UTILIZATION OF ADAPTATION STRATEGIES TO CLIMATE CHANGE AND VARIABILITY BY FARMERS IN AGRICULTURAL ZONE OF NIGER STATE, NIGERIA

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ABSTRACT

The research entitled ‘’ adaptation strategies to climate change and variability by farmers in agricultural zone of Niger State, Nigeria” The study was carried out to describe the socio-economic characteristics of farming households, and to examine how much they know about climate change and variability, and to ascertain adaptation strategies to climate change and variability adopted by them and their perception of its effectiveness. It was also to determine the factors that influence climate change and variability adaptation strategies adopted by farming households and the constraints associated with farming households on the adoption of climate change and variability adaptation strategies in the study area. Multistage random sampling procedure was used to select a total of 188 respondents for the study based on Yamane formula of 1967. The data were collected through primary source using questionnaire and interview schedule and analyzed using percentages, mean scores, Likert type rating scale and Poisson regression. Results showed that majority 88.3% were male, while 11.7% were female; most 83.5% of the respondents were within the age range of 26-50 years, with mean age of 35 years; 35.6% of the respondents were married, while 64.4% were either single or widowed. It was also found that the household size of between 6 – 10 had the highest percentage 42.6% with mean score of 5 persons, and that 76.6% of the respondent had one form of education or the other. It also affirmed that majority of the respondents 90.4% engaged in farming with farming experience of 18 years and farm size of 1-5ha. The findings revealed Incident of heavy rainfall that caused damages to crop and livestock production having mean score of ($\overline{X}$= 2.71) and decrease in average temperature amount over the years having the lowest mean score of ($\overline{X}$=1.60). It also revealed the hierarchy in adoption of adaptation strategies to climate change and variability with planting early maturing varieties and planting of high yielding varieties were 100% adopted. These variables were closely followed by use of agro-chemicals and use of manure (organic or inorganic) with 98.9%. Rural – urban migration 44.1%, reduce cultivated farm size 42.0% was least adopted. The result revealed that planting of early maturing varieties of crop with mean score of ($\overline{X}$=4.49), and high yielding varieties with mean score of ($\overline{X}$=4.25), were more effective among the adaptation strategies adopted by the respondent. While diversifying from farm to non-farm activities ($\overline{X}$=2.64), rural-urban migration ($\overline{X}$=2.13) were found not to be effective strategies to mitigate against climate change and variability. The adaptation strategies adopted by rural farmers was tested for its effectiveness using the z-value from Poisson regression analysis. The estimated z –value (1.98) for age was positive and significant at 5% probability level. Education (3.94) was also positive and significant at 1% probability level. Farm size (5.23) was positive and significant at 1% probability level. In conclusion, adaptation strategies to climate change and variability that were found to be effective was identified and when adapted would reduce effect and impact of climate change and variability on farming household. Based on the findings of the study, the following recommendations were made, Weather information that is more reliable should be adequately communicated to farmers using right channel, High yielding and early maturing varieties should be made available to farmers at subsidized rate and timely by the releasing institutions and organization, Government and non-governmental organization should provide means that are easy to access soft loans without too much stress and collaterals.

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CHAPTER ONE

1. INTRODUCTION

1.1 Background to the Study

The economies of sub-Saharan African (SSA) countries are mostly dependent on agricultural production (Apata *et al.*, 2009; Alvaro *et al*., 2009). In the year 2008, about 17% of Gross Domestic Product (GDP) was obtained from agriculture in SSA, which shows the important role of agriculture. Over the years, in so many regions of the world, agriculture contributes significantly to the development of many countries in the world. Agriculture contributes to GDP of many African countries, provides employment opportunities to about 70% of Nigeria population, and about 80% of the food needs. Although, agriculture still accounts for about 88% of non-oil export earnings, its contribution has been seriously reduced over the years. It declined from about 75% of total export earnings in the sixties (1960s) to fewer than 12.3%, currently (Adeosun, 2018).

Increasing productivities in agriculture depend largely on a number of factors, including weather and climate conditions. Climate is defined as an average atmospheric weather condition of a place over a long period of time ranging from months to many years usually about 30 years. Weather is atmospheric condition of place over a short period of time. These important climate elements include temperature, rainfall, humidity and wind (World Metrological Organization (WMO), 2016). Climate change as put forward by United Nation Framework Convention on Climate Change is “attributed directly or indirectly to human activity that changes the composition of entire global atmosphere which is, in addition to natural climate variability observed over comparable periods”(UNFCCC,2015). Climate Change according to the Inter-Governmental Panel on Climate

Change (IPCC) Fourth Assessment Report (2007) refers to any change in climate over time, whether due to natural variability or as a result of human activity.

Climate variability is the variation in the mean state and other statistical measures (such as standard deviation, that occurs of extremes) of the climate on all term polar and spatial scales beyond that of individual weather events (IPCC, 2014). Local society already had indepth knowledge of climatic changes and variability as part of their local ecological ideas or knowledge obtained and transferred through generations (Berke *et al*., 2000). Climate variability pose a significant challenge bordering agricultural productivity in Africa and Nigeria in particular. It makes the entire African region vulnerable continents to the current climate variability with strong economic impacts.

The negative impacts of climate change and variability on agricultural sector are obvious. Nigeria has over the years experienced strong weather variability, characterized by irregularities of the seasons and distribution of precipitation, change in duration of annual rainfall from one point to another that fall within the same locality. Also, increase in drought period during raining season, sometimes heavy rainfall experience in some ecological zones, hot climate, soil degradation, high winds, unexpected flooding experienced by farmers in their localities which some time washed away their crops and animals and proliferation of pest and diseases. Thus, the importance of adaptation strategies for over 70% of the Nigerian farmers who depend largely on agriculture as a means of livelihood becomes an absolute priority, (Fadina, 2018).

In order to reduce the negative effects, of climate change and variability on agriculture-food system, farmers must adapt economic viable strategies that have positive effect on their farming operations. Adaptation to climate change and variability is a process that initially demands farmers

to think that the climate has changed and then identify the possible adaptation measure to be implemented.

1.2 Statement of the Research Problem

Climate change and variability is one of the most environmental challenges facing mankind world over. About 49 million more people will be at risk of hunger by 2020 and 132 million by 2050 due to climate change; yield from rain-fed agriculture may possibly be reduced by up to 50% by 2020 in a number of countries (International Fund Agricultural Development (IFAD), 2008). Africa is generally acknowledged to be the continent most vulnerable to vagaries of climate change and variability, as the scope of the impacts of climate change and variability over the last decades. It is doubtful whether farmers know immediately what constitutes the best response to climate change and variability when such agricultural practices as requires are not outside their range of experience nor can they be expected to recognize immediately that the climate has changed. These challenges increase farmer's vulnerability in an agricultural sector that is already prone to risks and uncertainties. It affects agriculture in diverse ways including its impact on food production. Climate change and variability is attributable to the natural climate cycle which included natural forces, such as solar variability, volcanic activity and shift in the earth orbit. Human activities such as agricultural activity, mining activity; increasing atmospheric concentration of greenhouse gases through emission of carbon monoxide from industries machine and vehicles had regrettably affected agricultural productivity in developing countries including Nigeria. As planet warms, rainfall pattern changes, and excessive events such as drought, flood and forest fires becomes more often which result in poor and unpredictable yields, thereby making farmers more prompted to climate change and variability particularly in Africa, West Africa and Nigeria inclusive. Famers (who constitute the bulk of the poor in Africa), face prospects of tragic crop and livestock failures,

decline in agricultural productivity, low income, increased hunger, malnutrition and diseases. Policy makers have expressed their concerns about the possible and adverse effects posed by climate change and variability on agricultural productivity. Climate change and variability is global because it affect all Countries in the world (Mandleni,2011). There are already increasing concerns globally regarding changes in climate that threatening to transform the livelihoods of the vulnerable population segments. Despite the importance of agriculture in Nigerian economy and livelihoods, there is very or not enough existing studies on climate change and variability as well as its effects on agricultural productivity. Crop yield in Nigeria may fall drastically as a result of climate change and variability, if appropriate strategies are not adopted by famers in their farming operation to overcome the great impact of the climate change and variability. Many farming activities depend largely on rain fed and hence fundamentally dependent on vagaries of weather. As farmers strive to overcome poverty and advance in economic growth, this trend of climate change and variability threatens hard to deepen vulnerabilities, clean off hard work gains and seriously undermine prospects for development. However, despite several efforts by the extension service delivery geared towards encouraging farmers to adopt the adaptation strategies to curb the effects of climate change and variability on their farming operations, many of the farmers are adamant or may be the strategies are not effective or up to the standard. Though a lot of studies have been carried out on the utilization of adaptation strategies to climate change, the result is still not farfetched. Therefore, there is need for concerted efforts toward solving these problems posed by climate change and variability to reduce its impacts on the small holder farmers and the nation at large. It is against this backdrop of the problems and challenges posed by climate change and variability that this study seeks to provide answers to the following research questions:

i. What are the socio economic characteristics of farming households in the study area?

ii. What are the levels of farmer's knowledge on climate change and variability?

iii. What are the adaptation strategies adopted by farmers and their perception of the effectiveness of the adaptations strategies?

iv. What are the factors that influence the adoption of climate adaptation strategies by the farmers?

v. What are the constraints associated with adoption of climate change and variability adaptation strategies by the farming households?

1.3 Aim and Objectives of the Study

The aim of this study was to examine the adaptation strategies to climate change and variability by farming households in Niger State. While the specific objectives of the study were to:

i. describe the socio-economic characteristics of farmers in the study area;

ii. examine the level of knowledge of farmers on climate change and variability;

iii. ascertain adaptation strategies to climate change and variability adopted by farmers and their perception of its effectiveness in the study area;

iv. determine the factors that influence climate change and variability adaptation strategies adopted by farmers in the study area, and

v. examine the constraints associated with farming households on the adoption of climate change and variability adaptation strategie in the study area.

1.4 Hypothesis of the Study

H_{01}, There is no significant relationship between the socio-economic characteristics of the farming households and adaptation strategies adopted by farmers in the study area.

1.5 Justification of the Study

The study is one of the efforts to provide a more in-depth empirical analysis of the effects of climate change and variability on crop with focus on Niger State Agricultural Zone I. The study was thus, aimed at revealing how climate change and variability affects crop and livestock production and to identify the appropriate adaptation strategies required to ameliorate the existing problems and prevent negative effects in the future. Adaptation Strategies to climate change and variability is the process of adjustment to actual or expected climate condition and its effects, which can be undertaken at individual farm level. Climate change and variability are changes in start/end of growing season that may lead to lower or higher yield (Gana, 2012). This can be a delay at the onset of rain and sudden caseation of rain. Its effect may result to reduction of water supply for crop growth and less potential for irrigation due to drought. Presently, there is information obtainable on the awareness of farmers concerning the dangers that climate change and variability pose to agricultural productivity in Nigeria especially in rural areas. This study will assist the government and other stakeholders in decision making and to inform farmers and communities in order to minimize the negative effects of climate change. The information to be generated in this study will assist policy makers in reviewing existing policies and to formulate effective strategies that will minimize the effect of climate change and variability to the environment and humans. The study will make farmers to be aware and understand the concept of climate change and variability. It will also provide suitable adaptation strategies recommendations to policy makers as well as helping farmers to identify adaptation strategies that are effective and mechanisms in handling climate change and variability thereby enhancing agricultural productivity. This study will further help to identify the weaknesses of current adaptation strategies of farmers that need to be corrected to bring about the desired results. The result of this research work will be a source of information or

knowledge to agricultural extension workers on ways to overcome climate change and variability and thereby enhancing food security and self-sufficiency in food production at the family level, nationally and globally. This study will serve as frame of reference for other researchers that want to conduct studies in similar area. Also it will inform farmers about planning guides for climatic risks in terms of food, animal feed and water security.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Climate Change and Variability and their Effects on Human Activities

According to the World Meteorological Organization (WMO, 2016), climate is the "average weather," in other words it is the measurement of the mean and variability of temperature, precipitation or wind over a period of time, ranging from months to thousands or millions of years". Weather "is the atmospheric condition over a short period of time" (WMO, 2016). IPCC (2007) reported that "climate change is any change in climate over long period of time, whether due to natural variability or as a result of human activity.

Climatic Change is one of the major global problems posing challenges to sustainable livelihoods, food availability and economic development, particularly for developing countries (Kibassa, 2013). Climate change, whether natural or human induced, can lead to change in the likelihood of the occurrence or strength of extreme weather and climate events or both (Cubasch *et al*.,2013). Human influence on the climate system is enormous, and recent anthropogenic emissions of greenhouse gases are the highest in history. Increase in population size, economic activity, lifestyle, energy use, land use patterns, technology and climate policy had been the main drivers of anthropogenic emissions of greenhouse gases. Since 1950 extreme weather and Climate Change events have been observed, whereby more than half of the observed increase in global average surface temperature from 1951 - 2010 was caused by the anthropogenic increase in greenhouse gases concentrations and other anthropogenic forces (IPCC, 2014b). Climate- related extremes such as heat waves, droughts, floods, cyclones and wildfires have modern impacts that reveal

significant vulnerability and exposure of some ecosystems and many human systems to current Climate Change and Climate Variability (IPCC, 2014a).

2.2 Farmers' Awareness of the Effects of Climate Change and Variability on Agricultural Production

Climate change and variability has been perceived as a serious challenge throughout the globe from Europe, Asia and Africa, especially Nigeria and action had long been taken to mitigate and cope with climate change and variability effects (Gana, 2012).

Gandure *et al*. (2012) revealed that farmers in sub- saharan Africa have perceived increase in temperatures, and indicated that summer temperatures were warmer while winter temperatures were colder. The same study also pointed out that warmer temperatures in the region are associated with high evaporation and increased crop water requirements. These perceptions were not in line with traditional weather descriptions because temperatures were above the normal temperatures as a result of change and variability in climatic conditions. Rainfall patterns were perceived to be vary and declining from 2000 - 2014. In a study conducted by Ariko (2019), there were changes in rainfall patterns as it is some years started to rain later than usual and this was damaging and harmful for the maturing of crops. The researcher further observed a decrease in the number of cloudy days during the monsoon. Sharma (2010) also revealed that about 40% of farmers in the Himalaya had changed their cropping patterns and the outstanding reasons for the change in their agricultural practices was inadequate chilling hours required, especially in case of fruits, the respondents perceived that the use of fertilizer and pesticides in farming had increased due to climate change that is taking place. There was definitely increasing household expenditures on farming activities as well as expenditures outside farming activities.

The indicators of climate change, according to the observations made by respondents, climate change indicators that they had used and observed were increased temperatures and erratic rainfall patterns. The observed results were a reduction in crop and fodder yields, and increased prevalence of diseases and pests. Rural dwellers farmers inclusive seems to be ignorant about climate change, and think that the incidence was an act of God that had become angry with the sinful acts of some human race. Others people in the study area were not ignorant about climate change. The only problem was the means to mitigate the effects of climate change and variability that were not available. A study conducted by Mubaya *et al.* (2010) in Zambia and Zimbabwe, revealed that about 80% of famers were aware of climate change as they had recognized persistence in droughts and excessive rainfall in the past years, which had both positive and negative effects on farming and productivity. Households further perceived an increase in temperatures throughout the year with cold periods being shorter than warm and hot periods respectively, winds were also perceived to be stronger especially toward the end of rain and dry seasons. Households perceived reduced of rainfall as a major challenges to their farming whereas others perceived excessive rainfall. Wind storm was also another major problem reveled in his study (Mertz *et al.*, 2009).

Some farmers throughout the world and Africa, especially Nigeria have perceived changes and variability in climatic conditions and are fully aware of its effects in productivity. The literature revealed that climate change and variability is existent and many farmers have become aware of this development in many countries across the globe. According to Mandleni (2011), climate change and variability has been perceived by farmers in terms of drought persistence, severe heat and temperature, heavy rainfall and floods which come at unexpected times of the year, resulting in disasters. On the other hand, farmers have perceived changes in climate conditions in terms of declining rainfall patterns and change in rainfall which normally starts later than in normal times.

Awareness has also been seen in terms of extreme heat which has been seen as leading factor to pests and diseases outbreaks which results in diseases in crop and livestock. Perceptions were further experienced in terms of an increase in sea-level, incidences of cyclones and increased pollution (Ifeanyi-obi *et al.*, 2012) .

The effects of climate change and variability have been negative in terms of reducing agricultural productivity as well as bringing economic and social instabilities. The changes and variability in climatic conditions have affected livelihoods of farmers. This phenomenon has further had adverse effects in consumers' welfare and households as well as their economies. The extreme heat and excessive rainfall levels have affected agricultural productivity adversely, increased crop pest disease incidence in agricultural productivity and reduces households incomes from agricultural productivity being practiced (Ifeanyi- obi *et al.,*2012).

The most undesirable aspect about climate change and variability is that it has been noticed to affect the poor. The poor have become vulnerable to climate change and variability due to the lack of resources to adapt to climate change and variability. It impacts had negative effects on the economy of the countries such as decreased in crop yield of the farmers, low income, lower foreign exchange earnings and decreased in GDP. This is because when farmers experience low yield in their production, these may likely be due to impact of climate change and climate variability.

However, as much as climate change and variability brings negative impacts on agricultural production, there are various manifestations of climate change and variability which leads to adverse effects on agricultural production such as change in average temperatures, change in average rainfall and extreme weather events. These manifestations have different impacts on agricultural production such impact maybe positive or negative.

2.3 Farming household s' Perception of Climate Change and Variability

Perception of farmers is that climate has changed, and the main changes observed were rainfall disturbances such as rainfall delays and early cessation, shortening of the small dry season, increasing in temperature, and sometimes, violent winds and other extreme phenomena such as floods in some areas (Gana, 2012; Adegnandjou *et al*., 2018) .

2.4 Effects of Climate Change and Climate Variability on Agriculture

Climate change and variability are changes in start and end of growing season that may lead to lower or higher yields. This can be a delay in the onset of rain and sudden caseation of rain. Its effect may result in reduction of water supply for crop growth and less potential for irrigation due to drought (Gana, 2012).

Adger *et al*. (2007) posited that climate variability, poor infrastructure, economic poverty, drought, excess rainfall, poor livestock health, reduced crop yields, low productivity and a range of other problems associated with climate variability will constitute important challenges for African Countries in particular. The effect of climate variation is being felt by the whole population but, it will disproportionately affect vulnerable groups (Lobell *et.al*, 2008a). Africa population, with Nigeria a key player in terms of population size and market for agricultural produce domestically is very vulnerable to climatic and non-climatic changes, with high level of poverty, conflicts and prevalence of diseases. Changes in climate are severely affecting agricultural production in many developing countries (UNEP, 2007). Increased temperatures and accompanying decrease in water availability reduce the length of growing seasons and yield potential and hence the areas suitable for agriculture, further adversely affect food security over the continent (Thornton *et al.,* 2006).

Africa is one of the most vulnerable continents to climate change in the world. Previous studies concluded that Africa countries in particular is vulnerable to the impacts of climate change because of factors such as widespread poverty, recurrent droughts, and inequitable land distribution and over dependence on rain-fed agriculture (Mary and Majule., 2009). Climate change and climate variability inhibit crop and| livestock growth, it also affects the choice of crop varieties and other farm management decisions (Howden and White, 2016). It causes Crop / livestock pest and disease infestation, land degradation, reduces crop yield, increase food costs, thereby leading to adaptation strategies on pest and disease control as well as land management. It also increase rural-urban migration thereby reduce the numbers of labour requirement for farming activities in the rural areas (Gana, 2012; Adegnandjou *et al*., 2018) .Changes were also perceived in temperature and drought; increase of length of the long dry season, rainfall changes and extreme events adversely affect crop production and impose a major constraint on farming (Gana, 2012; Adegnandjou *et al.,* 2018).

2.5 Shifts in Seasons or Planting Dates

It has been debated that climate change and variability will bring changes in the growing season of crops because it will shift climatic conditions favorable for the growing season. As highlighted by Gana (2012), Nigeria will be vulnerable to climate change and variability with some shifts in the seasons. According to Gray (2009), farmers over the years have experienced some erratic and delayed rainfalls. The rainfall comes unexpectedly in and out of these growing seasons, it has increased the length and frequency of the dry periods which affects the planting dates of crops negatively by shifting these dates. These shifts in growing seasons have adversely affected crop production in different ways, such as stages of plant growth and development. These changes in climatic conditions have resulted in premature ring flower sets which later become more

vulnerable to chilling spells (Linderholm, 2006; Rudolf *et al.,* 2009). Stated that even if there is sufficient rain, it irregularity can affect yields adversely if rain fail to arrive during the crucial growing stage of the crops. Also extreme weather leads to drying up of streams which are sources of irrigation water used by farmers during dry season crop production.

Considering the fact that most farmers depend solely on rain fed water for agricultural growth, they are at a high risk of experiencing crop failures as a result of erratic rainfalls and variations in rainfall supply (Masvaya *et al*., 2008). Farmers mostly suffer because of delayed rainfalls, thus leading to a short planting time, hence decreasing their hectares.

2.6 Farming and food security adaptation strategies to climate change by smallholder famers;

This emphasizes the various adjustments that farmers have made in their farming activities for the perceived changes in the climate. Adaptation strategies used by smallholder farmers to cope with Climate Change and Climate Variability are Shift to higher yielding crop varieties, irrigation and Shift to drought resistant crop varieties were found to be the most adaptation strategies used mostly by smallholder farmers (Frida., 2016).

2.7 Capacity and limitation on farming adaptive strategies to Climate Change and Variability among farmers

The capacity of farmers to implement adaptive strategies to Climate change and Variability was analyzed, and insight into why farmers were not capable of using all or some of the strategies available. An analysis was also done by (Frida.,2016) to identify their limiting factors. The analysis shows that very few farmers have the capacity to use those adaptive strategies due to various reason(s) like inadequate capital. While many farmers indicated that they had low capacity of adapting, although they had high possibility of using a broad range of strategies.

Some of the limitations were personal reasons such as financial, biophysical and technological barriers, while institutional barriers, information and skills barriers, and infrastructural barriers were governance related reasons, (Frida.,2016).

Lack of technological skills by farmers was seen as a barrier to adoption of adaptation strategies as most of them have no knowledge on better ways to harvest rain water and making underground well like tube well to get water for irrigation. This goes hand in hand with lack of capital and low level of education.

2.8 Temperature, Rainfall and Wind as element of Climate:

2.9.1 Temperature:

Temperature is the degree of hotness and coolness of a place or a body. It is one of element of climate. A change in one weather element can produce changes in regional climate. For example, if the average regional temperature increases significantly, it can affect the amount of cloudiness as well as the type and amount of precipitation that occur. High temperature has effects on agricultural production, likewise low temperature. The effect of increase temperature exhibits a large impact on grain yield than on vegetative growth because of the increased minimum temperatures. The most significant effect of temperature rise on crop largely is connected with impact it has on water availability, possible expansion spread of pest and disease, significant impacts on soil moisture and fertility due to increasing evaporative losses (Gana 2012). These effects are evident in an increased rate of senescence which reduces the ability of the crop to efficiently fill the grain or fruit. Warmer temperatures also lead to a chain reaction of other changes around the world, Africa, West Africa and Nigeria. That’s because increasing air temperature also affects the oceans, weather patterns, snow and ice, and plants and animals. The

warmer it gets the more severe the effects on people and the environment. Many weeds, pest, and fungi thrive under warmer temperature, wetter climate and increased CO2 levels.

2.9.2 Rainfall:

Rainfall is another element of climate. Its distribution determines the type of crops and animals that can be grown and reared in each ecological zone of the country Nigeria. Its change and variability also affect agriculture negative and positive. Heavy and high rainfall can results into flood, washing away of crops and soil fertility through erosion, inadequate rainfall can cause drought thereby hindering crop growth and yield (Adegnandjou *et al* 2018). Climate change increase the existing pressures on surface water resources due to poor management, degradation and competition in it uses. Irrigation alone will not be sufficient to adapt to climate change, and can indirectly drive vulnerability if water resources are not well managed (Howden and White, 2016). Declined in yields of key cereal crops are mostly due to temperature rise and decreasing water availability, this have significant implications for commercial farm investment because many farmers may not want to go into production of such cereals crops. Shortening of the small dry season, increasing of temperature and sometimes violent wind which causes destruction to farm crops and house properties is on the increased.

2.9.3 Wind;

Wind is another element of climate. The effect of wind due to climate change and variability causes destruction to human lives and properties, crops and livestock. This occurs usually at onset of rain seasons and end of rain seasons.

2.9.4 Impact of Climate Change and Climate Variability on Food Security

Food security is defined as situation in which all people at all times have physical social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life (FAO, 2012). Edward and Devereux (2003) confirmed that, Countries in Africa such as Nigeria are already among the most food insecure in the world. with increasing food demand and low capacity to meet up the demand could cause high risks to food security globally coupled with global temperature increases of 4°C or more above late 20th century levels. The significance of Climate change and variability for food security varies between regions. For instance, Sub-Sahara Africa is the most vulnerable food insecure due to extensive reliance on rain fed crops production, high intra- and inter-seasonal variability, recurrent flood and droughts that affect both crops and livestock which led to low yield thereby causes poor income and persistent poverty that limits the capacity of the farmers to adapt to strategies (Boko , 2007). Livelihood of the majority of farmers populations especially in African, West African and Nigeria at large are dependent of agriculture, minor variability in rain season of the year can causes increase or decrease to the yield of crops and income of the farmers because food security and weather are so tightly linked for smallholder and subsistence farmers (Eboh 2009). Food systems might be affected by climate change and climate variability in several ways ranging from direct effects on crop production such as changes in rainfall leading to flooding and drought, or warmer or cooler temperatures leading to changes in the length of growing season, as well as changes in markets, food prices and supply chain infrastructure (IPCC,2014b)

2.9.5 Other Factors Affecting adoption of adaptation strategies to climate change

Apart from the impacts of climate change and variability on food production, the global food situation is also redefined by many driving forces, whereby the combined effect of those factors affects food production and food security (Premanandh, 2011). Such factors include the followings;

1. Poor Household Economy (Poverty): The poor and food-insecure generally have a thin economic resource base with few options for expanding their incomes, either through on- or off-farm activities. They often lack access to adequate resources such as land, improved technology, credit, extension service and training and markets (most especially women farmers) (Jost, *et al.*, 2015). While women may even find themselves with additional work to enhanced greater food security, men are normally benefiting from Productivity-enhancing technological innovations. Similarly, men migration to the city or to work on large farms, results in an extra burden on the women who remain on the farms (Premanandh, 2011). Furthermore, low levels of education and skills, make the off-farm employment seasonal and low paid, and hence they end up purchasing a small quantity of food which is sometimes not enough to feed the whole household.

2. Population Growth that Threaten Agricultural Productivity and Increase Food Prices:

The global population rose to 6.9 billion in 2010, with the greatest number coming from the developing countries (FAO, 2009b). Thus increase in population and consumption growth poses a major threat to food security that is likely to increase over the next 40 years (Magadoff and Tokar, 2009). They concluded that decline in food production in developing countries, rise in the price of food, and growing production of bio-fuels are responsible for increase rates of food scarcity. Similarly, if population growth rates continue, increasing urbanization will potentially threaten for agricultural production and increase food prices due to increase demand.

3. Arable Lands Availability: Land degradation in all forms is a threat to food production and rural livelihoods, particularly in the poorest areas of the developing world (FAO, 2008a). Between 1960 and 2000 the ratio of arable land to population declined by up to 55% in the developing nations. Further indicate that, half of the current arable land will become unusable owing to land degradation and desertification by 2050 (UNCCD, 2008). Land demand for food production, wood and bioenergy has been increasing sharply in recent times, resulting in further decline land availability for food production2050.

4. Scarce Water Resources: The world's water resources are limited relative to its human needs due to increase population growth, industrial expansion and irrigated agriculture, exceeding supply in developed and developing countries (Gana, 2012). There is no creation or source of new water on the planet and hydrological cycle; the only way is to recycle available volume of water through a well- coordinated means between the earth and the atmosphere (FAO, 2008a). The volume of available and accessible water remains roughly the same and it is predicted that the situation will be worsen in the first half of the 21st century despite the growing population (FAO, 2008b). Availability of water is the key to food security as crops and livestock need water to grow, and generally agriculture requires large quantities of water for irrigation and of good quality for various productions processes (Ayanwuyi, 2010). Hence water scarcity might impact agricultural production as well as food security.

5. Lack of Food Availability and Accessibility: The combined effects of population growth, urbanization, climate change and reduced yield of crops have resulted in increased global food demand, and lowering of food reserves (FAO, 2008b). Despite declining food prices in late 2008, a sizable population around the globe does not have adequate income for a healthy diet, resulting in malnutrition and poverty (FAO, 2009a). However, having enough food does not guarantee access

to food, which is directly dependent on the level of income of an individual or family. For instance, rural communities with lower populations face the greatest challenges to food thus, food insecurity in many low-income countries remains and is expected to be precarious in the short term (FAO, 2008b).

6. Reduction of Feed Quality:

Climate change and variability changes will result in an increase in carbon dioxide in the air which will result in an increase in the production of pasture but at the same time will result in a reduction in the quality of pastures which livestock feed on and this will also lead to the decrease in the quality of forage which is found on pastures due to high carbon dioxide (Field *et al*.,(2007). According to Mandeni (2011), the effect of climate change and variability is more likely on the rangelands, where this effect of climate change and variability will limit the growth of plants through reduction in evapotranspiration as there is a major decrease in rangeland productivity. The climate change and variability will result in an increase of CO2 which will cause animal feed and forage become less nutritious and then affect the quality of the livestock. This will result in farmers who grow the animal feed products to use feed additives in order to get the required growth gains in livestock and also to run away from animal illness. This effect of climate change and variability will result in an increase in the cost of growers which will in turn result in high food cost for consumers. As this change in climatic conditions will some years limit water availability, it means that feed availability will reduce because the nutrients required for feed is under stressed in the soil in order to keep up with plants growth (Krunger and Shongwe; 2004. Field *et al.,* 2007). Drought will have negative effects and pressurize the pastures and feed suppliers of livestock. This will reduce the availability of grazing land for livestock which will

result in exposure of livestock to malnutrition and thereby led to diseases infestation because of not having good quality feeding (Mbwambo, 2016).

7. Increased Incidence of Diseases in Livestock:

Climate change and variability have adverse effects on livestock production through infestation of pest and diseases which may likely become more increase as a result of continue changes in climatic conditions and these incident will affect livestock health and transmitted to them through vectors such as ticks and flies thereby making it difficult for farmers to deal with the result of increased temperature (Aydinalp and Cresser, 2008; Musemwa *et al*., 2012).

On the side of Livestock production, Ozor (2009) stated that livestock production systems in Nigeria would be vulnerable to climate change in respect of anticipated decrease in rainfall in the Sudan-saheh zone and consequent reduction in the available pastureland. This he explained further by listing the various ways the anticipated decrease in rainfall will affect livestock as a result of decreasing surface water resources for animals. The possibility of increase in salinity at water resources points for animals, increase in temperature and evaporation in the face of reduced rainfall. This is to say that further changes in rainfall and temperature will affect livestock production as well as availability of animals. Some species might be unable to adapt quickly enough to the condition climate change and variability pose to them and another habitants that might be favorable for them may not be available for them to move into. If global temperatures rise by 2 degrees Celsius, 30 percent of all land dwelling species of animal may be threatened by an increased risk of extinction. Though increase in temperature is generally seen to be destructive to the production of crops and human lives.

It is estimated that change in climatic conditions will encourage the increasing spread of diseases to be at dispersal on air and these diseases will lead to adverse effect on livestock which in turn

will result in high mortality rates by livestock as some of the diseases will be incurable and unnoticed. According to Bello (2009), there will be more insect pest and diseases which will be highly anticipated that will attack livestock productivity due to likely increase in hot climatic conditions and humidity most especially in temperate region climate. An increase in average temperature and decline in water availability also will lead to dominance of insect- pests which will further raise the attack on livestock by infestation of diseases and further lead to high decline in livestock production (Chakraborty, 2011). The spread of diseases will leads to increased level of pesticides and fumigants use which have negative effect on human health as well as livestock. The use of such fumigants may pollute environment and result in affecting the production as well.

8. Food Loss: Food loss refers to decline in the amount and value of food (quantitative and qualitative) (FAO, 2014). In the food supply chain, food loss occurs from production to consumption, whereby, at the production, part of the crop is lost due to pests and diseases. Similarly, lack of effective harvesting equipment, transport and storage facilities lead to losses at the farm level. Though, it is problematic to estimate the actual loss, variations in wastage rates that exist in different types of food. For example, non-perishable foods such as grains have least loss of (15%) before reaching consumers compared to perishable foods such as fruits and vegetables of which one-third might be lost. Also, it has been estimated that nearly one-third of all food purchased by households is wasted, which approximately half is inedible and half is edible. Notwithstanding, 40% of food losses occur at post-harvest and processing levels in developing countries and 40% at retail and consumer levels in industrialized countries. For instance; the current food wasted in Europe and Africa could feed 200 and 300 million people respectively. During harvest and in storage, food losses result into reduction on income of smallholders' farmers and into higher prices for poor consumers.

2.10.1 THEORETICAL FRAMEWORK ON CLIMATE CHANGE AND VARIABILITY

Climate variability leads to social change, this is because climate change and variability is a global phenomenon which brings about changes in various aspects of a social system in which it occurs. Social change is defined as the process by which alteration occur in the structure and function of a social system (Ekong, 2010) . It therefore involves any change in ideas, goal, changes and environment or in the organization of the society (Jibowo, 2000). These changes could be planned or un planned, Examples of unplanned change could be flooding, erosion and drought, conversely, planned change entails the direct human intervention in shaping the direction of change towards some per-defined goals. For example, in the case of a social system that has been hit by the impact of climate change and variability, this could involve a deliberate plan or attempt to develop local technologies or agricultural production practices to adapt to the effect of climate change and variability. Social change pervades all aspect of social life and may manifest as economic change, political change, and technological change, cultural change and behavioral change. Climate change and variability does not just occur in a vacuum but in a society that is always changing, therefore climate change has a lot of social change implication, hence the theories of social change which are relevant to this study and from which this study draws it framework theoretically were considered and adopted for this study.

2.10.2 Diffusion Theory:

Rostow, Hirschman, Roger and Hoselitz (1962) view diffusion theory as an educational process: They place less stress on the internal state of individuals as such, but hold that the world society could be divided in two camps on the basis of the relative modernity or primitive of each segment. The modern sector is represented by the technologically advanced nations in the area of technologies and strategies that when adopted could mitigate the effect climate change and variability pose to them, while the lagging sector is represented by the technologically underdeveloped nations who are indeed lacking of such technologies and strategies that can minimize the effect climate change pose to them. Modern technology and strategies must therefore diffuse from the modern to the lagging sectors. For diffusion to be effective, it must include adequate communication, skills, democratization and educational approach. Diffusion theory is also ethnocentric in nature in the sense that, it claims western culture to be the criterion yardstick for measuring development. It assumes that social change is unidirectional which means that, all societies must go into the same direction in order to develop. The proponents, such as Roslow therefore, advocate the diffusion of western economic, social and political institutions to the less developing countries as necessary conditions for growth.

2.10.3 Personal Trait Theory:

This theory according to Chauhan (1978) emphasizes individual differences in social change based on individual traits, that is , modes of behavior and exposure that are manifested consistently. Traits are not static in nature but with experience, change can comes in that can make young people flexible in farming experience and that is why young people respond more to change than old people. Trait are also learned in the interaction with the environmental stimuli. They are determining by disposition and intellectual potentialities of the members of society.

2.11 Conceptual Framework on Climate Change and Variability

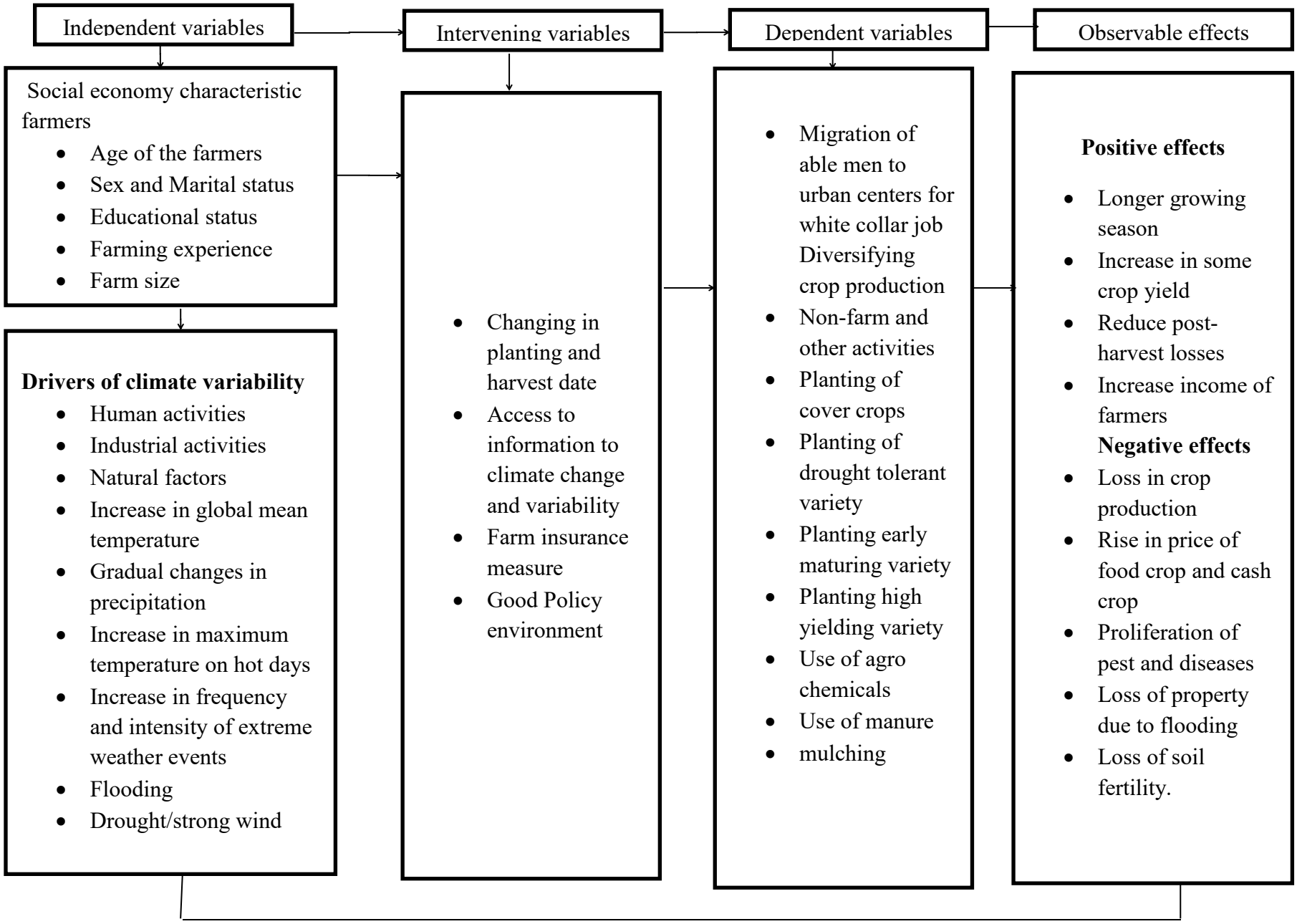
The conceptual framework present below shows the linkages between climatic variables, crop yields, adaptation strategies and policy framework. Exposure to climate variability and change affects livelihood patterns and autonomous adaptation strategies. The framework illustrates drivers of climate variability and intervening variables directly influence plan adaptation to climate change and variability. Plan adaptation strategies may reduce vulnerability of households and builds resilience to climate extremes through the adoption of climate-smart agricultural technologies. The framework highlight eight independent variables such as age of the farmers, marital status, educational status, farming experience, farm size, human activities and natural factors as drivers of climate change and variability. The single edged arrows which link the drivers of climate change and variability to increase in mean temperature, gradual changes in precipitation, increase in maximum temperature on hot days, flooding, drought and strong wind. The framework is a dependent on climate change and variability on which the development of agriculture and livelihoods of farmers are affected. The degree of the effects of climate change and variability on food crop production depends on the extents of climate change and variability and how effectively food crop farmers are able to adapt to the situation.

However, activities of human such as mining, Industrial and agriculture have intensified the emission of the natural greenhouse gas which increases the concentration of the GHGs in the atmosphere. This has led to the rise of temperature and has affected global precipitation (FAO, 2008). This indicates that climate change and variability occurs naturally, but an increase in the concentration of greenhouse gases in the atmosphere as a result of activities of human being have further multiply the intensity of climate change and variability . These further have a negative or positive impact on environment due to anthropogenic activities, many researches on climate change and variability and change have come up with theories that, an increase constant heavy

rainfall will led to an escalation in flood intensity and frequency .While decrease in rainfall together with high temperature will turn dry areas drier leading to severe drought in some parts of the world, Africa, West Africa and Nigeria most especially Sahel region. It could also reduce or shorten the length of growing season thereby by resulting to food crop loss, rise in price of food crops and cash crop, proliferation of pests and diseases, loss of property due to flooding and loss of soil fertility as a result of erosion. Positive impact may be longer growing season, increase in some crop yield, reduce post-harvest losses and increase farmers income (Watt, 2012).

On a general note, the adverse impacts of climate variability and change on agricultural activities in rural areas are more often to be felt as loss of employment for farm workers, reduction in wage earnings, loss of purchasing power for agricultural wage workers and decrease in crop yield for house hold consumption. These are some time drive rural urban migration which provides chances for rural farmers and other farm workers to improve upon their livelihoods (FAO.2008). In the farmer's quest to survive, some farmers may diversify their source of income by engaging in non-farm or off farm activities to complement their farm wages.

The intervention must clearly seek to establish the association between several strategies and those that are environmentally friendly (IPCC, 2012). Furthermore, some farmers may resort to other farming practices such as use of agro chemical, use of irrigation scheme, use of manure, planting of cover crops, planting of drought tolerant varieties and planting of high yielding varieties.



Source: Adopted and modified from FAO (2008). Climate variability and food crop production.

CHAPTER THREE

3.0 METHODOLOGY

3.1 Study Area

This study was conducted in agricultural zone I of Niger State. The State lies between Latitude 80 to 11^0 30 North and Longitude 3^0 to 7^0 40' East. (Niger State Bureau of Statistics, 2012). The State is bordered, to the north, by Zamfara State, to the north-west, by Kebbi State, to the south by, Kogi State, to the south-west by Kwara State, north-east by Kaduna State and south-east by Federal Capital Territory (FCT). The State also has an international boundary with Republic of Benin along Agwara and Borgu Local Government Areas (LGA) to the North-West. Niger State, with Minna as the State capital was created on 3rd February, 1976 from the defunct North-Western State, (Niger State Geographical Information System, (NIGIS, 2017).

The dry season is between November and April with a monthly temperature of about 32^0 and lowest in June. The rainy season is between April and October, with highest rainfall occurring in August. It has a mean annual rainfall range of 1000 mm – 1450mm. the population of the state grew from 2.4 million persons in 1991 to 3.9 million in 2006 and the projected figure of 5,631,578 million persons in 2018 using growth rate of 2.8 percent of (National Population Commission (NPC, 2006). The total land area of the State is about 76,481 Kilometer square or about 8.3 million hectares which represent 8% of the total area of Nigeria (Wikipedia, 2008; (Niger State Bureau of Statistics,(NSBS), 2012). The major tribes of the state include Nupe, Gwari and Hausa. Agriculture is the major occupation of the people with about 85% of the population engaged in farming. Major crops grown are yam, rice, millet, beans, guinea corn, maize; groundnut and sugarcane, Livestock reared include cattle, sheep, goat and poultry.

3.2 Niger State Agricultural Zone 1.

Niger State Agricultural Zone one (1) comprised of 8 local government area which are Lapai, Agaie, Katcha, Bida, Gbako, Lavun, Edati, and Mokwa. This Zone lies on latitude 3.20^0 East and longitude 11.30^0 North. (Niger State Bureau of Statistics, 2012). The people in this area are Nupes and it has a total land mass of 18,343.5 Kilometer square, the population of people in Zone based on 2006 census was 1,296,032 million and projected figure of 3,628,889 million persons in 2020 using growth rate of 2.8 percent of National Population Commission (NPC,2006). Soil type in the Zone are sandy, clay, loam and clay-loam. The majority of the populace in the zone are farmers who specialized in crop and livestock and their major Religion are Islam and Christianity, it annual rain fall is 1,600 mm.

3.3 Population of the Study

The population of the study was registered small scale farmers with Geographic Information system (G I S) from the selected 27 villages numbered 2,400. These farmers mostly specialized in growing crops which include Rice, Sorghum, Maize, Cassava, Cowpea and Millet. They also reared animal which include cattle, sheep, goat and poutry.

3.4 Sampling Procedure and Sample Size

.A multi-stage sampling technique was adopted for the study. First stage involved random selection of Agricultural zone 1 from the 3 Agriculture zones of the state using simple random sampling through picking. The second stage involved random selection of three Local Government Areas (LGAs) from eight in Agricultural zone 1. The third stage involved random selection of one (1) extension Block from two that are present in each local government Area selected. The fourth stage involved random selection of three extension cells out of eight from

each Extension blocks. The fifth stage involved random selection of three villages out of six from each extension cell. The sixth and last involved proportional selection of 188 respondent using Yamane of 1967 formula based on sample frame obtained from NAMDA.

$$n = \frac{N}{1+N(e)^2}$$

Where:
n = sample size
N = finite population
e = level of significance at (0.07)
1 = unit

Table 3.3.1 Sample Outlay for the study

LGA	Extension Block	Extension Cell	Selected Villages	Sample Frame	Sample Size
Katcha	Katcha	Ekugi Cell	Jibo	100	8
			Emigi	80	6
			Ghaza	120	10
		Yinti Cell	Sagi	80	6
			Magoyi	56	4
			Gbakogi	64	5
		Egbanti Cell	Egbanti 1	180	14
			Egbanti 2	120	9
			Egbant 3	100	8
Lavun	Doko	Gaba Cell	Gaba	120	10
			Sheshibikun	100	8
			Washi	80	6
		Majingari Cell	Majingari	100	8
			Chanchaga	80	6
			Kusotachi	50	4
		Tafiyan Cell	Barizhe	80	6
			Darata	70	5
			Mawogi	120	10
Gbako	Lemu	Edozhigi Cell	Edozhigi	120	10
			Pati	80	6
			Gusadi	100	8
		Essan Cell	Kuchita	80	6
			Patigi	70	5
			Ndagbira	50	4
		Gbadafu Cell	Gbadafu	100	8
			Biramafu	60	5
			Evungi	40	3
			Total	**2400**	**188**

Source: NAMDA, 2013.

3.5 Method of Data Collection

Data for this study was mainly from primary source. A well- structured interview schedule and questionnaire were designed to illicit information data required for the study from the respondents, such data included social economic characteristics, farmers knowledge on climate change, adaptation strategies adopted, effectiveness of its, factors that influence adoption of adaptation strategies and the constraint faced by farmers in adopt the strategies, using trained enumerators under the supervision of the researcher.

3.6 Measurement of Variables

Dependent variables

Y= Number of adaptation strategies to climate variability adopted by farming household were measured by number adopted by each farmers.

The adaptation strategies to climate change and variability include, increase rural- urban migration, diversifying from- on farm to non-farm activities, membership to cooperative, use of irrigation scheme, vegetation cover, crop rotation, timing of farm operations, planting drought tolerant varieties, planting early maturing varieties, planting of high yielding varieties, use of agro- chemicals, use of manure (organic or inorganic), reduce the size of cultivation farm. In all a total of 13 adaptation strategies were consider..

Independent variables

Xi.= Socio economic characteristics.

i. Age: were measured in years

ii. Sex: male farming household were score 1, while female were assign 0

iii. Level of education: it was measured by number of years spent in formal school

iv. Farming experience: actual number of years spend in farming activities.

v. Farm size: area of land cultivated by a farmers in hectares

vi. Marital status: were measured based on married, single, divorce, widow (er) and separated.

vii. Household size: were measured as total number of people living within the family.

viii. Membership of co-operatives: was measure if a respondent belong to co-operative (i) or not (0)

ix. Extension visit: measured as the actual number of time that the respondent had contact with extension agent.

x. Access to credit: was measured based on amount received in ₦

xi. Training: number of times respondent received training on climate adaptation strategies

xii. Land tenure: own land =1 not own land =0.

xiii. Income of the farmer: was measured in average amount realized from farming activities.

3.7 Method of Data Analysis

The data collected were analyzed using descriptive and inferential statistics. The descriptive statistics used included frequency count, percentages and mean. Inferential statistics used include Poisson regression model. Z –value of the Poisson regression result of objective iv was used to

test the relationship between the social economic characteristic of farming households and adaptation strategies adopted by respondents.

The socio economic characteristics of this study were measured using descriptive statistics. The knowledge level of the respondent was measured using descriptive statistic: three point Likert scales were used to measure the knowledge level of the respondent. The adaptation strategies adopted by respondents was measured base on the numbers of strategies adapted using descriptive statistic. The factors affect climate change and variability adaptation strategies adopted by respondents was measured using Poisson regression model. This model is used to a count data and contingency table. The constraints of the respondents to adopt adaptation strategies to climate change and variability was measured using descriptive statistics, 3- point Likert type-rating scale were used to measure the constraints.

Objective I, was achieved using descriptive statistics like frequency distribution, percentages and mean.

Objective II, was achieved using descriptive statistics: 3- point Likert scales was used to measure the knowledge level of farmers on climate change. It was measured as (Highly Knowledgeable (HK) = 3, Moderate Knowledgeable (MK) = 2, Less Knowledgeable (LK) = 1, The decision rule was based on bench mean score obtained by adding 3+2+1= 6/3 to get 2.0

Any value above ≥ 2.0 implies that the respondent is highly knowledgeable to climate change and variability. any value that is less than < 2.0 will be classify Not knowledgeable.

Objective III, was achieved through descriptive statistic to determine numbers of adaptation strategies adopted by respondents; (five point Likert scale was used to measure the level of farmers adaptation strategies on climate change and variability). it was determine as follow

(Very effective (VE) =5, Effective (E) = 4, Undecided (U) = 3 Fairly effective(FE) = 2) Not effective (NE) =1, any statement that mean score is ≥ 3 .0 will be classify as significant while any statement with less than < 3 .0 not significant . The decision rule will be based on the bench mean score obtain by adding 5+4+3+2+1=15/5 to get 3, any value equal to or above 3.0 implies that the adaptation strategies is effective while value less than 3.0 implies that the adaptation strategies is not effective.

Objective iv, was achieved using Poisson regression model. This model was used to determine the factors that influencing climate change and variability adaptation strategies adopted by farmers. The implicit form of model is expressed as:

$Y= F (X_{1,} X_{2,} X_3, X_4, X_5, X_6, X_7, X_8$----------$X_{12}$

The functional form is expressed in the explicit form as:

$Y= b_0+ b_1x_1+b_2x_2+b_3+x_3+b_4+x_4+b_5+x_5+b_6x_6+b_7x_7+b_8x_8+u$----------2

Where:

Y= Numbers of adaptation strategies adopted by farming household (count variable)

X_1=Age (in years)

X_2=Sex (Male =1 Female =0)

X_3=Education level (No of years spent in school)

X_4=Farming experience (No of years spent in farming activities)

X_5=Farm size (In hectare)

X_6=Marital status (Married=1 otherwise=0)

X_7=Household size (No of people in the household)

X_8=Cooperative membership (if a member=1, otherwise= 0)

X_9=Extension contact (Number of visit)

X_{10}=Access to credit (Amount in ₦)

X_{11}=Training (Number of time)

X_{12}=Land tenure (Land owner=1, otherwise= 0)

X_{13}=Farm income (₦)

In= logarithm.

bo= Constant.

b_1- b_{13}= Regression coefficient.

X_1-X_{13}= Independent variables.

U= error term.

Objective v. The constraints facing the farmers to adopt adaptation strategies to climate change and variability were measured using descriptive statistics: 3- point Likert type-rating scale was used to measure the constraints. it was determine as follow: (Very severe (VS) = 3. Severe (S) = 2, Not severe (NS) = 1. The decision rule was based on bench mean score obtain by adding 3+2+1= 6/3 to get 2.0, any value $\geq$ 2.0 was classify as severe, any value less than $<$ 2.0 classify not severe.

3.8 Model Specification

Poisson regression is a form of regression analysis used to model count data and contingency tables, Poisson regression assumes the response variable y has a Poisson distribution and assumes the logarithm of its expected value which can be modeled by a linear combination of unknown parameters, Poisson regression model is sometimes known as a log- linear model, especially when used to model contingency table, Poisson regression model are generalized linear models with the logarithm as the link function and the Poisson distribution function.

3.9 Testing of hypothesis

The Z – value of the Poisson regression results of objective (iv) was used to test the relationship between the socio economic characteristics of farming household and adaptation strategies adopted by respondents.

CHAPTER FOUR

4.0 RESULTS AND DISCUSSION

4.1 Socio-Economic Characteristics of respondents

The socio-economic characteristics of the respondents in the study area were classified based on the following variables: Sex, Age, Marital status, educational qualification, Primary occupation, Secondary occupation, Farming experience, Farm size.

4.1.1 Age of respondents

Age is the duration of human existence from birth to the day of data collection of the study. The results in Table 1 revealed that 77.5% of the respondents were within the age range of between 26-50 years, with mean age of 27 years. This implies that majority of the respondents were still in their active and productive age. People in this age category are likely to supply labour requirement in adapting to adaptation strategies to climate change and variability activities confronting the farming operation in the study area. Farmers who are in their active age were most likely to have better understanding on the effects climate change and variability pose on food crop and livestock production and might be willing to adopt effective adaptation measure against climate change and variability. This findings is in line with Oremo (2013) who reported that farmers within age range of 25-60 were on the active age who are mostly engaged in food crop production than the farmers at lower age below 25 and above 60years.

4.1.2 Sex Distribution of respondents

Table 1 show that, the majority 88.3% of the respondents were male, while 11.7% were female. This implies that there were more of Male rural farming households in the study area than the Female. This indicated that, farming activities in the study area were mostly engaged in by the

88.3% of men, who are also believed to be the head of the household. This result agreed with finding of Oluwasusi., *et al* (2013) who reported in his study on farmers adaptation strategies to the effect of climate variation on Yam production, that majority of yam producers were male.

4.1.3 Marital status of respondents

Marital status indicate if an individual as married, single, divorced and widow(er). Marital status may invariably influence the types and level of available labour supply to be used in production. Married individual for instance, may have more helping hands in the production process in terms of family labour and this means more production can be obtained as well as more consumption of food by member of the family. The result in table 1 shows that 35.6% of the respondents were married, while 64.4% were single and widowed.

4.1.4 Household size of respondents

Household size shows the number of persons that reside in the respondents household (Mcata,2012). The result of the study revealed that household size that ranges from 6 – 10 had the highest percentage 42.6%. This is an indication that there was a moderate household size that contributed to labour capacity present in form of elderly, middle, aged and young members. This implies that, the moderate the household size, the more it has positive influence on labour requirement on the production, processing and marketing of agricultural product that sometime required large number of labour.

4.1.5 Level of Education

The result in Table 1 revealed that 32.4% had primary education and 30.4% had secondary education, while 13.8% attended post- secondary school education with 23.4% had non- formal

education. The level of education is important because literacy which is obtained through education had been identified as one of the major tools which enable farmers to obtain concrete knowledge and good information's (Sibanda, 2012). It is also expected that the level of education play an important role on adoption of new technology as well as implementation of new practices that equip individuals with the required knowledge of how and where to make a living in selection of good agronomy practices and inputs. The household who had obtained education and have it to the highest stage is of great advantage to be able to interpreted information as well as pen it down where necessary. This result is in line with the findings of (muchara, 2011), who stated that the level of education of respondents in his study on analysis of food value chain in smallholder crop and livestock ranges from primary, secondary, post- secondary (formal) to non-formal, with primary, secondary and non-formal were the majority in the study area.

4.1.6 Primary occupation

The result in Table 1 shows that majority of the respondents 90.4% engaged in farming most especially crop and livestock. While 9.6% were involved in one occupation or the other. This implies that majority of the respondent were actively involved in crop and livestock production as their primary occupation.

4.1.7 Secondary occupation

The result in Table 1 shows that 41.5% of the respondents had farming as their secondary occupation. While 58.5% were involved in one activities or the other as their secondary occupation. This implies that more than averages of the respondent were involved in one occupation or the other as complement to farming occupations like trading, artisan, civil servant, hunting and others.

4.1.8 Farming experience

This is numbers of years the farmer had being cultivating a particular crop or rearing of a particular livestock. Farming experience is one of the indicators in decision making on what to produce, how to produce and from where to produce it. It also guides farmers on adaptation of new technologies as well the application of different techniques or strategies. The result in Table 1 shows that 37.8% of the respondents were highly experience in both crop and livestock production with age range of experience from 11 – 20 years having the highest percentage. The high number of years of farming experiences in crop and livestock production may likely contributed positively to adaptation strategies that may mitigate the effect of climate change and variability in the study area.

4.1.9 Farm size for crop production

The result in Table 1 revealed that majority of the respondent 93.6% in the study area own farm size of between 1-5ha.This showed that respondents in the study areas had access to arable land and is a clear indication that respondents can easily adopt to adaption strategies to climate change and variability due to availability of having access to farmland that ranges from 1-5ha as a small scale farmers. Only 3.2% had crop farm size that ranges from 6-15ha. This implies that only few respondents are engaged in large scale crop farming, and it indicated that production of both food crops and cash crops will be limited where only few farmers are engaged in large scale farming. This result is in line with the findings of Umogbai., (2011) who reported in his study that farming in the northern Nigeria are mostly practiced by small scale farmers, where about 86% still make used of hand hoe.

Table 1: Socio-Economic characteristics of Respondents in the study area (n = 188)

Variables	Frequency	Percentage	Mean
Age (Years)			
25 and below	6	3.2	27
26 -30	26	13.8	
31 -35	28	14.9	
36 -40	50	20.6	
41 -45	30	16.0	
46 -50	23	12.2	
51 –and above	25	13.3	
Sex			
Male	166	88.3	94
Female	22	11.7	
Marital status			
Married	67	35.6	
Otherwise	121	64.4	
Household size			
1 -5	55	29.2	
6 -10	80	42.6	
11 -15	37	19.7	
16 -20	12	6.4	
21 -25	3	1.6	
26 -30	1	0.5	

Source: Field survey 2019

Table 1 cont'd: Distribution of respondents according to education level, primary and secondary occupation, farming experience and farm size

Variables	Frequency	Percentage	Mean
Education level			
Primary	66	32.4	
Secondary	57	30.4	
Post-secondary	26	13.8	
Non-formal	44	23.4	
Primary occupation			
Farming	170	90.4	
Trading	5	2.7	
Artisan	4	2.1	
Civil servant	8	4.3	
Others	1	0.5	
Secondary occupation			
Farming	78	41.5	
Trading	38	20.2	
Artisan	34	18.1	
Civil servant	17	9.0	
Hunting	13	6.9	
Others	8	4.3	
Farming experience			
1 -10	30	16.0	38
11 -20	71	37.8	
21 -30	58	30.9	
31 -40	21	11.2	
41 -50	8	4.3	
Farm size (ha)			
Less than 1	6	3.2	47
1 -5	176	93.6	
6 -10	5	2.7	
11 -15	1	0.5	

Source: Field survey 2019

4.2.1 Co-operative membership, years of being a member, access to credit, source of credit and source of land

The result in Table 2: shows that majority of the respondents 81.9% belong to one co-operative association or the other; only 18.1% respondents do not belong to any co-operative society. This implies that the farmers can benefit from help that is usually rendered through cooperative society by government, non-governmental organization and great philanthropist. The table also revealed how long respondents had being a member to co-operative association with 24.5% of respondents fell within 1-5 years, 39.4% respondents had 6-10 years for being a members while 11-15,16-20 years is 12.8%, 5.3% respectively. The Table 2 indicated the respondent accessibility to credit facilities with 75.0% having access to credit while 25.0% do not have access to credit. The result shows that majority of the respondents obtained their credit facilities from friends/relatives 42.5%, personal savings 22.9%, bank loan 17.6% and co-operatives having the least percentage of 17.0%. This implies that co-operative association in the study area are not standing up to expectation of helping its members by given a short term loan that will be of benefits to them or their may be likely a problems of loan repayment by the members.

Table 2: Distribution of respondents according to co-operatives membership, Years of being a member, Access to credit and sources of credit

Variables	Frequency	Percentage
Membership to co-operative		
Member	153	81.9
Non- member	34	18.1
Years of membership to co-operatives		
1-5	46	24.5
6-10	74	39.4
11-15	24	12.8
16-20	10	5.3
Undecided	34	18.0
Access to credit		
Accessed credit	139	75.0
Not access to credit	49	25.0
Source of credit		
Personal savings	40	22.9
Bank loan	30	17.6
Co-operatives society	28	17.0
Friends/ relatives	72	42.5

Source: Field survey 2019.

4.2.2 Amount of credit obtained by respondents in the last cropping seasons

The result in Table 3: shows that 85.6% of the respondents found it difficult to obtain loan for their farming operation that is above forty thousand naira (₦40,000) , since 42.5% of the respondents have access to loan through friends/relatives who may not have much money to give as loan. This is because their money had been spread on many businesses of store farm crops which might have not yielded much income at the onset of rain season and they may not want to dispose it at giveaway prices. Also collateral that is usually demand by commercial Banks before loan is being given to an individual or group of individual served as major constraints to farmers who may wish to obtain huge amount of money for their farming activities. This is because not all can meet up with the bank requirement for obtained enough loan from bank. While only 3.2% of the respondents obtained loan that is above one hundred thousand naira (₦100,000).

Table 3: Distribution of respondents based on amount of credit obtained last cropping seasons (n=188)

Amount received ₦	Frequency	Percentage	Mean
20,000 and below	66	35.1	31,333
20,000 – 40,000	95	50.5	
40,001 – 60,000	14	7.4	
60,001 – 80,000	3	1.6	
80,001 – 100,000	4	2.1	
Above 100,000	6	3.2	

Source: Field survey 2019.

4.2.3 Annual income of respondents from crops and livestock

The result in Table 4: shows that majorities 64.8% of the respondents obtain annual income of (₦100,000-300,000) from crop farming, 28.8% obtained annual income from between ₦300,001-above ₦600,000. This implies that majority of the farmers were mostly affected by changes in start and end of growing seasons which was characterized by delay in onset of rain and sudden cessation of rain that led to low yield output due to drought there by resulted to low income of the farmer. This finding is in line with Gana, (2012) who reported in his study, that climate variability and changes contributed to lower or higher yields of the farmer and their income from crops and livestock.

Table 4: Distribution of annual income of respondents from Crop and Livestock (n=188)

Variables ₦	Frequency	Percentage	Mean
Annual income from crop			
Less than 100,000	12	6.4	₦26,857
100,000 – 200,000	83	44.1	
200,001 – 300,000	39	20.7	
300,001 – 400,000	21	11.2	
400,001 – 500,000	15	8.0	
500,001 – 600,000	8	4.3	
Above 600,000	10	5.3	
Annual income from livestock			
₦20,000 and below	32	17.0	₦31,333
₦20,000 – 40,000	127	67.6	
₦40,001 – 60,000	23	12.2	
₦60,001 – 80,000	1	0.5	
₦80,001 -100,000	3	1.6	
Above – 100,000	2	1.1	

Source: Field survey 2019.

4.2.4 Respondents sources of information, access to extension agent and frequency of contact

The result in Table 5: revealed that majority of respondents are conversant with information on climate change and variability with the respondents 55.9% received their information from extension agents, while 19.7% got theirs from co-farmers and relatives, 19.1% of the respondents received their information through Radio. Only 3.7%, 1.6% of the respondents got their information on climate change and variability through television and newspaper respectively. The table also revealed that, 89.9% of respondents had access to Extension Agent while 10.1% did not have access to extension agent. The degree of frequency of respondents that had contact to Extension Agent with 58.5% on monthly contact, while 36.7% meet with extension agent on both weekly and forth nightly bases. Only 4.8% of the respondents came in contact with extension agent on yearly bases. This implies that the more respondents had contact with extension agent, the more they are enlightened on the challenges faced on their farming activities. This result agreed with the findings of Opara (2008), who reported in his study on Agricultural information sources used by Farmers, that 88.1% of his respondents indicated Agricultural extension agent as their source of information and preferred extension agent to other media. Similarly, Ozowa (2008) also reported that among all the existing channel of communication, extension workers ranked first in providing concrete information to Nigeria farmers.

Table 5: Distribution of Respondents sources of information, access to extension agent and frequency contact (n=188)

Variables	Frequency	Percentage
Sources of information		
Extension agents	105	55.9
Radio	36	19.1
Television	7	3.7
Newspaper	3	1.6
Co-farmers/relatives	37	19.7
Extension contact		
Yes	169	89.9
No	19	10.1
Frequent of extension contact		
Weekly	36	19.1
Fortnightly	33	17.6
Monthly	110	58.5
Yearly	9	4.8

Source: Field survey 2019.

4.2.5. Distribution of Training received by respondents in the last farming season

Table 6: shows that majority 65.4% of the respondents received one form of training or the other while 34.6% did not received any training last farm seasons .It revealed also that, 49.5% of the respondents received pre-season training, while 31.4% received on-season training with only 19.1% received post-harvest training from Agricultural organization like National Cereals Research Institute (NCRI) Badeggi and Niger state Agricultural Mechanization Development Agency.(NAMDA) Bida branch. Table 6: Also shows number of persons that migrated from house hold to town due to climate change and variability with two (2) and below having the highest percent of 48.9% while 8 and above having 5%. This implies that migration of able men form rural areas to urban center seeking for paid jobs may not solve the challenges pose by climate change and variability to the house-hold.

Table 6: Distribution of respondents that received training last farm season and number of person that migrated to town due to climate change variability (n=188)

Variables	Frequency	Percentage
Receiver of training last farm season		
Attended training	123	65.4
Not attended	65	34.6
Type of training received		
Pre-season	93	49.5
On-season	59	31.4
Post-harvest	36	19.1
No of persons that migrated due to CC&V		
2 and below	92	48.9
3 -5	62	33.0
6 -8	18	9.6
9 -11	8	4.3
12 -14	3	1.6
15 -17	4	2.1
18 and above	1	0.5

Source: Field survey 2019.

4.2.6 Distribution of respondents on climate change and variability awareness, sources of information

The results in Table 7 showed that majority of the respondents 97.3% were aware of climate change and variability. Only 2.7% of the respondents were ignorant of the change. This result is in line with the findings of Mubaya *et al* (2010) who revealed that over 80% of the rural farmers were aware of climate change and variability as many of them identified persistence in drought as well as increasing and decrease in rainfall in the past few years, which had both positive and negative effects on farming and Agricultural productivity. Respondents also perceived significant increase in temperature characterized by extreme heat which has been seen as contributing factors to increase pest and diseases outbreak of crop and livestock. Akponikpe *et al.,* (2010) also conduct a similar study which came up with the same findings of increasing temperatures and extreme hot days that was experienced throughout the seasons.

Table 7, Also revealed that, respondents sources of information on climate change and variability were through government officers with 69.7% who are likely to be from agricultural development agency and university most especially Academicians. While other source of information to respondents in the study area were through Radio 17.0%, friends 10.1% and television 1.6% respectively.

Table 7: Distribution of respondents on climate change and variability awareness, sources of information. (n=188)

Variables	Frequency	Percentage
Climate change and variability awareness		
Aware.	183	97.3
Not-aware.	5	2.7
Source of information on climate change		
Government officers	131	69.7
Friends	19	10.1
Radio	32	17.0
Television	3	1.6
Others	3	1.6

Source: Field survey 2019.

4.2.7 Farmers knowledge level on climate change and variability

The result in Table 8: showed the distribution of the farmer's knowledge level on climate change and variability. From the result in Table 8:.Incident of heavy rainfall that causes damages to crop and livestock production having mean score of ($\bar{X}$ = 2.71), incident of high temperature that causes damages to crop and livestock production ($\bar{X}$= 2.56), shifting time of rainfall in the season over the years ($\bar{X}$=2.50), observed variation in rainfall in the past 10 years ($\bar{X}$ = 2.48), observed increase in the average rainfall amount over the years ($\bar{X}$=2.43), Temperature variation for the past 10 years ($\bar{X}$=2.39), observed increase in the average temperature amount ($\bar{X}$=2.32), incident of drought experience during raining seasons that causes damages to crop and livestock production ($\bar{X}$=2.28), observed constant average temperature amount in past 10 years ($\bar{X}$=1.88), decrease in rainfall and constant average rainfall amount over the years having the same mean score of ($\bar{X}$=1.77), while decrease in average temperature amount over the years having the lowest mean score of ($\bar{X}$=1.60). This implies that, majority of the respondent agreed that there were variation of both rainfall and temperature, and are more knowledgeable of the effect and impacts climate change and variability had on food security.

The result also revealed farmers awareness on the incident of heavy rainfall and high temperature that causes damages to crop and livestock production with highest mean score of (ẋ=2.71) and (ẋ=2.56) respectively. This result is in line with the finding on perception of farming household by Adegnandjou *et al.,* (2018), who confirmed that climate has changed and varies, and the changes observed were rainfall disturbances such as rainfall delays and early cessation, shortening of dry season, increasing temperature, violent winds and extreme occasion such as flood which causes destruction to crop and livestock, washing away of top fertile soil that is capable of supporting plant growth. This result also agreed with the findings of Edward and

Devereux (2003), who reported that Countries in Africa with Nigeria inclusive are already among the most food insecure in the world with increasing food demand that could translate to high risk of food security globally, coupled with global increased in temperature.

Table. 8:.Distribution of farmers on knowledge level of climate change and variability (n=188)

Variables	HK F (%)	MK F (%)	LK F (%)	Mean	Rank	Remark
Does the incident of heavy rainfall causes damage to crop and livestock production:	135(71.8%)	52(27.7%)	1(0.5%)	2.71	1st	Highly knowledgeable
Does the incident of high temperature cause damages to crop and livestock production:	111(59.0%)	72(38.3%)	5(2.7%)	2.56	2nd	Highly knowledgeable
Does the timing of rainfall in the season been shifted over the years:	95(50.5%)	92(48.9%)	1(0.5%)	2.50	3rd	Highly knowledgeable
Have you observed any variation on Rainfall in the past 10 years:	94(50.0%)	90(47.9%)	4(2.1%)	2.48	4th	Highly knowledgeable
Have you observed an increase in the Average rainfall over the years:	83(44.1%)	102(54.3%)	3(1.6%)	2.43	5th	Highly knowledgeable
Have you observed Temperature Variation in the past 10 years:	73(38.8%)	115(61.2%)	---	2.39	6th	Highly knowledgeable
Have you observed increase in the average Temperature amount over the years:	66(35.1%)	116(61.7%)	6(3.2%)	2.32	7th	Highly knowledgeable
Does the incident of droughts experience during raining season cause damages to Crop and livestock production:	56(29.8%)	129(68.6%)	3(1.6%)	2.28	8th	Highly knowledgeable
Have you observed constant in average Temperature amount in the past 10 years:	40(21.3%)	85(45.2%)	63(33.5%)	1.88	9th	Low knowledgeable

Table 8: Distribution of farmers on knowledge level of climate change and variability continue. (n=188)

Variables	HK F (%)	MK F (%)	LK F (%)	Mean	Rank	Remark
Have you observed decrease in the average rainfall amount over past 10 years?	43(22.9%)	59(31.4%)	86(45.7%)	1.77	10th	Low knowledgeable
Have you observed constant in average rainfall amount over the years?	24(12.8%)	96(51.1%)	68(36.2%)	1.77	10th	Low knowledgeable
Have you observed decrease in the average Temperature amounts in the years?	29(15.4%)	54(28.7%)	105(55.9%)	1.60	12th	Low knowledgeable

Source: Field survey 2019. HK= Highly knowledgeable, Lk= Low knowledgeable

4.2.8 Adaptation strategies adopted by respondents to mitigate climate change and variability

Adaptation strategies adopted by respondents to cope with climate change and variability is shown in Table 9: The result revealed the hierarchy in adoption of adaptation strategies to climate change and variability with planting early maturing varieties and planting of high yielding varieties were 100% adopted. These variables were closely followed by use of agro-chemicals and use of manure (organic or inorganic), this implies that, majority (98.9%) of the respondents adapted adaptation strategies climate change and variability earlier mention above in the study area. This result corroborate the findings of Howden and White (2016) who observed that climate change and variability inhibit crop and livestock growth, it affects the choice of crop varieties and other farm management decision. The result further revealed planting of drought tolerant varieties 97.9%, crop rotation 94.1% and used of irrigation scheme 93.6% were also adopted by majority of the respondents who think deeply and are highly experienced that this adaptation strategies could be a way out of the effect climate change and variability pose to crop and livestock production.

Similarly, this was also identified by Anyanwu (2008), who observed that availability of water is the key to food security as crops and livestock required water to grow, and generally Agriculture need large quantities of water for irrigation and of good quality for various production processes. Table 9 further shows that timely farm operation 87.8% was adopted by the majority of respondents to avoid the time of flooding in low land ecology that some time ravages their farm. This result agreed with (Acqual., et al 2011) who reported in his study on farmers perception and adaptation to climate change, that farmers had adopted to timely in planting and harvested their crops before flood set in on their farm. Vegetation cover and diversifying from farm to non-farm

activities were also adopted by majority of the respondents as a way to mitigate climate change and variability with vegetative cover, and diversifying from farm to non-farm activities having 87.8% and 64.9% respectively. Rural –urban migration 44.1%, reduce cultivated farm size 42.0% was least adopted. This implies that migration of active able men to urban centers and reduction of cultivated farm size that is not enough as a result of land tenure system may not likely provide solution to the challenges of climate change and variability, rather it could worsen it by mounting pressure on infrastructures in the urban centers and reduction of cultivated farm size could increase food insecure. This is in line with Ozor,(2009), who stressed that Nigeria may be vulnerable to climate change and variability with respect to consequent reduction to available cultivated crop and pastureland.

Table 9: Distribution of respondents on adaptation strategies adopted to mitigate climate change and variability (n=188)

Variables	Frequency	Percentage	Rank
Planting early maturing varieties			
Adopted	188	100.0	1st
Not adopted	0	0	
Planting of high yielding varieties			
Adopted	188	100.0	1st
Not adopted	0	0	
Use of agro-chemical			
Adopted	187	99.5	3rd
Not adopted	1	0.5	
Use of manure(organic or inorganic)			
Adopted	186	98.9	4th
Not adopted	2	1.1	
Planting drought tolerant varieties			
Adopted	184	97.9	5th
Not adopted	4	2.1	
Crop rotation			
Adopted	177	94.1	6th
Not adopted	11	5.9	
Use of irrigation scheme			
Adopted	175	93.6	7th
Not adopted	13	6.4	
Vegetation cover			
Adopted	165	87.8	8th
Not adopted	23	12.2	
Timely of farm operation			
Adopted	165	87.8	8th
Not adopted	23	12.2	
Diversifying from farm to non-farm activities			
Adopted	122	64.9	10th
Not adopted	66	35.1	
Rural- urban migration			
Adopted	83	44.1	11th
Not adopted	105	55.9	
Reduce the size of cultivated farm land			
Adopted	79	42.0	12th
Not adopted	109	58.0	

Source: Field survey 2019

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4.2.9 Adaptation strategies adopted by farmers and their effectiveness

The result in Table 10 showed the distribution of respondents on perception of adaptation strategies adopted and it effectiveness. The result revealed that planting of early maturing varieties of crop and high yielding varieties were more effective among the adaptation strategies adopted by the respondents in the study area with mean ($\bar{X}$=4.49), ($\bar{X}$=4.25) respectively. This implies that majority of respondents are fully aware of the effect climate change and variability could posed to them and their entire household, if planting of early maturing and high yielding varieties were not adopted among the strategies as its effect may led to reduced yield of crops, there by resulted into increased global food demand, and lowering of food reserves (F A O, 2008b).

Table 10 also identified use of irrigation scheme ($\bar{X}$=4.20), planting of drought tolerant varieties ($\bar{X}$ =4.19) were also among the adaptation strategies that were mostly used by respondents in the study area, but with use of irrigation scheme having a greater challenge by the farming household as irrigation equipment's and facilities testified to be beyond the rich of many respondents due to high cost in their prices and also availability of water during the drought period and dry seasons (F A O,2008b). Use of manure (organic or inorganic) ($\bar{X}$ =4.14), use of ago-chemical ($\bar{X}$ =3.96), Timely in farm operation ($\bar{X}$=3.87), crop rotation ($\bar{X}$=3.56), vegetation cover ($\bar{X}$ =3.40), membership to co-operative ($\bar{X}$ =3.32) were also found to be effective as strategies to mitigate the effect of climate change and variability. While diversifying from farm to non-farm activities ($\bar{X}$=2.64), rural-urban migration ($\bar{X}$=2.13) was found not to be effective strategies to mitigate against climate change and variability. Reduce cultivated farm size ($\bar{X}$=2.82) were respondents who are undecided on the effectiveness on climate change and variability.

Table 10: Distribution of farmers on adaptation strategies adopted and their effectiveness

Variables	Very effective F(%)	Effective F(%)	Undecided F(%)	Fairly effective F(%)	Not effective F(%)	Mean	Rank	Remark
Planting of early maturing varieties	106(56.4)	75(39.9)	2(1.1)	4(2.1)	1(0.5)	4.49	1st	E
Planting high yielding varieties	66(35.1)	112(59.6)	3(1.6)	5(2.7)	2(1.1)	4.25	2nd	E
Use of Irrigation scheme	75(39.9)	89(47.3)	10(5.3)	14(7.4)	_____	4.20	3rd	E
Planting drought tolerant varieties	69(36.7)	101(53.7)	3(1.6)	14(7.4)	1(0.5)	4.19	4th	E
Use of manure (organic or inorganic	55(29.3)	119(63.3)	1(0.5)	11(5.9)	2(1.1)	4.14	5th	E
Use of agro –Chemicals	47(25.0)	113(60.1)	1(0.5)	27(14.4)	_____	3.96	6th	E
Timely in farm operations	75(39.9)	55(29.3)	19(10.1)	36(19.1)	3(1.6)	3.87	7th	E
Vegetation cover	26(13.8)	80(42.6)	28(14.9)	52(27.7)	2(1.1)	3.40	8th	E
Membership to co-operatives	31(16.5)	81(43.1)	3(1.6)	63(33.5)	10(5.3)	3.32	9th	E
Reduce cultivated farm size	10(5.3)	41(21.8)	78(41.5)	24(12.8)	35(18.6)	2.85	10th	NE
Diversifying from farm to non-farm activities	12(6.4)	35(18.6)	38(20.2)	78(42.0)	24(12.8)	2.64	11th	NE
Rural urban migration	12(6.4)	18(9.6)	42(22.3)	27(14.4)	89(47.3)	2.13	12th	NE

Source: Field survey, 2019.
E = Effective
NE = Not Effective

4.2.10 Factors influencing adoption of adaptation strategies to climate change and variability

Factors influencing adoption of adaptation strategies to climate change and variability was determined using Poisson regression model and the result presented in Table 11 revealed that eight out of thirteen variables were statistically significant in the model used to determine factors that influencing adaptation strategy to climate change and variability, the likelihood ratio statistic as indicated by x^2 statistic (-416.46152) was significant at 0.01 probability level, (Prob >chi2 = 0.000) suggesting that the model had a strong explanatory power. The result revealed coefficient of determination, R^2 was 0.22215 which implies that 22% of the variation on the factors influencing adoption of adaptation strategies to climate change and variability was explained by the independent variables included in the model. Farming experience was negatively significant at 10% probability level holding other variables constant. This implies that as farmers are having more experience in farming, the level of adaptation strategies to climate change and variability ought to increase in line with more experience he or she had, but reverse is the case with this result. This is an indication that many of the respondents lack the detail knowledge on how to mitigate the effect and the impacts climate change and variability pose to farming activities of the household, and ways of overcoming it becomes a challenge to them. Conversely, educational level, farm size, membership to co-operative and land tenure were all positively significant at 1% probability level, while age and household size, were significant at 5% probability level. This implies that as the age of the farmers increased, the rate of adoption of adaptation strategies to climate change and variability increased and as the number of household size increased, more labour supply from family members is grantee, thus reducing the cost of labour through hire labour holding others factors constant. Extension contacts were also positively significant at 10% probability level. This implies that, the frequent at which farmers having access to extension

agent, the more they are been guided and trained on adoption of adaptation strategies that will helped them in adapting to climate change and variability strategy and likely increase crop and livestock output.

Table, 11: Poisson regression on the factors influencing adoption of adaptation strategies to climate change and variability

Variables	Coefficient	Z-ratio	P-value
Constant	0361583	0.15	0.879
Age(x_1)	0170429	1.98**	0.048
Sex(x_2)	-.046639	-0.55	0.581
Education(x_3)	.0554899	3.94***	0.000
Farm size(x_4)	.2320175	5.23***	0.000
Farm experience(x_5)	-.0163782	-1.77*	0.077
Marital Status(x_6)	-.1059676	-1.18	0.239
Extension contact(x_7)	.214678	2.01*	0.044
Household size(x_8)	.0216287	1.92**	0.054
Coop society(x_9)	.2527516	2.85***	0.004
Training(x_{10})	-.0248364	-1.51	0.132
Credit(x_{11})	1.9408	0.07	0.942
Land Tenure(x_{12})	.3834145	4.04***	0.000
Farming income(x_{13})	-4.1907	-1.16	0.248

Source: Field survey 2019.

Log likelihood -416.46152; LR chi2(13) = 115.15 prob>chi^2 =0.0000* Pseudo R^2=0.22215**

Number of obs = 188 * significant at 1%; ** significant at 5%; * significant at 10%**

4.2.11 Constraints faced by respondents on adoption of adaptation strategies to climate change and variability in the study area

Table 12: shows the major constraints hindering adoption of adaptation strategies to climate change and variability among farming households. The table revealed inadequate capital to procure equipment's and facilities needed to mitigate climate change and variability with mean score of ($\bar{X}$=2.55), poor extension services delivery ($\bar{X}$=2.53), as the major severe constraints face by the respondents in the study area.

This result is in line with Jost, *et al.,* (2015),who identified poor extension service and training as major constraints to technologies adoption. Low technical know-how on climate elements ($\bar{X}$=2.39), lack of credit facilities and incentives ($\bar{X}$=2.34), Inadequate information about climate change and variability ($\bar{X}$=2.19), Inadequate access to high yielding and early maturing varieties ($\bar{X}$=2.17), insect pest and diseases ($\bar{X}$=2.15) and land tenure issues ($\bar{X}$=2.06) were the severe constraints identified in the study area. This result also collaborate the finding of Jost, *et al.*, (2015), who revealed that rural farmers lack access to adequate resources such arable land, improved technology and credit. Challing., *et al.*, (2003), noted that availability and accessibility of climate information and forecast would help farmers to make strategies decision concerning their farm operation, as Lack of information has been a severe constraints in his study area. Access to good agro-chemicals ($\bar{X}$=1.99) and access to labour availability ($\bar{X}$=1.68) does not constituted any constraints to respondents in the study area.

Table 12:The constraints faced farmers in adaption of adaptation strategies to climate change and variability

Variables	Very severe F(%)	Severe F(%)	Not severe F(%)	Mean	Rank	Remark
Inadequate capital to procure equipments and facilities required to mitigate CC&V effect.	108(57,4)	75(39.9)	5(2.7)	2.55	1st	Severe
Poor extension services delivery	106(56.4)	78(40.4)	6(3.2)	2.53	2nd	Severe
Low technical know-how on climate Element strategies	77(41.0)	107(56.9)	4(2.1)	2.39	3rd	Severe
Lack of credit facilities and incentives	68(36.2)	116(61.7)	4(2.1)	2.34	4th	Severe
Inadequate information about climate Change and variability	55(28.3)	113(60.1)	20(10.6)	2.19	5th	Severe
Low access to high yielding and early maturing varieties	51(27.1)	118(62.8)	19(10.1)	2.17	6th	Severe
Insect pest and disease	47(25.0)	123(65.4)	18(9.6)	2.15	7th	Severe
Land tenure issues	30(16.0)	139(73.9)	19(10.1)	2.06	8th	Severe
Inadequate access to good agro-chemicals	53(28.2)	81(43.1)	54(28.7)	1.99	9th	Not severe
Inadequate of labour availability	21(11.2)	86(45.7)	81(43.1)	1.68	10th	Not severe

Source: Field survey, 2019.

4.2.12 Hypothesis Testing

The null hypothesis, which stated that there was no significant relationship between selected socio-economic characteristics age, sex, education, farm size, farming experience, marital status and household size of the farmers and adaptation strategies adopted was tested using the z-value from Poisson regression analysis. The estimated z –value (1.98) for age were positive and significant at 5% probability level. This implies that as the age of the farmers increased, the adoption of adaptation strategies to climate change and variability increased. Education (3.94) was also positive and significant at 1% probability level. This implies that level of education play an important role on adoption of new technology as well as implementation of new practices that equip individuals with the required knowledge of how and where to make a living and selection of good agronomic practices and inputs as a farmer. Farm size (5.23) was positive and significant at 1% probability level. This implies that increased in farm size could contribute to adoption of adaptation strategies to climate change and variability. The null hypothesis is hereby rejected, while the alternative hypothesis that there is significant relationship between age, education, farm size, farming experience and Household size of the farming households and adaptation strategies adopted by rural farmers is accepted. However, sex and marital status of the rural farmers and adoption of adaptation strategies to climate change and variability is accepted. This implying that there is no significant relationship between sex and marital status of rural farmers to adoption of adaptation strategies to climate change and variability.

Table 13: Regression coefficients of the null Hypothesis

Variables	Coefficients	Z –value	P > | z|	Decision
Age	.0170429	1.98**	0.048	Rejected, $H_0$1
Sex	-.046639	-0.55	0581	Accepted $H_0$1
Education	.0554899	3.94***	0.000	Rejected $H_0$1
Marital status	-.1059676	-1.18	0.239	Accepted $H_0$1
Farm size	.2320175	5.23***	0.000	Rejected $H_0$1
Farming experience	-.0163782	-1.77*	0.077	Rejected $H_0$1
Household size	.0216287	1.92**	0.054	Rejected $H_0$1

Source: Field survey,2019

***** Implies significant at 1% , ** significant at 5% , * significant 10% .**

CHAPTER FIVE

5.0 SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Summary

The study was conducted to determine the adoption of adaptation strategies to climate change and variability in Agricultural zone of Niger State, Nigeria. The specific objectives of the study were to describe the socio-economic characteristic of farming households, examine the level of knowledge of farming households on climate change and variability, and ascertain adaptation strategies to climate change and variability adopted by farming households and their perception of its effectiveness, determine the factors that influence climate change and variability adaptation strategies adopted by farming households farmers and examined the constraints associated with farming households on the adoption of climate change and variability adaptation strategies.

Multi-stage random sampling techniques were adopted to select 188 respondents. Data were obtained with the aid of structured questionnaire complemented with interview schedule Data were analyzed using both descriptive and inferential statistics. Descriptive statistics involved frequency distribution tables, percentages and mean, while the inferential statistics involved Poisson regression model as well as knowledge level, adaptation strategies effectiveness, constraints faced by farming household were measured using Likert type-rating scale. The result of the analysis obtained shows that mean age of the respondents was 35 years, while majority of the respondents 88.7% were male while 11.7% were female. 35.6% of the respondents were married, while 64,4% were single and widowed. Household size that ranges from 6-10 had the highest percentage 42.6% with the mean of 5.persons per household. Majority of the respondent attended secondary with 76.5%, while 13.8% attended tertiary institution and 23.4% did not attend formal education.

Majority of the respondents 90.4% engaged in farming as primary occupation, while 58.5% were involved in other activities as secondary occupation. The farm size of respondents was between 1-5ha with 93.6%, while farming experience of the respondents ranges from age 11-20 years with mean of 18. Method of acquiring farm land was through inheritance with 61.7%, other means were lease-hold, borrowing, purchase and gift. The respondents 73.0%, have access to credit, and the main source of credit was through friends/ Relatives with 38.3%.

The mean annual income from crops and livestock were ₦42587.81, and 96.8% of respondents received information through different means on climate change and variability with extension agent source having the highest of 55.9%. While 97.3% were aware of the climate change and variability, only 2.7% was ignorant of it. Variation in rain fall and temperature were perceived by the respondents in respect to increase and decrease in both rainfall and temperature which cause damages to crops and livestock production. Most of the adaptation strategies outline in study were adapted by the respondents with planting of early maturing varieties 100.0%, planting of high yielding varieties 100.0%, use of agro- chemical 99.5% and use of manure 98.9%(organic or inorganic), were mostly adapted. Planting of early maturing varieties, timely in farm operation and high yielding was perceived to be very effective, effective with mean of 4.49, 3.87 and 4.25 respectively.

Poisson regression model on the factors influencing adaptation strategies to climate change and variability of farming household result shows the likelihood ratio statistic as indicated by x^2 statistics (-416.46152) was significant at 0.01 probability level, (Prob >chi2 = 0.000) suggesting that the model had a strong explanatory power in explained adoption of adaptation strategies to climate change and variability. Out of thirteen independent variables included in the model, eight variables were found to be statistically significant at 1%, 5%, and 10% level of probability. The

constraints indicated by respondents were inadequate capital to procure equipment's and facilities needed to mitigate climate change and variability with mean score of ($\bar{X}$ =2.55), poor extension services delivery ($\bar{X}$=2.53), as the major and very severe constraints face by the respondents, While access to good agro-chemicals ($\bar{X}$=1.99) and access to labour availability ($\bar{X}$=1.68) does not constituted any constraints to respondents.

5.2 Conclusion

Based on the empirical evidence from findings of this study, it could be concluded that adoption of adaptation strategies, planting of early maturing varieties and planting of high yielding varieties were 100% adopted and were closely followed by use of agro- chemicals and use of manure (organic or inorganic) with 98.9%. while Rural – urban migration 44.1% and reduce cultivated farm land 44.0% were least adopted. Variables such as Education, Farm size, Coop society, Land Tenure, Age, Household size, Farming experience and Extension contact were found to be major factors influencing adoption of adaptation strategies to climate change and variability. The adaptation strategies to climate change and variability that were found to be effective was also identified and when adapted may likely reduced effect and impact of climate change and variability on farming household.

5.3 Recommendations.

Based on the findings of this study, the following recommendations are put forward.

i. Provision of credit facilities and incentives should be made available to farmers by well to do individuals who are into marketing of Agricultural products and Government to motivate them in production.

ii. Extension services delivery should be re-awaked and be given adequate attention by the government to ensure provision of agricultural based skills to the farmers.

iii. Weather information that is more reliable should be adequately related to farmers using right channel through extension agents and mass media to farmers by the National Metrological agency.

iv. Government and non-governmental organizations should provide means that are easy to access soft loans without too much stress and condition.

vi. High yielding and early maturing varieties should be made available to farmers at subsidized rate and timely by the releasing institutions and organization (Seed council of Nigeria).

vii. Land use act of 1978 should be revisited to correct abnormality in that act for farmers to have access to farm land irrespective of gender by the National assembly.

REFERENCES

Acquah, D. H. (2011). Farmers perception and adaptation to climate change: A willingness to pay analysis, *Journal of Sustainable Development in Africa,* 13 (5) 150-161.

Adegnandjou, M. R.F., & Dominique,B., (2018) Farmers adaptation strategies to climate change and their implications in the zou department of south Benin. *MDPI Journals A-Z 5 (1).*

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

Akponikpe, P., Johnston, P., & Agbossou, E. K. (2010). Farmers' perceptions of climate change and adaptation strategies in sub-Sahara West Africa. *2nd International Conference on Climate, Sustainability and Development in Arid Regions, Fartaleza-Ceara, Brazil.*

Anselm, A.E.& Taofeeq, A.A (2010) Challenges of Agricultural adaptation to climate change. *Journal of field action science report* (4), 1-22.

Apata T. G. Samuel, K. D. & Adeola, A. O. (2009). Analysis of Climate change perception and Adaptation among Arable Food Crop Farmers in south Western Nigeria. Paper presented at the conference of International Association of Agricultural Economics . 2-9

Ayanwuyi, E., Kuponiyi, F. A, Ogunlade, I.& Oyetoro, J. O. (2010)**.** Farmers' perception on impact of climate change on food crop production in Ogbomoso Agricultural Zone of Oyo State, Nigeria. *Agricultural Economics* 4. . 19-25.

Berke, F., Colding, J., & Folke, C.(2000), Rediscovery of Traditional Ecological Knowledge as adaptive management. Ecological Applications (10), 1251-1262.

Boko, M .I., Niang, A., Nyong, C., Vogel, A., Githeko, M., Medany, B., Osman, E. R. T., & Yanda, P., (2007). Impact, adaptation and vulnerability. Africa climate change' contribution of working GroupII to the fourth Assessment Report of the Intergovernmental panel on climate change, MI, Parry, of, Canziai, JP, Palutikof, PJ, Vander linden & Hanson CE, (Eds)., Cambridge University Press, Cambridge UK 433-467

Cubasch,U,D., Wuebbles, D., Chen, M,C., Facchini, D., Frame, N., Mahowald & Winther, J, G (2013), Introduction In: Climate Change 2013: The Physical Science Basis. Contribution of

Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change[Stocker, TF, Qin, D, Plattner, GK, Tignor, M, Allen, SK, Boschung, J, Nauels, A, 98

Eboh, E. (2009). Implications of climate change for Economic growth and sustainable Development in Nigeria. Enugu forum policy paper 10. African Institute for applied economics. Nigeria

Ekong, E.E. (2003). Rural Sociology: An Introduction and Analysis of Rural Nigeria. Dove Educational publishers, Uyo.

Fadina .A & D. Berjolle (2018). Farmers Adaptation Strategies to Climate Change and Their Implication in the Zou Department of South Benin. *Journal of Enviromental Sciences, 5 (11): 15*

Field, C. B., Mortsch, L. D., Brklacich, M., Forbes, D. L., Kovacs, P., Patz, J. A., Running, S. W. & Scott, M. J. (2007); Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change Parry, M.L., O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson (eds.). Cambridge University Press, Cambridge, United Kingdom.

Food & Agriculture Organization F A O (2008a) . Challenges for sustainable land management (SLM) for food security in Africa,25th Regional conference for Africa, Nairobi Kenya, Information paper 5, pp. 15.

Food &Agriculture Organization F A O (2008b), Assessment of the world food security' Food and Agriculture Organization of the United Nations, Rome.

Gana, A. K., (2012), Appropriate agronomy practice adoptable for climate change. *International Journal of life Sciences and technology* 5 (4), 24 – 28

Gandure, S., Walker, S. and Botha, J. J. (2012)**.** Farmers'perceptions of adaptation to climate change & water in a South African rural community. *Environment Development. Available* http://dx.doi.org/10.1016/j.endev. (Accessed on 20 July 2014).

Gray, L. (2009). Climate change shifting seasons is causing widespread hunger. Available: http://www.telegraph.co.uk/earth/environment/climatechange/5749560/Climate-change shifting-seasons-is-causing-widespread-hunger.html. (Accessed on 10 October 2013).

Howden S.M. & White D.H. (2016); Climate and Its Effects on Productivity and Management Soils, Plant Growth and Crop Production, NSW, Australia.

Ifeanyi- Obi, C C., Etuk, U. R., & Jike – Wai, O.(2012). Climate change, Effects and adaptation strategies; Implication for Agricultural Extension system in Nigeria. *Greener Journal of Agricultural science.* 2 (2),. 053 – 060

IPCC (2007); 'Climate Change: Impacts, Adaptation and Vulnerability' Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, Parry, ML, Canziani, OF, Palutikof, JP, van der Linden, PJ & Hanson, CE, (Eds)., Cambridge University Press, Cambridge, UK, pp. 976.

IPCC (2012). Summary for policy makers, "In; Field, C., B., Barres, v., Stocker, T., F., Qin, D., Dokken, D., J., Ebi, K., L., Mastrandrea, M., D., Mack, K., J., Plattner, G., K., Allen, S., K.,Tignor, M., & Midgley, P., M., (Eds.), Managing the risks of extreme events and disasters to adva- nce climate change adaptation. A special report of working Group I and II Intergovernmental panel on climate change, Cambridge University press, Cambridge, pp 1- 19

IPCC (2012), 'Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation' A Special Report of Working Groups I and II of the Intergovernmental Panel on Climate Change [Field, C ,B., Barros, V., Stocker, T ,F., Qin, D., Dokken, D,J., Ebi, K,L., Mastrandrea, M,D., Mach, K,J., Plattner, G,K, Allen, S,K., Tignor, M & Midgley P,M., (eds.)], Cambridge University Press, Cambridge, UK, and New York, NY, USA, pp. 582.

IPCC 2014a, 'Climate Change 2014: Synthesis Report' Contribution of Working Groups I, II and III to the Fifth Assessment Report of the IPCC [Core Writing Team, Pachauri RK, & Meyer LA, (eds.)], IPCC, Geneva, Switzerland, pp. 151.

IPCC 2014b, 'Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects' Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Field, C,B., Barros, V,R., Dokken, D,J, Mach, K,J., Mastrandrea,M,D., Bilir, T,E., Chatterjee, M., Ebi, K,L., Estrada, Y,O., Genova, R,C., Girma, B., Kissel, E,S., Levy, A,N., MacCracken, S., Mastrandrea, P,R., & White L,L.,(eds.)],Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 1132.

Kibassa, D. (2013); 'Indigenous Rain Water Harvesting Practices for Climate Adaptation and Food Security in Dry Areas: The Case of Bahi District' ATPS Research Paper No.22

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

Mandleni, B. & Anim F. D. K., (2011). Climate Change Awareness and Decision on Adaptation Measures by Livestock Farmers in South Africa. *Journal of Agricultural Science.* 3:3

Mary, A.L. & Majule, A (2009), 'Impacts of climate change, variability and adaptation strategies on agriculture in semi-arid areas of Tanzania. *African Journal of Environmental Science and Technology,* vol. 3, pp. 206-218.

Masvaya, E., Mupangwa, W. & Twomlow, S. (2008). Rainfall variability impacts on farmers management strategies and crop yields. Paper presented at the 9thWaterNet/WARFSA/GWP- SA Annual Symposium, Johannesburg, South Africa.

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

Mubaya, C. P., Njuki, J., Liwenga, E., Mutsvangwa, E. P., & Mugabe, F.T. (2010). Perceived Impacts of Climate Related Parameters on Smallholder Farmers in Zambia and Zimbabwe. *Journal of Sustainable Development in Africa*. 12 (5), 170 – 186.

Muchara, B. (2011), Analysis of food value chain in smallholder crop and livestock enterprises in Easter Cape Province of South Africa. MSc Thesis, University of Fort Hare, RSA.

Musemwa, L., Muchenje, V., Mushunje, A. & Zhou, L. (2012). The Impact of Climate Change on Livestock Production amongst the Resource-Poor Farmers of Third World Countries: A Review. *Asian Journal of Agriculture and Rural Development.* 2 (4). 621 – 631.

National population Commission, NPC (2006) population figure. Federal republic of Nigeria, Retrieve from http:// www.npc.gov.NIGIS (2017) Niger State Geographical Information System.

Odjugo, P.A.O.(2010), Regional evidence of climate change in Nigeria. *Journal of Geography and Regional Planning*.;3(6):7-

Okpe, B. E. & Aye, G. C. (2015). Adaptation to climate change by farmers, *International Journal Agriculture and ecology Research.* 2 (1); 46 – 57

Okoroh, J., P., Olaolu, M., O., & Igbokwe, E., M. (2016) Climate change mitigation and adaptation strategies used by farmers. *Journal of Agricultural Extension*. 20 (10); 130 – 142

Oremo, F. O. (2013). ―Small-scale farmers' perceptions and adaptation measures to climate change in Kitui county, Kenya.‖ Available at www. erepository. uonbi. ac. ke (Accessed on 20 April 2014).

Premanandh, J (2011), 'Factors affecting food security and contribution of modern technologies in food sustainability' *Journal of Science Food Agriculture*. vol. 91, (15), 2707-2714.

Rudolf, W. & Hermann, W. (2009) .Climate risk and farming Systems in Rural Cameroon. Instituteof Development and Agricultural Economics. University of Hannover, Germany 21-24.

Sharma, D. D. 2010. People's perception on the effect of climate change - A case study of tribal district of Himachal Pradesh, Reflections of Climate Change Leaders from the Himalayas, Leadership for Environment and Development (LEAD) report, India, New Delhi.

Thornton, P. K.; Jones, P. G.; Owiyo, T. M.; Krusta, R. L.; Herero, M. & Kristyanso, P. (2006). Mapping Climate Vulnerability and Poverty in Africa. Report to the Department for International Development. *International Livestock Research Institute*, Nairobi, 200p.

Ubokudom, E. O., Damian, I., A., Offiong, U. U., & Taofeeq, A. A. (2018). Effective choice of Livelihood Adaptation strategies to climate variability; Empirical evidence from rural farm households *International Journal of development and sustainability* 7 (6), 1992 – 2003.

Umogbai, V. I., (2011) Development of Double-Neck yoke and harness for Animal Traction. *Journal of Emerging Trends in Engineering and applied Sciences*. 2 (1), 87-95

UNFCCC (2008). *UNFCCC* Resource Guide for Preparing the national communications of non-annex 1 parties. Module 2 Vulnerability and adaptation to climate change

Vikas, S., (1967) English, Book, iilustrated edition: Elementary sampling theory by Taro Yamane.

Watts, A. (2012). Global precipitation variability decreased from 1940 to 2009.‖ Available at wattsu with that. com/2012/.../global-precipitation-variability-from-1940 (Accessed on 13 August 2013).

World Meteorological Organization (WMO) 2016, 'Climate and Weather definitions' Available at: https://www.wmo.int/. Accessed on May 20, 2016.

Ziervogel, G., A. Nyong, B. Osman, C. Conde, S. Cortes, & Dowing, T. (2006). Climate variability and change: implications for household food security. Assessments of Impacts and Adaptations to Climate Change (AIACC) Working Paper No. 20, January 2006. The AIACC Project Office, International START Secretariat, Washington DC,USA.

Zoellick, & Robert, B. A. (2009). Climate Smart Future. The Nation Newspapers. Vintage Press Limited, Lagos, Nigeria. P.18.