www.elsevier.com/locate/wace

Wisner, B., and Mbithi, P.M. (1974). Drought in eastern Kenya: nutritional status and farmer activity. In White, G.F., (eds), *Natural hazards, Local, National, Global*, New York, Oxford University Press, London, Toronto

WMO (2011). Integrated Drought Management Programme; *A joint WMO-GWP Programme: Concept Note.* Pp 1-11

Appendix: i**:**

Questionnaire to the respondents

Introduction

The purpose of this questionnaire is to collect information about the occurrence, impacts and various adaptation strategies for mitigating the impact as well as the sustainability of those strategies in meeting the basic needs of a rural household in Jigawa state. All information given will be treated confidentially and for academic purposes only.

Section A. Personal data: Please fill and tick ( ) where appropriate

1. Name and G. P. S. of a village……

2. Name of a Local Government Area……..

3. Age (years): a. 30-40 ( ) b. 41-50 ( ) c. 51-60 ( ) d. above 60 ( )

4. Gender: a. Male ( ) b. Female ( )

5. Marital: a. Married ( ) b. single ( ) c. Divorce ( ) d. widow ( )

6. Household Size: a. 1-5 ( ) b. 6-10 ( ) c. 11-15 ( ) d. above 15 ( )

7. Educational qualification: a. primary ( ) b. secondary ( ) c. tertiary ( )
d. Islamic Education ( )

8. For how long have you been in this area? a. 10-15years ( ) b. 16-20years ( ) c.21- 25years d. above 25 years ( )

Section B: Agricultural activities

9. Head of household's primary occupations: a. farming ( ) b. business ( ) c. civil service

d. others, specify……..

10. What type of farmer are you? a. Commercial ( ) b. subsistent ( ) c. both ( )

11. What is your farm size? a. 1-5 hectares ( ) b. 6-10 hectares ( ) c. 11-15 hectares ( ) d. 16-20 hectares ( ) e. above 20 hectares ( )

12. For how long have you been farming? a. 10-15years ( ) b. 16-20years ( ) c. 21-25years ( ) d. 26-30years ( ) e. above 30years ( )

13. What type of crops do you cultivate? a. Millet ( ) b. Sorghum ( ) c. peanut ( )

d. others…….

Section C: Farmers drought perception and adaptation strategies

14. Have you ever experienced drought episode in your area? a. yes ( ) b. no ()

15. If yes, in your opinion, what do you consider as drought? a. extension of dry season beyond its normal duration ( ) b. drying of crops ( ) c. persistence of moisture deficits condition through a series of years ( ) d. others, specify ……..

16. In your perception what causes drought? a. an act of God ( ) b. man ( ) c. climate change ( ) d. wind (

) e. spirit ( )

17. Do you agree that drought occurrence goes through a definite time circle? a. Yes ( ) b. No ( )

18. If yes, what is the usual periods between two (serial) droughts a. 2years ( ) b.5years c. 10years ( ) d. others, specify……

19. Did you notice any changes in the frequency and intensity of drought occurrence in the area? a yes ( ) b no ( )

20. If yes how? a. abrupt Rainfall onset and cessation on the increase ( ) b. Decrease in rainfall amount annually ( ) c. Reduction in number of rainy days/months/yearly ( ) d. others, specify……..

21. What brings about these changes in the occurrence of drought? a. climate change ( ) b. excessive cultivation ( ) c. desert encroachment ( ) d. others, specify……..

22. In what ways has drought affected your farming activity? a. poor yield ( ) b. poor soil fertility ( ) c. short/stunted growth ( ) d. pests/diseases ( ) e. others, specify…….....

23. Can you say that drought influences your yearly income generation? a. Yes ( ) b. No ( )

24. If yes, what are the socio-economic implications on you and your household? a. high rate of poverty ( ) b. high food prices ( ) c. famine(inadequate food) ( ) d. conflict () e. others, specify …….....

25. Apart from socio-economic impact does drought has any other impact on your household? a. yes ( ) b. no ( )

26. If yes what are these impacts? a. soil degradation ( ) b. vegetative degradation () c. health problem ( ) d. degradation of water resources ( ) e. others, specify……..

27 kindly rank the mentioned drought impacts in order of their influence on your household livelihood using a scale of 0-3 (3 = highly impacting;2 = moderately impacting; 1 = less impacting; 0 = not impacting).

28. Over the years of experience were you able to develop adaptation strategies against the vagaries of the drought? a. yes ( ) b. no ( )

29. What are those strategies? List them……

30. How effective are these strategies in meeting the basic need of the household? a. increase in yield per hectare ( ) b. normal yield per hectare ( ) c. increase in annual income () d. others, specify ……

31. How effective are these strategies in maintaining environmental resources? a. improve soil fertility ( ) b. improve vegetative resources ( ) c. improve water resources ( ) d. others, specify……..

32. How sustainable are these strategies in meeting the basic needs of the household over the years with an increase in family size? a. increase in annual yield yearly b. increase in annual income ( ) c. diversify source of income ( ) d. others, specify……..

33. Kindly rank the mentioned drought adaptation strategies in order of their effectiveness using a scale of 0-3(3 = highly effective; b2 = moderately effective; 1 = less effective; 0 = not effective).

34. Does governments come to your aids either during or after the drought events? a. yes ( ) b. no ( )

35. What type of support does it offer to you? a. extension service ( ) b. information about drought ( ) c. improve seed and fertilizer ( ) d. aid in money or foods ( ) e. others, specify…….

36. Has any nongovernmental organization ever come to your aid? a. yes ( ) b. no ( )

37. If yes what are those supports? Mention them……

38. Is your family safe with current climatic trend in terms of basic needs? a. yes ( ) b. no ( )

39. Are there any constrains militating against effective adaptation? a. yes ( ) b. no ( )

40. If yes mention them…….

……

41. Kindly grade the perceived barriers based on a 0–3 Likert scale (*i.e.*, ranging from “not a problem” to “highly problematic”)

Appendix: ii

Questionnaire to the government's organizations officials relevant to agricultural practice

Introduction

The purpose of this questionnaire is to collect information about the occurrence, effects, impacts and various adaptation strategies to drought for minimizing the impact as well as the sustainability of these strategies in meeting the basic needs of a rural household in Jigawa state. All information given will be treated confidentially and for academic purposes only.

Section A. Authorities Information: Please fill and tick ( ) where appropriate

1. Capacity of the respondent.....

2. Name of the Authority.....

3. State of location and its GPS.....

Section b: Drought Challenges to Agricultural Activities

4. Does your authority have records of droughts episode in the area? a. yes ( ) b. no ()

5. If yes, Over the years what is the trend? a. increase in the frequency of occurrence ( ) b. increase in the intensity of drought ( ) c. decrease in the frequency of occurrence ( ) d. decrease in the intensity of drought ( ) e. normal occurrence ( )

6. Drought causes a lot of destruction to the people and their environment. Is your authority assisting the community? a. yes ( ) b. no ( )

7. Economically, what impact does drought have on rural household (farmers)? Mention them.....

8. List the social impact of drought on rural household (farmers)……..

…….....

9. List the health impact of drought on rural household (farmers)…….. .....

10. List the environmental impact of drought on rural household (farmers)…… .....

11. Has your authority supported rural household in minimizing the impact? a. yes ( ) b. no ( )

12 If yes, how.....

13. With your authority's support were the communities able to develop adaptive strategies to minimize

the effect? a. yes ( ) b. no ( )

14. If yes, List the strategies.....

.....

15. How effective are these developed strategies? a. increased annual yield per plot annually ( ) b. increase in annual income annually ( ) c. increase access to new technology and strategies to drought ( ) d. others, specify.....

16. Are the strategies environmentally sustainable? a. yes ( ) b. no ( )

17. If ye why? A. improved soil fertility () b. improved water resources ( ) c. improved vegetative resources ( ) d. others, specify……..

18. Are there any problem faced in trying to assist the farming communities to minimize drought impact? a. yes ( ) b. no ( )

19. If yes what are these problems? List them……

……

20. How do you think the problems could be solved? .....

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