VULNERABILITY OF FOOD CROP FARMERS IN OSUN STATE TO CLIMATE CHANGE

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DEDICATION

This work is dedicated to God the Father, the Son and the Holy Spirit.

ABSTRACT

The uncertainties and variation in the pattern of weather have adverse and devastating effects on food crop production in Nigeria. Dependence on weather and low adaptive capacity due to low technology level makes food crop farmers vulnerable to change in climate. Studies have always focused on effects of change in climate on crop productivity, but empirical information on vulnerability of food crop farmers to change in climate is not well documented. Hence, vulnerability of food crop farmers to change in climate in Osun State was investigated.

A three-stage sampling procedure was used to randomly select a Local Government Area (LGA) from each of the three senatorial districts in Osun State. Thirty percent of the communities were randomly selected from each LGA. Systematic random sampling was used to select 270 households proportionate to size of the communities. Using a structured questionnaire, data were obtained on farmers' socio-economic characteristics (age, sex, marital status, educational status, household size and farm size), distance to farm, perception of change in climate (drought, rainfall, flood and changes in temperature) and adaptation strategies employed (crop diversification, change in planting and harvesting time). Vulnerability index was generated from Principal Component Analysis based on the extent of (0-2 = most; 3-5 = more and 5-6 = least) vulnerability of the farmers. Change in climate Adaptive Index was based on number of strategies employed (1 = low; 2 = medium, and 3 = high). Data were analysed using descriptive statistics and Tobit regression at $\alpha_{0.05}$,

Age of the farmers was 49.6±12.4 years with 76.1% being male, 86.6% were married and 49.4% had at least secondary education. Farm size was 3.1±3.4 hectares with farm distance of 2.7±2.7 kilometers to homestead. Extremely high temperature (41.7%) and prolonged rainfall (37.7%) were the most perceived change in climate indicators. Vulnerability index was low among farmers that were above 60 years (0.2), households with more than 6 members (0.3), land size above 5 hectares (0.5), and the widowed (0.2). Major adaptation strategies were crop diversification (42.9%), change in planting and harvesting time (38.9%) and diversification into non-farm activities (27.1%). A higher percentage of the farmers (55.9%) with low change in climate adaptive capacity were the most vulnerable. Number of farm plots (β =0.02) and access to extension services (β=0.06) were found to significantly increase probability of farmers adaptation to change in climate, while age (β=-0.01) reduced it. Vulnerability of food crop farmers to change in climate was significantly increased with drought (β = 2.38), changes in temperature (β = 0.59) and occurrence of flood (β =1.68), while farm size (β=-0.08) and crop diversification (β=-3.18) reduced it.

Vulnerability of food crop farmers to climate change was high with older farmers, large farming households and farmers with land size above five hectares in Osun State.

Keywords: Change in climate, Adaptation strategies, Vulnerability of farmers, Vulnerability index.

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CERTIFICATION

This is to certify that this project work was carried out by OPEYEMI ABIMBOLA LONGE under my supervision in the Department of Agricultural Economics, University of Ibadan.

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CHAPTER ONE

INTRODUCTION

1.1 Background to the Study

Globally, climate change refers to natural phenomenon that has been subjected to too much consideration and which is seemingly unebbing. This is because it has emerged as one of the significant challenges which pose serious risk and deprivation for crop farmers not just in the growing nations, but as well as in the industrialized nations. Worthy of note is that change in climate has eventuated to planet warming which resulted in rainfall pattern shifts and natural events like droughts', floods, wild forest fires which have become rampant. In essence, Agricultural yields also become more unpredictable, thereby making farmers more vulnerable with particular reference to Africa (UNFCCC, 2006).

According to World Bank (2003), the recurrence of overwhelming precipitation occasions has expanded over most land territories and far reaching changes in outrageous temperatures has been recorded in the last 50 years. These ongoing trends show an inclination towards more noteworthy extremes where arid or semi-arid regions particularly in northern, western, eastern and parts of southern Africa will turn out to be relentlessly drier, with expanded extent and inconstancy of precipitations and storms. Atmosphere science argues that regardless of whether all anthropogenic ozone depleting substance emanations stopped instantly, the world is still bound to experience significant environmental change, (Intergovernmental Panel on Change in climate IPCC, 2007; JNCC, 2008). In furtherance of this phenomenon, farmers (who comprise the main fraction of the impoverish people in Africa) are face with the possibility of poor yield, decreased rural efficiency, shrinking economic income, lack of healthy sustenance and ailments (Zoellick, 2009). In the light of this, it is estimated that harvest yield in Africa may go down by 10-20% by 2050 or even up to 50% because of change in environmental (Jones and Thornton, 2002), particularly when it is evident that African agribusiness is overwhelmingly precipitation-sustained and henceforth subject to the ideas of climate alterations (Ozor *et al.*, 2010).

Change in climate can be described as the alteration in the mathematical allocation of weather conditions about an average in a period of time that vary from decennia to megs of time (Wigley, 1999). Almost in the same manner, Onyimonyi (2012) viewed change in climate as a progression through which the usual climate conditions of a given area within a stretch of time become dissimilar as against the usual. Vulnerability to change in climate in the African continent, limits the viability of improvement intercessions and calls for more prominent endeavors in lessening the rate of earth-warming globally. This issue then calls for mechanized nations to accelerate efforts to reduce their emissions of greenhouse to evade risky alteration in climate. Farming promotes almost 50% portion of the world's emissions of two most powerful ozone depleting substances; methane and nitrous oxide (World Bank, 2008). This is so because agricultural production comprises the utilisation of composts; raising of animals and related land clearing that impact the two levels of ozone depleting substances outflow in the environment and as well with the potential for carbon graduation and stockpiling (Mark *et al.*, 2008). The African continent including Nigeria is striving to overcome poverty and at the same time advance economic growth, but this change in climate phenomenon is threatening to further entrench vulnerabilities, disintegrate well-earned positive results and truly weaken development predictions (WBGU, 2004).

1.2 Statement of Research Problem

The African continent risks becoming a major global food crisis epicenter if climate change issues remain unaddressed at local levels. The vulnerability of African communities to climate change is exacerbated by high poverty levels, high temperature and low precipitation (Bunce *et al.*, 2010). The International Energy Agency stated that sub-Saharan Africa is a minor contributor to global CO_2 emissions with just about 0.9 metric tonnes or 1.7% or less than 4% of global annual carbon-dioxide, CO_2 emission (Ball, 2008). The minor contribution of Africa to global Green House Gases (GHG) emission is related to the low level of industrial activity (Paehler, 2007).

Agriculture is the mainstay of most rural economies in Africa. However, negative developments such as adverse consequences of climate change are obvious if not devastating, especially in Nigeria where it affects farmers as a result of low technology levels, weak purchasing power due to poverty and reliance on the environment and natural resources for livelihood (Oyekale, 2008). This suggests a usual instance of negative endless impacts, and externalization of costs: in which a non- involved party bears the costs of a third party's actions (Medugu, 2008). Thus, the low level of technology which pervades livelihood in sub-Saharan

Africa ensures that climatic factors have serious consequences for numerous farmers and non-farmers whose livelihoods are heavily intertwined with the climate.

Furthermore, the impact of climate change has affected humanity in multifarious fronts, of which one is the unfavourable effect on production of food. As such, alteration in climate, said to be attributable to common atmosphere cycle and human exercises, has led to low agricultural products. Evidence abound that change in climate has indeed affected harvest income in several nations (BNRCC, 2008; Deressa *et al.*, 2008; IPCC, 2007), especially countries with low-income (Apata *et al.*, 2009; SPORE, 2008). Aside from this, numerous African nations are especially defenseless against change in atmosphere (Mendelsohn *et al.*, 2006).

The advancement of dynamic agricultural processes, equipped for adjusting to the difficulties of alteration in the atmosphere, requires a helpful and consistent policy regime (Enete and Amusa, 2010). This has practically been inadequate/lacking in Nigeria as substantive governments regularly influence a U-to turn on strategies set up by their antecedents. This is asserted by Enete *et al* (2008) who opined that weak infrastructure and irregularity in government arrangements have dependably been the significant tangles in the improvement of farming in Nigeria. This increases farmers vulnerability to the impacts of atmospheric change (Action Aid, 2008) and it is predicted that it will result in a 50% reduction in the agricultural output of some African countries by 2020 (IPCC, 2007). In the North, declining precipitation and rising temperatures portend more droughts thereby creating shift of human population and livestock including cattle and poultry which are the most important sources of animal protein sources in Nigeria. These have led to the movement of the cattle rearers to the south leading to encroachment and destruction of farmland and may lead to serious food insecurity issues if not dealt with very soon.

Lack of appropriate safety nets and social protection mechanisms to cater for needs of vulnerable members constitute another serious issue, at the present. Climate change is thence perceived as a major multiplier of hunger-risk except serious measures are taken, and nations find measures of diminishing the effect of ozone depleting substance discharges from the environment, it will be progressively troublesome and costly to adjust to change in atmosphere as currently, there are challenges of which include sparse and badly prepared climate stations, and horticultural foundation (Odjugo, 2010).

World Bank (2006) detailed the presence of deficient storerooms and decaying farming foundation in Nigeria. In expansion, the main little part of the national grain stockpiling frameworks that were built in the nation are not appropriately overseen and the whole system is a long way from being finished (Mogues, *et al*. 2008). The deficiency of storerooms postures genuine dangers to agriculturists in nourishment conservation, most particularly amid collect periods. Thus, most yield agriculturists are frequently in a race to send cultivate deliver to showcase instantly after reap, not disapproving the related low costs. This could go about as a disincentive to interest in agribusiness and thus predict genuine dangers to rural adjustment to change in atmosphere. The financial rebuilding being executed in Nigeria has for the most part caused some macroeconomic shakiness. Today, ranchers have kept on confronting horrible terms of exchange and poorer access to numerous horticultural data sources, for example, enhanced seed and agro-synthetic compounds, and also lower and more dubious nourishment costs. As a component of the auxiliary change process, governments have concentrated on the center assistance parts of Ministries of Agriculture (MOA).

There is an advancing accord in the academic writings that over the coming decades, higher temperatures and changing precipitation levels caused by change in atmosphere will cause low yields in various countries (Fischer, 2005). This is especially valid in low-salary nations, where versatile limits are seen to be low particularly in the rural area of southwest of Nigeria where the study area is situated. Numerous African nations including Nigeria, which have economies to a great extent in light of climate delicate rural preparations system, are especially helpless against change in atmosphere (IFPRI, 2008). Therefore, the study will seek to provide answers to the following research questions:

i. What are the perceived effects of climate change on farming households?
ii. What is the extent of vulnerability of farming households to climate change?
iii. What are the factors influencing farmers' vulnerability to climate change?
iv. What are the adaptive strategies to climate change in the study area?
v. What are the factors influencing the choice of farmers' adaptation strategies?

1.3 Objectives of the Study

The general objective of this study is to assess the vulnerability of farming households to climate change in Osun State. The specific objectives are to:

i. profile the perceived effect of climate change on food crop farmers in the study area;
ii. assess the vulnerability status of food crop farmers to climate change;
iii. examine the factors influencing crop farmers' vulnerability to climate change in the study area;
iv. identify the adaptive strategies adopted by food crop farmers in response to climate change in the study area;
v. examine the factors influencing the choice of adaptation strategy by the farmers.

1.4 Justification of the Study

Studies abound about the industrial countries advances in agriculture and the challenges they face with how those challenges were surmounted (Wigley, 1999; USAID, 2007; Biermann, 2007). Also, there exists studies about Nigeria's farming activities and the effects of climate change (Onyenekwe and Madueke, 2010; Falola *et al.*, 2012, Adesina and Odekunle, 2011; Madu, 2012; Ajibola, 2014). However, despite the magnitude of adverse and dysfunctional consequences of change in climate on food crop production, available studies have largely focused on overall agricultural productivity, adaptation measures and mitigating approaches (Oyekale 2009; Adesina and Odekunle, 2011; Madu, 2011; Ajibola 2014). This research will therefore add to literature on this important area of agricultural research in rural Osun State.

More work on effects of vulnerability and adaptations is nevertheless required, mainly at the regional level (UNFCCC, 2006) as these will be used to generate the composite vulnerability index and change in climate adaptive indices. Furthermore, there are a few studies that have explored changing farming practices in relation to vulnerability in Nigeria. This research thus determines to contribute to research and literature by assessing farmers' adaptation strategies in relation to their vulnerability to climate in change in Osun State Nigeria.

This work carried out an exhaustive scrutiny of the local level exposures by incorporating quantitative examination together with qualitative data gathered from field survey for primary data. Therefore, this study resolves to have a composite vulnerability index and change in climate adaptive indices that can vividly portray the extent of vulnerability and changing farming practices of the households using the Principal Component Analysis (PCA) and Change in Climate Adaptive Index (CCAI) respectively. Over the years, people had undertaken many adaptation measures like livelihood diversification to cope with these vulnerabilities and effects. However, little is known about land sustainability methods in the face of change in climate in Nigeria as adaptation strategies. The farmers need to take decisions on soil conservation techniques based on their level of indigenous knowledge. Therefore, there is the need to understand the land sustainability techniques available to the farmers and the relevance of these techniques in the face of consistent influence of change in climate in the area of study.

Furthermore, plan of action reactions to change in atmosphere fluctuation have been for the mostly determined by wrangles among researchers, while the bits of knowledge of poor individuals living where the phenomenon persists have been generally disregarded (Mutekwa, 2009). Doss and Morris (2001) opined that the points of view of the indigenous individuals, the way they think and carry on in connection to change in atmosphere, and additionally their qualities and desires have a critical part to play in tending to change in atmosphere. In spite of this, indigenous and other customary individuals are just once in a while considered in scholarly, arrangement and open talks on change in atmosphere, regardless of the way that they are significantly affected by approaching changes of atmosphere and most vulnerable (Berkes and Jolly, 2001; Ajibefun and Fatuase, 2011). This study will reveal the extent of farmer's vulnerability to change in climate and as well, the land sustainability measures they're using to surmount the circumstances. A research of this nature will assist in giving a structure to approach detailing and better research introduction.

1.5 Plan of Study

This study is divided into five chapters. Chapter One constitutes the background to the study, problem statement, justification, objectives of the study and plan of the study. Chapter Two dwells on theoretical framework, conceptual framework and review of empirical studies. Chapter Three describes the research methodology that will be used for the study; Chapter Four discusses the results and findings. Chapter Five contains a summary of major findings, conclusion and recommendations.

CHAPTER TWO
LITERATURE REVIEW

2.1 Theoretical Framework

2.1.1 Theory of Anthropogenic Global Warming

This study's theoretical framework is derived from the drivers of climate and human systems as they affect human existence (e.g. solar radiation, ocean circulation, population trend and urbanization). This study is also built on the theory of Anthropogenic Global Warming. The theory argues that human being discharges of green-house gases (GHGs) especially Carbon (IV) Oxide (CO_2), Methane and Nitrous Oxide account for the sustained rise in global temperatures (Maslin *et al.*, 2004). The situation is called enhanced green-house effect. This can be constructed to imply that the sun radiates energy through space to the earth. The atmosphere is permissive to the light rays from the sun whence several of it (rays) get immersed and the rest mirrored back as heat in the atmosphere.

According to Doll and Baranski (2011), there are a few gases in the climate known as "green-house gases" that ingest the active reflection or inward warm radiation bringing about earth's environment getting to be hotter than it ought to be to this end. Water vapor is the real green-house gas representing around 36 to 90 percent of the green-house impact, trailed by CO_2 (<1 to 26 percent), Methane (4 to 9 percent) and Ozone (3 to 7 percent) (Bast, 2010). In recent times, human exercises, for example, consuming of wood, bush and fossil fuels, deforestation, and gas flaring among many others are said to have increased CO_2 concentration by almost half. The sustained high level of fossil fuel burning furthermore, deforestation could twofold the measure of CO_2 in the environment in the following 100 years supposing nature does not regulate the trend (Bast, 2010).

In the global world, climate responds to various sorts of outside impacts, for example, fluctuations in solar heat and earth's trajectory. However, these "forcings" impact as per the opinions of AGW theory are not sufficient to clarify the ascent in earth's temperature over the past natal cycles or 25 years. They claimed, the man induced green-house gases forcing is little however, positive feedbacks increase the effects of the gases by 200-400%. Therefore, units rise in temperature results in more than proportionate rise in evaporation which releases more water vapor into the atmosphere hence more warming. They further explained that 0.7°C warming of the last 150 years and 0.5°C in the past 30 years can be attributed to man-made green-house gases. They predicted the doubling of CO_2 in the atmosphere would result in a 3°C increase in atmosphere's high temperature by year 2100 (Ologunorisa, 2011).

The advocates of AGW hypothesis guaranteed man-made CO2 is in charge of surges, dry seasons, extraordinary climate conditions, failures of crop, loss of biodiversity (flora and fauna), spread of diseases, food insecurity, conflicts, power problems (for economies that rely on hydroelectric power) among many others (Bast, 2010). They opine a substantial and rapid reduction in human emissions (mitigation) is the only remedy for the impending dangerous events. This theory explains how greenhouse gases are emitted and these gases continuous emission lead to depletion in ozone layer, thereby exposing the ozone layer to different effects of climate change and variability. These observed climate changes directly affect farmers and reduce crop production across sub-Sahara Africa. This study conceptualizes the anthropogenic global situation in terms of resultant effect which leads to climate change.

2.1.2 Theory of Adaptation

There are three paradigms used to clarify determinants and conduct of farmers in embracing another innovation. Innovation in this regard means method of reducing the effect of climate change on the farmers. They are the economic constraints, adoption perception, and innovation-diffusion model.

Innovation-diffusion model

There are four components in the diffusion of innovation model. The proponent (E.M. Rogers) of innovation-diffusion theory characterizes innovation as a thought, put into practice or task seen as innovative by a person or different reception units (Rogers, 2003; Sahin, 2006; Robinson, 2009). The term innovation is relative as an individual calls something new based on his/her exposure to the process. The newness characteristic of an adopted innovation is inherent in three steps (Knowledge, Persuasion and Decision) (Sahin, 2006; Robinson, 2009; Evangelista, 2011).

However, an innovation can be an instance of an adaptation method and its diffusion is the measure and level of acceptability of such adaptation methods by the farmers. From the newness characteristics of an adopted innovation, the three key steps of knowledge, persuasion and decision is used. Farmers must be knowledgeable or have the knowledge about climate changes, so as to adopt or adapt to any mitigation options. Some farmers will be persuaded in order for them to embrace the new adaptation methods, while other farmers will make the decision easily to adopt the new mitigating options in respect to climate change. The following are the four elements of Innovation-diffusion model:

a. **Uncertainty:** Uncertainty is a serious obstacle to the adoption of innovations. The consequence of changes of an individual or a social system is uncertainty. The consequence then materializes through the difference between "what used to be" and "what is" of an individual as a consequence of the acceptance or otherwise of a novelty. The decrease in the level of uncertainty resulting from innovation/ technology is often implicit in the exposure to information based on the merits and de-merits of their actions. (Evangelista, 2011).

   To this end, the outcomes of climate change adaptation process can be attractive versus bothersome, coordinate versus aberrant (prompt outcome or a result of quick outcome) and foreseen versus unforeseen (acknowledged and intended or not).

b. **Communication Channels:** Communication channel is very critical to the adoption of an innovation. For this study, innovation is the adaptation strategy "S_n" that a farmer "F" has not accepted before but is capable of being picked out of available strategies "S_t". Communication occurs through channels. Communication is the process by which messages are transferred from a sender to the receiver with appropriate feedbacks to the sender given the communication channel. Communication could be through "one on one" contacts, group contacts, oral media and mass media. Similarly, diffusion is a product of communication. It is a social process involving interpersonal communication relationships resulting in transfer of technology (Fregene, 2009). In adopting a new innovation, the importance of communication cannot be over-emphasised. Hence, in climate adaptation theory, effective communication of new adaptation strategies to affected farmers is of utmost importance.

c. **Time:** Rogers (2003) explained time as critical in any innovation-diffusion procedure, categorization of adopter and adoptions rate. Meaning, this adaptation processes should be communicated to the vulnerable farmers at the right season in order for the efficient use of available information to reduce the effect of climate change on their farm output.

d. **Social System:** The social framework (or system) is the last component in the dissemination (otherwise called diffusion) procedure. A social system refers to a series of interconnected and interdependent segments interacting towards solving problems for the achievement of predetermined objectives. However, the social structure is the major determinant of diffusion within a social system (Sahin, 2006). Innovation decisions follow a five-step procedure i.e. Awareness (knowledge), Interest (love development for the phenomenon), Evaluation (assessment of the phenomenon), Trial (testing the usability and usefulness of the phenomenon) and Adoption (actual utilisation) (Fregene, 2009).

- Awareness stage: Awareness is the level at which the new innovation is introduced to a potential adopter using appropriate communication channel.
- Interest: Interest is created when the individual (potential adopter) develops a negative or positive mind-set in the direction of the novelty. This involves asking questions from the sender on the message to help judgment on the use.
- Evaluation stage: is the stage at which the individual processes information he/she was given on the innovation. It involves counting the cost and benefit within the context of farm objectives.
- Trial stage: This involves the potential adopter trying out the innovation in small quantities to see if it will work as promised/stated or not.
- Adoption: This is the product of evaluation of the outcome of the trial stage which could show the way to the final scale implementation of the novelty (Ovwigho, 2013).

According to Rogers (2003), innovation decision is a product of cost-benefit analysis whereby the major obstacle is uncertainty. The underlying assumption is that people are rational and they adopt innovations that enhance their utility. Therefore, they must be sure the innovation yields more result than the idea it precedes before they adopt it. The level of disruption of routine activities is seen as costs and the compatibility with the daily habits and user friendliness are factors to be considered in adoption.

Within this context, novelty choice procedure is referred to as the psychological course of action in the course of which a personality passes from knowledge, attitude, implementation and confirmation of their decision. In this manner, an individual person accumulates information at the different stages of the decision for innovation course so as to minimize risk of vagueness as regards the invention’s anticipated consequences. This makes Innovativeness to be important in the adoption process. In fact, the notion of innovativeness can be divided into five divisions. These are:

(i) Innovators

(ii) Early Adopters

(iii) Early Majority

(iv) Late Majority and

(v) Laggards

A fruitful advancement takes after a belly molded or S-formed dispersion bend for its subordinate and it takes after normal circulation (Dearing and Permanente, 2012). Innovators: Innovators are defined as adventurous and educated as they have affinity for new ideas. They are willing to accept the challenges inherent in new technology use. They are said to constitute about 2.5% of all the adopters.

Early Adopters: The social leaders, popular people and opinion leaders belong to this category. They are willing to try new ideas but they are careful about it. Early adopters are fascinated by high reward projects and high risk. They do not consider the cost of the novelty so long the long-standing gains are guaranteed. This cluster accounts for 13.5% of all adaptors.

Early Majority: These are the careful but thoughtful adopters. They accept change more quickly than the average. They have access to information than others and they are seen as opinion leaders. Adoption of innovation by this category is a pointer that a large number of people will follow suit. They constitute 34% of the adopters.

Late Majority: The fourth category of adopters is the late majority. They are skeptical people and they adopt new technologies when they have seen others try it. They have lower socioeconomic status and they are extremely price sensitive (Evangelista, 2011). They constitute 34% of all the adopters.

Laggards: They are people that adopt innovation when it is no longer new. They strive to maintain status quo and as such are not open to new technologies. They constitute 16% of all adopters.

In summary, in climate-adaptation studies, the effective passage of information (communication channels) cannot be over-emphasized. This is because, rural farmers comprise of different set or group of people like innovators, early adopters, early and late majority and laggards. This invariably dictates their level of participation in climate adaptation process which has a direct effect to their vulnerability to climate change. It is of great relevance that the interest of the farmers is built in the adaptation processes as they evaluate the novelty in order to give a trial on their farmland, and if the results are impressive, moving forward to reduce their level of vulnerability to climate change, the farmers will begin to adopt these mitigation strategies.

2.2 Concept of Vulnerability and Adaptation

2.2.1 Vulnerability to Climate Change

Literature is replete with many definitions of vulnerability. According to UNDP (2004), vulnerability has been defined as a human condition or process happening in light of physical, social financial and common variables which decide the probability and size of harm from the effect of a given danger. In this way, vulnerability is explained as the danger of antagonistic results to presentation by human gatherings, biological system and networks to changes in atmosphere and the degree to which a framework is delicate or unfit to adapt to unfavourable impacts of atmosphere inconstancy's and extremes. Accordingly, its capacity of character, magnitude and rate of atmosphere variety to which a framework is uncovered, its affectability and versatile limit. IPCC (2001).

Okunmadewa (2003) saw defenselessness in the probability of a stun, causing a noteworthy welfare misfortune. He opined that weakness relies upon presentation to dangers (indeterminate occasions that can prompt welfare misfortunes) and on chance administration moves made to react to dangers, which might be ex-stake (previously) or ex-post (after). In this way, it is the extent to which a framework is sensitive and predisposed or incapable to handle with the negative symptoms of change in climate. Almost within the same context, Santiago (2001) described susceptibility as the amount a characteristic or societal framework is helpless in supporting harm arising from environmental alteration. This can be constructed to connote susceptibility inclusive of climate variability and extremes.

As such, vulnerability isn't just a component of presentation; however it is likewise of individuals' inclination to adjust to change. Using the World Bank (2004) article of weakness as a concept, this implies affinity of a general public (family units) to encounter generous harm and interruption on aftereffects of risks (e.g. conflicts, flood, drought etc). If lack of capacity by the people to adjust to change stays unaltered, exposure to increase in change of climate will eventually leads to increase in vulnerability. In this manner, defenselessness is caused by imbalance, improper administration structures and maladaptive monetary and agrarian advancement (Jagtap, 1995). In Nigeria as a country, the vulnerability of farming households can be viewed in terms of the difficulties facing each household, which hampers the maximization of agricultural products. This can be separated into stuns and drifts. The stuns regularly include: pest, diseases and drought and flood while patterns incorporate change in costs, irregularities in strategies, insufficient access to credit and deficient labor amid agricultural seasons.

2.2.2 Adaptation to Climate Change

The concept of adaptation is eclectic as it is a product of many disciplines. As an agricultural concept, the concept adaptation means whichever variation, regardless of regardless of whether inert, responsive or eager that is proposed as strategies for improving the anticipated antagonistic consequences related with ecological alteration (Alao, 1999). These suggest that it is the practice that people use to deal or contend with changes in climatic condition. From this perspective, adaptation is acclimation to or mediations, which happen with a particular true objective to manage the hardships or adventure the open entryways introduced by an evolving atmosphere (IPCC, 2001). Adaptation is the way toward enhancing time scales, from here and now (e.g., regular to yearly) to long haul (e.g., decades to hundreds of years). In this manner, it is also a step of muddling through to fit in an environment that has been altered by change of climate. The IPCC (2001) posits that adaptive capacity is the capability of a framework to acclimate to environmental change (climate extremes and change inclusive), to direct potential harms, to exploit openings, or to adapt to consequences. The objective of adjustment measure should be aimed at building the limit of a framework to survive external changes and shocks.

As indicated by Santiago (2001), adaptation includes acclimation to upgrade the practicality of economic and social exercises and to lessen their defenselessness to atmosphere, including its present fluctuation and outrageous occasions and also longer-term environmental change. Accordingly, adjustment to atmosphere is the blend of past understanding through which individuals lessen the symptoms of atmosphere on their wellbeing and personal satisfaction and exploit opportunities that their climatic condition gives. As far as the IPCC Third Assessment Report is concerned, adaption can possible lessen unfriendly effects of environmental change and to improve valuable effects yet will bring about cost and would not keep all harms. Imperative adaptation adjustment alternatives in the agric sector incorporate mixed cropping, crop diversification, utilising varieties of different crops, livestock farming, and sensitive high yield water crops (Jagtap, 1995). Adjustment in agriculture includes two sorts of alterations in the system of production. The number one is diversification increase which includes activities of production engagement which are tolerant to drought and stresses of temperature resistance so also the activities making efficient utilisation and taking the advantage fully of the water and temperature conditions, not jettison other factors. Yield enhancement can fill in as protection against precipitation inconstancy as various products are influenced contrastingly by atmosphere occasions.

The second procedure centers practices of management of crop aimed at securing the stages of growth of crop did not collude with extremely harsh condition of the climate, such as dryness in the mid season. Besides, crop farmers conform to drought by broadening developing seasons because of unforeseen environmental change and building water system framework with a specific end goal to upgrade item yield. The versatile choice made by these product farmers because of the regular variety in atmosphere factors are affected by some financial factors, for example, family unit asset and attributes, access to data and accessibility to formal organizations (information and yield markets) for even dispersion and utilisation. In aggregate, adjustment to environmental change involves changes in agrarian administration rehearses because of transformations in atmosphere conditions. This inculpates a mix of various individual reactions at the homestead level. It additionally surmises that yield agriculturists approach elective practices and advancements accessible in their home.

2.3 Empirical Framework

In this section, studies were reviewed on climate change in Nigeria, climate change impacts and its effect on agriculture, adaptation to climate change and the methodological review.

2.3.1 Climate Change in Nigeria

Presently, change in climate is bearing a momentous negative consequence in Nigeria, with the possibility of further future effects. It is estimated that, without adjustment, change in atmosphere could bring about lost in the vicinity of two and eleven of Nigeria's GDP by year 2020. The figure is projected to increase to in the vicinity of six and thirty percent constantly 2050. This misfortune is equal to between fifteen trillion naira or one hundred billion dollar and sixty-nine trillion naira or four hundred and sixty billion naira. The anticipated cost is the consequence of an extensive variety of atmosphere impacts as it affects the different sectors of the Nigerian economy (BNRCC, 2011).

No doubt Nigeria is among the highest greenhouse gases emitters in Africa. The bulk of these greenhouse gases come from generators, motor vehicles, waste dumps, bush burning, agricultural activities, deforestation, and gas flaring among many others (Ugwuoke *et al*., 2012). Change in climate is a serious environmental challenge in Nigeria. Rise in temperature of between 0.2°C and 0.3°C per decennium has been experiential in diverse environmental climatic zone of Nigeria. The Sudan-sahel regions have been witnessing persistent droughts since the late 1960s (Odjugo, 2010, Ologunorisa, 2011, BNRCC, 2012). In contrast, precipitation increase of about two to three percent for each of the quantities of global warming is envisaged in tropically humid areas of Nigeria. Thus, it is not out of place to anticipate that precipitation level will rise by about five to twenty percent in the exceptionally damp zones of the backwoods locales and southern savannah regions. However, increment in temperature in those zones would likewise prompt increment in evaporation influencing the precipitation to increment inadequate (BNRCC, 2012). The Inter-Governmental Panel on Change in Climate, (IPCC, 2007) predicts a rise in rainfall level in the very humid regions of Nigeria. This could result to increase in cloudiness which can affect visibility of airplanes, cars etc and rainfall intensity especially in severe storms. Change in climate effect similarly materializes in increased rainfall level which could also shift patterns of geographical precipitation and alterations in the environmental sustainability (BNRCC, 2008; BNRCC, 2011).

Therefore, since rise in high temperature might synergise vaporisation and evapotranspiration consequently, there could be droughts in components of the wet areas of Nigeria. Infact empirical researches have demonstrated that the Sudan-sahel savannah area of Nigeria has persevered through a decreasing in precipitation in the extent of around 30-40% (3-4% consistently) since the beginning of nineteenth century. The condition may compound from diminish in precipitation with abnormal state of vulnerabilities (Odjugo, 2010).

Within this perspective, climate in change is a grave environmental challenge in Nigeria. As pointed out by Banire, (2012) Nigeria has a peculiarity as a nation because while other nations have only either the problem of flooding, desertification or erosion, all are witnessed in Nigeria. Resultantly, the environmental effects of change in climate in the country effectually abound. An example is the average ambient temperature between 1901 and 2005 was 26.6°C while temperature increased by 1.7°C. This is well above the universal average temperature intensify of 0.74°C experience beginning from inception of measurement of temperature scientifically in 1860 (Spore, 2008; Odjugo, 2010; Falaki *et al*., 2013). Should this pattern proceed unchecked, Odjugo (2010) anticipated that Nigeria may involve between the center of 2.5°C and high 4.5°C hazard temperature (IPCC, 2014) constantly 2100. Odjugo (2010) additionally demonstrated that precipitation slant in Nigeria in the vicinity of 1901 and 2005 dropped by 81mm. He further stated that in spite of the fact that there is a general abatement in precipitation in Nigeria, the beach front regions of Nigeria like Warri, Brass and Calabar are seen to encounter marginally expanding precipitation as of late (Odjugo, 2011). This, as per IPCC (2007b) followed this to environmental change in light of the fact that an outstanding effect of environmental change is, rising precipitation level in most beach front regions and diminishing downpours in the mainland interiors.

Furthermore, the frequency of precipitation time plunged by 53% and 14% in Northeastern Part and Niger-Delta coastal regions of Nigeria correspondingly. Odjugo (2010) reiterated that while the regions encountering twofold precipitation maximal is moving South-ward, the diminutive waterless time of year known as (“August Break”) is now a July phenomenon as against its typical event in August before the 1970's in Nigeria. Falaki *et al*., (2013) have also corroborated this by pointing out that numerous waterways have been accounted for to have gone away or are ending up more occasionally traversable in Nigeria while Lake Chad contracted in territory from 22,902 km2 in 1963 to a simple 1304 km2 in 2000. This demonstrates what is left of Lake Chad in the year 2000 is only 5.7% of 1963 (Vincent, 2009; Odjugo 2010; Ologunorisa, 2011). Abubakar (2009) and Vincent (2009) likewise affirmed the way that Lake Chad has contracted by over 90% since the 1960s. These are noticeable changes in the climatic patterns of Nigeria establishing the existence of the negative side effects of change in climate.

Consequently, environmental change has antagonistic impact on human wellbeing as it expands wellbeing dangers, aside from the genuine negative reaction on crops. The effect of environmental change on human wellbeing can be immediate or coincidental. As indicated by BNRCC referred to in Eke and Onafalujo (2012), the immediate outcomes of environmental alteration in Nigeria incorporate cardiovascular respiratory issue of the aged, meningitis of the cerebra-spinal, malignancy of skin, hypertension, intestinal sickness, cholera and environmental change posture extreme danger on kid and maternal mortality. The threat of climatic changes if unmanaged is clear in the expansion in horribleness rate caused by worsening of old and new viscera wellbeing dangers like skin tumor, hypertension, warm stroke, flu, psychosis and conceivable hypochondria.

Environmental change is a factor fit for expanding the recurrence and seriousness of sick wellbeing or instantiate it (Eke and Onafalujo, 2012). Wellbeing is imperiled when encompassing temperature turns out to be high to the point that it influences the Central Nervous System (CNS), along these lines encouraging hypertension. The entrance of bright beams causes skin tumor and hatchling in pregnant lady is in danger if presented to bright beams as ozone layer keep on being exhausted (Popoola, 2014). This is not unconnected to high level of child mortality in developing countries (Eke and Onafalujo, 2012). The resultant effect of ocean and sea level rises during rainy seasons is a higher probability of flooding. This makes poor households vulnerable to malaria, cholera and pneumonia (Eke and Onafalujo, 2012).

2.3.2 Climate Change Impacts and Effect on Agriculture

Change in climate impacts can be categorised into two groups. These are: biophysical and socioeconomic impacts.

a. Biophysical impacts: The biophysical impacts entail the physiological consequences and degradation of biophysical conditions on pasture, crops, livestock and forests (quality), water resources, changes in land, and soil (quality), shifts in spatial, increased weed and pest challenges, sea level rise, temporal distribution of impacts, sea temperature rise and changes in ocean salinity which causes aquatic animals to dwell in unusual abode.

b. The socioeconomic impacts: These entangles reduction in production and crops, diminished minimum Gross Domestic Product (GDP) agriculturally, prices in world market fluctuations, variation in regimes of trade geographically, and numerous individuals in danger of hunger and sustenance instability. Change in climate poses grave and elongated time confrontations which have negative possibility of influencing the global world in its entirety. However, the Least Developed Countries (LDC) is the majorly susceptible to the concomitant side effect of climate change. This is due to the fact that poverty inhibits adaptive capacity of the people and sustainability in the environment is very germane for human and economic development.

According to Okali (2010) precipitation inconstancy isn't the main exogenous factor influencing farm yield and wage. In any case, it is a noteworthy imperative of wage amplification and prosperity of rural family units. Environmental change affect as a rule, upsets regular cycle, in this manner hurting biological systems, adjusting water supply influencing farming and causing critical ascent in ocean level. Atmosphere inconstancy has consequential effect on the sector of agriculture from its greater impact on agricultural yields, selection of agricultural advances, total nourishment generation, prices of the market and monetary improvement. The effects of atmosphere fluctuation are both ex post and ex risk. Ex post impacts infer the misfortunes that accumulate from an atmosphere stun. Atmosphere extremes created from atmosphere stun, for example, dry seasons and surges when combined with weakness to these perils through the presentation of networks and framework that add to low rural execution. On account of *ex ante* impacts, they mean the open-door cost related with moderate techniques that hazard loath chiefs receive ahead of time to shield themselves from the massive of atmosphere stuns. In any case, to isolate the ex post from exante effects of atmosphere fluctuation is frequently exhausting from a methodological perspective. In any case, a mix of risk presentation and helplessness, poor creating countries encounter atmosphere related mishap such as drought, flood, land degradation, landslides and famine which are products of change in climate. Hence, as the weather becomes more intense and storm increases in frequency and intensity, serious socioeconomic impact emerges. Change in climate can adversely affect agricultural production with negative consequence on food security especially in rain-fed agricultural economics (BNRCC, 2011).

Accordingly, many causal factors are responsible for land degradation, which affects the quality and productivity of land. This is because; change in climate is part of the underlying factors consequential in wind and water erosion, with consumption of minerals as well as substantial metal sullying. Although, precipitation inconstancy isn't the main exogenous factor influencing income and farm yield, it is however one of the basic challenges to earnings optimisation and wellbeing of crop farmers. Change in climates also links other kind of strain inherent in agrarian production. Change in climate affects productivity and crop yields in various directions given the type of practices in agriculture. However, these effects may eventually result in precipitation changing level, growing season's length, increased temperature, timing of basic limit occasions with respect to development of crop and even livestock production. In essence, exploring the impacts of change of climate on farming family units that are seriously impressed by scarcity and inequality is not only expedient but advantageous to sustainable development and growth in the country. Infact as Anderson (2006) and Ologunorisa (2011) anticipated that by 2100, Gross Domestic Product (GDP) misfortunes coming about because of environmental change alone could make extra 45 million individuals exist on under $2 day by day in sub-Saharan Africa (SSA), which consists of not less than48 African countries. Imperatively, constant climatic variability consequently connotes the poverty dimension in our country can worsen if not put under check. Environmental cost at the local, national and global levels optimally impact the underprivileged that principally trust on agricultural practices as a means of their survival coupled with increased intensity of drought and flood inhibiting hydrological cycles and change in precipitation variance impact significantly on food security status in the country. In effect, about twenty-five to forty two percent of species habitats could be vanished, influencing both non-food and food crops. As FAO (2015) put it in struggling nations, 11 percent of arable land could be influenced by environmental change, including a decrease of oat generation in up to 65 nations, and around 16 percent of agrarian GDP in these nations.

2.3.3 Adaptation to Climate Change

Adaptation to the adverse climate impacts is drawing serious concerns globally. The consistent rise in global temperatures has tremendous impact on productivity, diversity, ecosystem balance and functioning and for the economies, livelihoods and cultures dependent on them (Parry *et al*., 2005). There is growing recognition of long-term and short-term implications of change in climate for sustainable development. This has sparked off serious discussions and actions with respect to adjustment at the global and national point. The prominence of efforts to cope and build resilience against adverse change in climate impact is growing.

Also, knowledge on how to respond to the complex situation of the effects of environmental change is increasing. To this end, there is the need to incorporate adaptation dimensions into sustainable development policy. The reason for this is because adjustment to human-incited environmental change is another procedure for all countries, irrespective of the stage of their development. Fatuase and Ajibefun (2013) and Fussel (2007) argued that importance be supposed to be laid on adjustment since human exercises have just affected atmosphere and environmental change is already a sustained reality.

According to Speranza (2010), adjustment to environmental change is referred to as the long-term strategies devised to reduce or eliminate change in climate impacts. In the context of this research, adaptation is viewed as the alteration in characteristic or human frameworks which reduces the injury or utilises useful openings related with environmental change. As such, adjustment is viewed as a continuous process in ensuring the sustainability of result obtained from adjustment of climatic impacts. It accentuates effective and manageable utilisation of assets including arranging, consolidating new as well as old techniques and information and discovering choices as the situation might request (BNRCC, 2011).

Adaptation can also imply any accommodation, regardless of whether aloof, responsive or expectant that is investigated for the point of limiting foreseen results related with environmental change. Thus, the concept of adaptation to change of climate is eclectic and multidimensional as it requires the expertise of analysts and specialists in climatology, environment, financial aspects, and administration of common assets, general wellbeing, and catastrophe and hazard lessening.

In light of the planning, reason and objective of usage adjustment can either be receptive or expectant, open or private, arranged or self-governing. Adjustment can likewise be in short or long haul, limited or far reaching (IPCC, 2001). Therefore, for this study, the adaptive strategy adopted by crop farmers will be considered and may be classified as follows:

Reactive or Anticipatory: This is the adaptive strategy adopted after the underlying effects of environmental change have happened. Expectant adjustment likewise happens before impacts progress toward becoming highly noticeable.

Private or public: This classification depends on whether adjustment is persuaded by crop farmers, where firms are termed; private and government termed public respectively.

Planned or Autonomous: Planned adaptation emerges from consider approach choice, in light of the mindfulness that conditions have been modified or anticipated that would change and that some sort of activity is required to keep up a worthwhile state. Self-governing adjustment includes modifications that frameworks will experience in light of changing climatic conditions independent of any arrangement, plan or choice.

In sum, the importance of climate variability is contingent on the level of change experienced and the properties of the society exposed to it. The properties connote the differences in the level of defenselessness of a framework. Atmosphere actuated changes can thus have various effects on communities and state and even countries because of the divergence in exposures and adaptive strategies. Impoverish developing economies are particularly more prone to susceptibility of change in climate impacts because they have lesser coping capacities than developed economies.

The reasons for this are not farfetched. Amongst them are:

1) State of economic wealth
2) Income inequality and polarization
3) Overpopulation (subject to productivity, available income and natural resources)
4) Heavy reliance on atmosphere delicate sensitive agricultural services, forestry, tourism and aquaculture.
5) Debilitated ecological base in terms of land degradation and fragmentation.
6) Poor pre-existing health conditions
7) Weak socio-cultural rigid land use practices

Holding the foregoing constant, reducing vulnerability entails the reduction of exposure through specific measures or enhancing adaptive capacities of people like the crop farmers. This has made adaptation suggested as a veritable reaction measure to change in climate. This claim is not unconnected to be view of IPCC (2001) that regardless of how vigorous alleviation measures are, a specific level of environmental change is unavoidable because of chronicled discharges and the latency of the atmosphere framework. In such manner, the impact of moderation may take quite a few years to emerge; most adjustment exercises are of quick viability. Henceforth, such versatile measures can be connected on a provincial or neighborhood level and their viability is less reliant on the activity of others.

In conclusion, adaptation does not only address risk associated with alterations in the climate in future, it also strives to reduce risks inherent in climate variability.

2.4 Methodological Review

This section presents a review of methods used in measuring vulnerability to climate change. A few techniques are utilised for estimating vulnerability to atmosphere change. However, the most prominent two strategies regularly utilised in literature are the econometric and indicator methods which were adopted for this study as discussed.

2.4.1 Econometric method

The econometric technique is much related to the development and literature on poverty. It makes utilisation of family unit level financial study information to examine the level of helplessness of various social gatherings. As indicated by Hoddinott and Quisumbing, (2008), the strategy is separated into three classes. These are: Vulnerability as Uninsured Exposure to hazard (VER), Vulnerability as Low Expected Utility (VEU), and Vulnerability as Expected Poverty (VEP). All the three methodologies share a typical quality in developing a measure of welfare misfortune ascribed to stuns.

(i) Vulnerability as Expected Poverty (VEP)

According to Christiaensen and Subbarao, (2004), the expected poverty framework, is imagined as the possibility of that individual getting to be poor later on if at present not poor or the possibility of that individual proceeding to be poor if as of now poor. All things considered, powerlessness is seen consumption and expected poverty utilised as an intermediary for prosperity. This approach is in light of evaluating the likelihood that a given stun, or set of stuns, activates utilisation of family units underneath a given least level of consumption poverty line or drives the utilisation level to stay beneath the given least necessity on the off chance that it is as of now beneath that level. This method if no doubt has its limitations as pointed out by Hoddinott and Quisumbing (2008), that one of the limitations of this approach is that, if estimation is based on a solitary cross-segment, one must make a presumption that cross-sectional fluctuation is captured by temporal variability. This assumption may however not be constant all the time.

(ii) *Vulnerability as a Low Expected Utility (VEU)*

Ligon and Schechter (2003) clarified powerlessness as the variety between the utility got from some level of sureness proportionate utilisation at or more which the family unit would not be viewed as defenseless and the normal utility of utilisation. Ligon and Schechter (2003) connected this technique to a board informational collection from Bulgaria in 1994 and found that destitution and hazard assume generally break even with parts in lessening welfare. The hindrance of this technique is that it is hard to represent a person's hazard inclination, given that people are not well educated about their inclinations, particularly those identified with dubious occasions (Kanbur 1987).

(iii) *Vulnerability as Uninsured Exposure to Risk (VER)*

According to Hoddinott and Quisumbing (2008), the VER technique depends on ex post facto evaluation of the degree to which a negative stun causes welfare loss. This approach keeps up that, the effect of stuns is surveyed by utilising board information to measure the adjustment in actuated utilisation. Skoufias (2003) utilised this approach in Russia to investigate the effect of stuns and found that, the nonappearance of hazard administration instruments, stuns forced a welfare misfortune that is emerged through decrease in utilisation. The measure of misfortune caused because of stun breaks even with the sum paid as protection to keep a family unit to be fortunate as before any stun happens. The restrictions of this approach are that without board informational collections, appraisals of effects, particularly from cross-sectional information are regularly subjective and made uncertain.

2.4.2 Indicator method

The pointer technique of measuring susceptibility is established on the selection of a number of pointers from the entire situate of possible pointers and the combination of the chosen pointers in a systematic manner to indicate the vulnerability levels. Using this method at whichever extent, two options are applicable for the calculation of the level of vulnerability. The first is to assume that all markers of weakness have square with significance and along these lines giving them rise to weights (Cutter, Mitchell, and Scott 2000). The second is to allot distinctive weights to keep away from the vulnerability of equivalent weighting given the assorted variety of pointers adopted. Some of the approaches often employed to assign weights comprise specialist decision (Kaly and Pratt, 2000), vital segment examination (Cutter, Boruff, and Shirley 2003), relationship with past debacle occasions (Brooks, Adger, and Kelly 2005), and utilisation of fluffy rationale (Eakin and Tapia 2008). Although this method attempts to give weights, their appropriateness is still doubtful. This is because of the unavailability of standard weighting technique against which every strategy can be evaluated for accuracy. Nevertheless, the Principal Component Analysis will be employed in this study and some useful indicators are examined to show the level of vulnerability.

2.4.3 Review of Methodologies used in Vulnerability to Climate Change

Researchers and scholars have carried out significant empirical investigations on change in climate awareness. Adebayo *et al*. (2013) conducted a study in Adamawa State of Nigeria among farmers, and they found out 90 percent of the respondents knew about change in atmosphere. They further affirmed that temperature has been increasing while rainfall was decreasing with significant increment in recurrence and length of droughts. In contrast however, Adetayo and Owolade (2013) in their research investigated Change in climate adaptation and awareness in Oyo State; and they found that the level of change in climate consciousness was small amongst supply deprived farmers. In their study, Ayanwuyi, Kuponiyi, Ogunlade and Oyster (2010) assessed perception of farmers of impacts of change in climate in Ogbomosho, Oyo State. They selected 360 farmers using technique of sampling randomly. Multiple regression was utilised in analysing the relationship between perceived change in climate impacts and strategies of adaptation, they found that 61.2% of the changes in the dependent variable (change in climate perception) was as a consequence of the changes in the independent variables (shading, farm size, mulching, and shelter access to credit, extension, educational level and among others). The study's result proposes that impacts on the livelihood of farmers be supposed to be given consideration in the formulation of adjustment of rural creation frameworks to change in climate.

The plausible reason for this suggestion is that among others, the perceived impacts of change in climate on agriculture are low yield, hindered development, high daylight power and expanded rate of nuisances and infections. (Ademola andOyesola, 2012, and Ozor *et al*., 2012). Also, there are reported cases of farmers being aware of change in climate without any adaptation measure while some crop farmers often adopted change in planting dates because of the absence of direct cost implications. Sofoluwe *et al*. (2011) established that, there are six significant imperatives militating against selection of adjustment strategies. These are absence of data on suitable adjustment options, death of change in climate research and inefficient extension services. Others include lack of capital, poor irrigation potentials and poverty.

Still on the empirical review, Bidoli *et al*. (2012) completed an investigation on the impacts of progress in atmosphere on domesticated animals' cultivation and practices in Jigawa State, Nigeria and found out that change in climate impacted negatively even on production of domestic animals. The consequences for animals incorporate decrease in feed consumption, growth rate, enhanced abortion, reduction in birth rate, and increase in the incidences of parasites, disease conditions and mortality rates. Furthermore, Farauta *et al*., (2012) and in their study on adjustment techniques to change in atmosphere by edit agriculturists, found that multiple cropping, crop rotation, mulching, alteration in cultivation times and increased use of agrochemicals as the basic dominant adaptation strategies adopted by farmers. The study also revealed that attack of cows and herders, lacking supply of horticultural information sources and access to credit were inhibitive of the adjustment techniques utilised by the farmers.

Climate change is a mega problem (Harper, 2012). These natural phenomena also have impact on human beings. Climate change can lead to kidney stone because of dehydration (Wadinga, 2012). This is evident in the rising incidence of kidney diseases in Northern Nigeria. A lot of diseases become more propagated during the heat season when compared to wet season because of the opportunity of vectors to travel by air. Change in climate has led to the migration of able-bodied youths hitherto involved in agriculture to urban areas where supposed opportunities abound (Okoh, 2012). Communities in Delta, Rivers, Akwa Ibom and Bayelsa are highly vulnerable to flooding. Some of the farmers in the South South region are confused as regards causes of change in climate. In fact, some communities commission rain makers who get paid as much as N40, 000 per task (Solomon, 2012). Thus, Climate change is a wicked issue (Hopkins, 2013). Friedlingstein *et al.* (2006) identified six features of a wicked issues or wicked problems associated with change in climate. The features are that it is characteristic of a deeper problem, has restricted opportunities for trial and error response, unfit to offer a reasonable arrangement of elective alternatives, described by conflicting certitudes and is persistent and insoluble.

As indicated by Epstein and Mills (2005) ongoing change in atmosphere has made extraordinary warmth waves two to four times more probable, and throughout the following 40 years, these outrageous warmth occasions will end up 100 times more probable. This model of progress in atmosphere predicts increment in normal temperature, as well as expanded changeability of climate conditions and more extraordinary and outrageous climate occasions to intense warmth waves and more grounded storms. In any case, with direct changes in temperature and precipitation in the following couple of decades – there might be great open doors for adjustment by the human populaces. On account of cardio-vascular chilly and warmth push, it isn't the normal temperature that executes, however the extraordinary temperature. As atmosphere warms, the effect of temperature weight on mortality isn't probably going to be maintained a strategic distance from regarding cool pressure. Human populaces can just adjust to new least mortality temperatures and somewhat hotter temperatures will have the impact of cool extremes which may cause cardio-vascular chilly pressure, particularly in more established grown-ups or physically tested individuals who experience issues adjusting to quick influxes of temperature.

There is generous confirmation in atmosphere writing that, not just that ongoing temperatures have demonstrated more factors with all the more to a great degree sweltering temperatures (or huge upward divergences from the base mortality temperature), however that the inconstancy of temperatures and the recurrence of warmth waves is probably going to quicken in the coming decades (IPCC, 2001), no single climate occasion can be unmistakably connected to change in atmosphere, since there have dependably been atmosphere variances and infrequent extremes. In any case, as Hales *et al* (2003) called attention to that adjustment in atmosphere has expanded the recurrence and power of extraordinary climate, causing a sharp rise in climate related passing. The impact of extraordinary climate has been horrifying. Upwards of 50,000 individuals kicked the bucket in the 2003 warmth wave in Europe (Brücker, 2005). This was a high toll, which mirrored an absence of arrangement which has since been adjusted. In any case, actually outrageous climate occasions as a rule cause huge quantity of passing. Indeed, even in the created or creating countries, the U.S. experienced 1,800 passing Hurricane Katrina in 2005, and in excess of 700 fatalities from a 1995 warmth wave in Chicago (Klinenberg, 2002). Likewise, because of the warmth floods of summer 2006, no less than 1,000 individuals passed on in the Netherlands and 200 in the US.

In India, warm waves in which temperatures some of the time reached 49^{o}C killed in excess of a thousand people on numerous events lately De, *et al (*2005). The UNEP Global Environment Outlook 2000 report predicts the accompanying Co2 radiating sources later on:

- There will be one billion autos by 2025 when contrasted with 40 million out of 1945, delineating expanded outflows of carbons.
- A quarter of the world's 4360 kinds of warm-blooded animals and 11 percent of the 9, 675 feathered creature species are at genuine danger of annihilation.
- More than half of the world's coral is in danger of a dangerous atmospheric deviation.
- 80 percent of backwoods have been cleared.
- One billion city occupants are presented to wellbeing danger of air contamination.
- The worldwide populace will achieve 8.9 billion of every 2050.
- Global warming will raise temperatures by 3.6▫C bringing about ocean level and more extreme cataclysmic events.
- Global pesticides utilisation is causing 5 million intense harming episodes yearly.

For the most part, ozone harming substances (GHGs) are discharged and caused by characteristic and human exercises. Quantitatively, the biggest offer is traceable to control age. They are vaporous constituents of the air; both normal and anthropogenic that ingests and transmits radiation. The essential ozone harming substances are water vapor (H2O), Carbon dioxide (CO_2), Nitrous Oxide (NO_2), Methane (CH4) and Ozone (O_3). However, of all the GHGs, CO_2 is the most abundant but Methane and Nitrous Oxide have more global warming potential than Carbon dioxide. The peculiarity of GHG emission is such that the effect of emission in one location may be felt in another location. Thus, there is the need to act in order to avert the impending GHGs build up furthermore, a dangerous atmospheric deviation at a conceivably tremendous cost to the economy and society around the world (Ugwuoke, Agwunobi and Aliyu, 2012).

According to Ifeanyi-Obi, Eluk and Wali (2012), there is consensus in literature increment in air grouping of ozone depleting substances (GHGs) dates back to the industrial revolution. This increase in GHGs is essentially because of human exercises, for example, burning of non-renewable energy source (Ugwuoke *et al.*, 2012), changes in the land utilise, deforestation, and extension and commercialization of agribusiness (Popoola, 2014). These have made, Shamsuddoha and Chowdury (2007) to emphasize that Carbon dioxide concentration which was 280 Parts Per Million by Volume (PPMV) in 1880, has since increased to 354 PPMV in 1990 (about 25 percent) and currently increasing at the rate of about 1.8 PPMV per year (0.5 percent) due to anthropogenic emissions. In essence, increasing atmospheric Carbon dioxide and other greenhouse gases would affect the earth's radiation budget thereby, resulting in global warming with serious repercussion of the sea level change. In the last one century, the annual average sea level rise was from 0.5 mm to 3.0 mm. Even, some studies reported 10 to 25 cm sea level rise. However, in spite of the conflicting views on the causal relationships between a worldwide temperature alteration and ice sheet liquefying in the Antarctic and the Arctic locale, there is no controversy on the extension of ocean water with the ascents of temperature, as water thickness and temperature are inversely related.

Human activities that emitted enormous volume of "heat trapping" gases in the earth's atmosphere is responsible for the global warming effect. However, there are some underlying cogent factors which account mainly for the global environmental crisis. These compelling factors are:

- Technological advancements throughout ages which enhanced the capability of people in the exploitation of its resources and the environment for their means of livelihoods.
- Rapid increase in human population in recent centuries (from 6bn to 7bn), which has led to significant rise in population densities across countries.
- Weighty increase in human usage of regular assets especially finished the most recent hundreds of years.
- Existence of free market economies and neo-liberal strategies in which monetary components assumed the focal part in the basic leadership about generation asset use, individual tastes, preferences and the culture of different nationalities.

In addition to these underlying factors offered by Shamsuddoha and Chowdury, (2007) the likelihood of numerous individuals, organizations and nations for here and now benefit expansion as opposed to speculation for maintainable advancement and practical asset utilise (Parry and Hammill and Drexhage, 2005)

2.5 Conceptual Framework on Vulnerability and Adaptation to Climate Change

Climate change has wide-ranging effects on the environment, and on socio-economic and related sectors, including water resources, agriculture and food security, human health, terrestrial ecosystems and biodiversity and coastal zones. Changes in rainfall pattern are likely to lead to severe water shortages and/or flooding. Rising temperatures will cause shifts in crop growing seasons which affects food security and changes in the distribution of disease vectors putting more farmers at risk from diseases affecting their crops. A rise in extreme events will have effects on the output of farmers, therefore making them vulnerable to Climate Change.

Vulnerability assessment is the analysis of the expected impacts, risks and the adaptive capacity of a region or sector to the effects of climate change. Vulnerability assessment encompasses more than simple measurement of the potential harm caused by events resulting from climate change, it includes an assessment of the region's or sector's ability to adapt. The term vulnerability is used differently in the climate change context. The IPCC Fifth Assessment Report defines vulnerability to climate change broadly as "The propensity or predisposition to be adversely affected. Vulnerability encompasses a variety of concepts including sensitivity or susceptibility to harm and lack of capacity to cope and adapt".

On the other hand, adaptation is a process through which farmers make themselves better able to cope with an uncertain future in climate change eventualities. This entails taking the right measures to reduce the negative effects of climate change (or exploit the positive ones) by making the appropriate adjustments and changes. There are many options and opportunities to adapt. These ranges from technological options such as increased sea defenses or flood-proof houses on stilts, to behavior change at the individual level, such as reducing water use in times of drought and using insecticide-sprayed mosquito nets. Other strategies include early warning systems for extreme events, better water management, and improved risk management, various insurance options and biodiversity conservation or no adaptation at all. Because of the speed at which change is happening due to global temperature rise, it is urgent that the vulnerability of developing countries to climate change is reduced and their capacity to adapt is increased and national adaptation plans are implemented. Future vulnerability depends not only on climate change but also on the type of development path that is pursued to cope with the effects of the climate change.

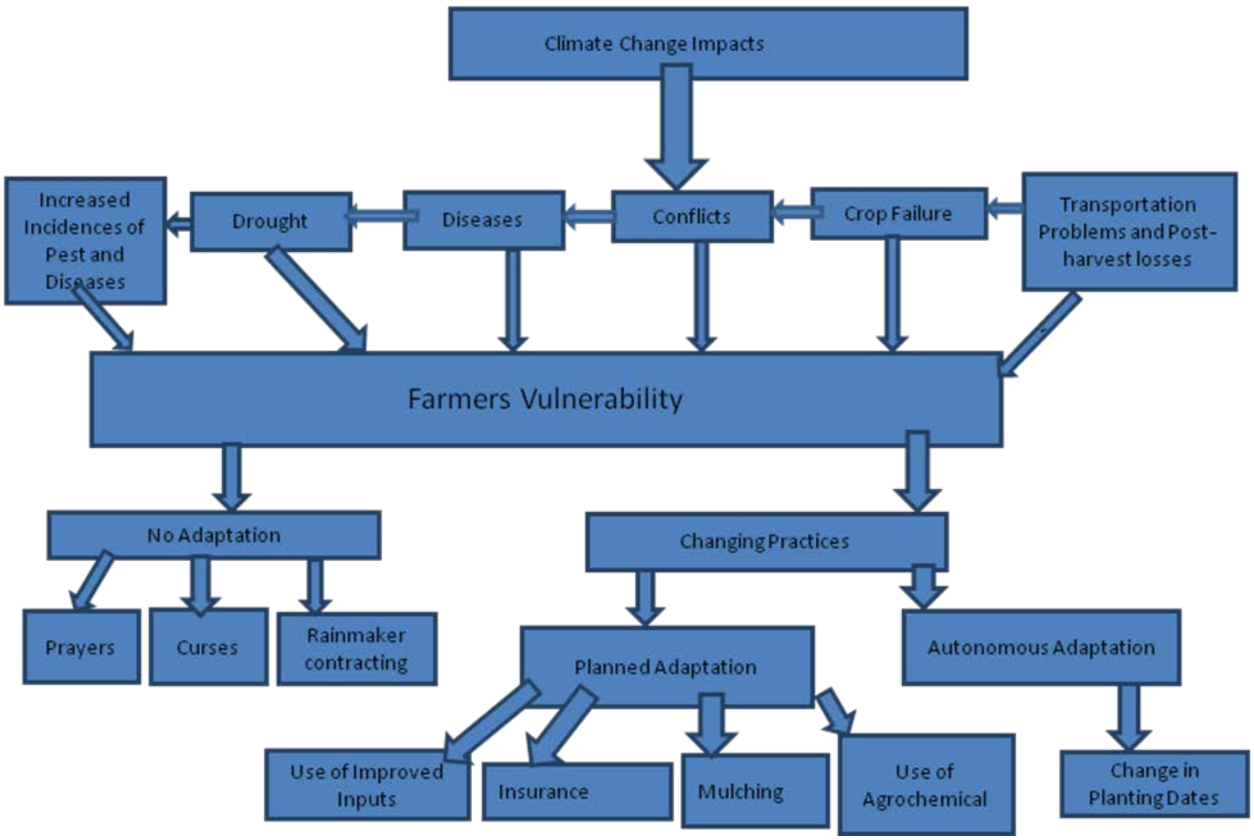

Figure 1: Conceptual Framework on Climate Change Impact, Farmers Vulnerability and Changing Practices among Farmers.

Source: Author's Conception

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Study Area

This study was carried out in Osun State, Nigeria. The state covers a land accumulation of approximately 14, 875 square kilometers and lies between longitude 04^0 $30^'$ 00' E and latitude 07^0 $30^'$ 00' N. The population of Osun State according to the 2006 census is 3.1 million. The State is bounded by Ogun, Kwara, Oyo and Ondo States in the South, North, West and East respectively and has 30 Local government areas, with three senatorial districts. It is predominantly an agrarian society with over 70 percent of the population engaged directly or indirectly in agriculture and agricultural related occupations.

Agriculture is the main stay and the predominant occupation of most of the populace alongside with other allied vocations trading, crafts, agro- processing etc. Major food crops grown zone include cassava, yam and maize while cash crops include cocoa, cashew, and oil palm.

Figure 2: Map Showing the Study Area

3.2 Types and Sources of Data

This study utilised primary data collected through well-structured questionnaire. Data were collected on socioeconomic characteristics of the respondents, Farm and non-farm income sources of the respondents, observed changes in weather, coping methods adopted in the selected research area and confinements to acclimation, sources of climate change information among others, vulnerability indicators (sensitivity, exposure and adaptive capacity). The farm characteristics considered were farm size, land area cultivated for food crops. Institutional factors include access to expansion benefits on edit creation, data on change in atmosphere, access to credit, social capital, which incorporate farmer-to-farmer augmentation administrations.

Data were also collected on household’s land under farming activities, the labour used for farm activities and their cost, the region of land planted, the amounts collected, devoured and sold, and different cost, for example, seeds, manure and pesticides, light and substantial hardware and creatures utilised as a part of agrarian work; cultivating related structures, farmers' entrance to data on cultivating exercises and the sources and cost of this data, gauge of the homestead family's aggregate pay (for both and non-cultivating exercises), charges paid and appropriations got. Farmers' view of short and long-haul change in atmosphere, adjustment and adapting procedures in light of helplessness to change in atmosphere was appropriately gathered.

3.3 Sampling Technique and Sample size

A four-stage sampling procedure was used in collecting data for the study. The first stage was the purposive selection of Osun State because the state has one of the highest food crop farmers in Southwest Nigeria (estimated to be around 50,000 full-time food crop farmers by IITA), and as a result it is known to be one of the highest producers of food crop in southwest Nigeria, notably Cassava (IITA, 2017). The second stage involved the random selection of one local government each across the three senatorial zones of the state. They are, Osun Central, Osun East and Osun West respectively. Each senatorial zone consists of ten Local Government areas, where Osogbo, Atakunmosa East and Iwo were randomly selected respectively. The third stage involved the selection of three communities randomly from each LGA. Lastly, systematic random sampling was used to select 30 households from each community, making a total of 270 households from the three LGAs of the state. However, data from two hundred and forty-seven (247) households were used for analysis due to incomplete information and inconsistency.

3.4 Analytical Techniques

Different analytical tools were used in analysing the variables got from food crop farmers in the study area. These include: descriptive statistics, Principal Component Analysis (PCA), tobit regression, Change in Climate Adaptive Index (CCAI) and ordered probit models.

3.4.1 Descriptive statistics

Descriptive statistics such as frequency, percentages, means and standard deviation were used to describe the socio-economic characteristics of the food crop farmers and the perceived effect of climate change in the study area.

3.4.2 Assessment of vulnerability status of the rural households

The vulnerability status of the respondents was assessed through vulnerability index which was constructed using Principal Component Analysis (PCA) model. The principal component analysis involves resolution of a set of variables into a new set of composite variables or principal components that are uncorrelated with one another. This is accomplished by the analysis of the correlation among the variables. The result of this is a yield of factors which convey all the essential information of the original set of variables. Principal Component Analysis (PCA) is therefore a multivariate statistical technique that was used to reduce the number of variables in the data set into a smaller number of ‘dimensions’ without losing too much information in the process. The PCA technique achieved this by creating a fewer number of variables which explain most of the variation in the original variables. The new variables which are created are linear combinations of the original variables. The first new variables will account for as much as possible of the variation in the original data. The primary main segment might be seen as the absolute best outline of straight connections displayed in the information. The second segment is the following best straight mix of factors under the condition that the second segment is symmetrical to the primary segments. The second one must record for the extent of change not represented by the first. Resulting parts are likewise characterized until the point when every one of the information is depleted. PC requires the same numbers of parts as there are factors (Filmer and Pritchett, 1998; Adenegan, 2013).

Principal component model may be compactly specified as:

$$Zj = ajiFi + aj_2F_2 + aj_3F_3 + \ldots\ldots\ldots + aj_nF_n \qquad \ldots (1)$$

Where all of the n experiential variables are depicted linearly concerning the new unrelated components F_1, F_2, F_3...FN each of which in turn is defined as a linear combination of the n original variables and *Z* is the standardized variables of each household.

Principal Component Analysis (PCA) can decide the weight as a factor score for each vulnerability variable. It looks for a straight blend of factors to such an extent that the greatest fluctuation is extricated from the factors. It at that point expels this fluctuation and looks for second direct blends which clarify the most extreme extent of the rest of the change. To start with, primary part is the straight file of factors with the biggest measure of data normal to the majority of the factors. The vulnerability index derived from PCA for each household can be written as follows:

$$Aj = \sum_{i=1}^{n} f_i (aji - ai)/ Si \qquad \ldots (2)$$

where

A j is a vulnerability index for each household (j =1… n)

fi is the scoring factor for each durable asset of household (i =1…, n)

aji is the i th indicators of j th household (i, j =1, …, n)

ai is the mean of i th indicators of household (i =1, …, n)

Si is the standard deviation of i th indicators of household (i =1, …, n)

Derived from PCA, scoring factors of the first principal component (the efficient component) would be used for constructing the vulnerability index of each household.

This was used to generate a vulnerability index for each household based on the major vulnerability indicators identified by Ajibola, (2014) as

- Sensitivity
- Exposure
- Adaptive Capacity

3.4.3 Analysis of factors influencing vulnerability to climate change

Tobit regression analysis was employed in the study to analyse the various factors influencing vulnerability among the farming households. This can be expressed both in implicit form and explicit form:

$$Yi = \beta o + \Sigma \beta_m z_{jm} + \mu_j \quad \text{.... (3)}$$

where Z= 1, 2, 3,…, n

Y_i= Vulnerability Index

X_1 =Gender of the farmer measured as dummy (if male 1, 0 otherwise)

X_2=Age (Years)

X_3= Marital Status measured as dummy (if married 1, 0 otherwise)

X_4=Level of Education (Years)

X_5= Farming experience of the respondents (Years)

X_6=Farm size (Hectares)

X_7=Household size

X_8= Major occupation measured as dummy (if major is farming 1, 0 otherwise)

X_9=Mode of Farm Acquisition

X_{10}=Amount of credit obtained (N)

X_{11}= Access to Extension Services (Yes=1/No=0)

X_{12}= Income (Naira)

X_{13}=Drought (if experienced 1, 0 otherwise)

X_{14}= Temperature (if high 1, not high 0, low 1, not low 0)

X_{15}=Flood (if experienced 1, 0 otherwise)

$X_{16=}$ Rainfall (If experienced 1, 0 otherwise)

$\varepsilon_{i\,=}$ Error term

Table 1: A priori Expectations with respect to Factors Influencing Farmer's Vulnerability to Climate Change

Variable names	**Types of Measure**	**Expected Sign**	**Authority**
Sex	Dummy	+	Ajibola, (2014), Ajibefun (2011)
Age	Continuous	+/-	Falaki *et al.*, (2013), Apata (2009),
Household Size	Number	+/-	Ajibefun (2011), Apata, (2009)
Marital Status	Categorical		Adeshina (2011) and Adeleke (2011)
Year of Education	Continuous	+/-	Ajibola, (2014), Apata *et al.*, (2009)
Primary occupation	Categorical	+	Adeloye and Sotomi (2013), Apata *et al.*, (2009)
Income	Naira	+	Ogunleye (2013), Apata *et al.*, (2009)
Farm Size	Hectares	+	Ozoe *et al.*, *(*2010) *Apata* et al., (2009)
Access to Extension	Dummy	+/-	Muyanga *et al*, 2007 and Omonona (2009)
Farming Experience	Continuous	+	Oyekale, (2009) Ogunleye, (2013)
Improved Varieties	Continuous	+	Ajibola, (2011), Apata *et al.*, (2009)
Temperature	Continuous	-	Onyimonji, 2012Oyekale, (2009)
Rainfall	Continuous	-	Ajibola (2014), Oyekale, (2009)
Drought	Continuous	-	Banire, (2012), Oyekale, (2009)
Flood	Continuous	-	Oyekale, (2009), Apata *et al.*, (2009), Brooks (2005)
Access to Credit	Dummy	+	Adepoju *et al.*, (2011), Omonona, 2001.
Numbers of farms	Continuous	+	Apata *et al.*, (2009), Brooks (2005)

Source: Author (2015)

3.4.4 Classification of households based on adaptive strategies

Change in climate Adaptive Index (CCAI) for the households was constructed with a view to classify the households into different classes of adaptation levels, (Ajibola, 2014). This depended on the quantity of significant actions (changing of planting seasons, regular spraying e.t.c) against the adjustment in atmospheric factors as given in the instrument of the study. The greatest number of significant advances permitted to state in the instrument is five, so those family units who did not make any move get score of zero and were ordered to be of "No versatile limit", if one move was made such get a score of 1, two activities get a score of 2 and with three or more activities get a score of 3. Score of 1 implies low versatile limit, 2 is medium versatile limit while 3 implies high versatile limit.

3.4.5 Determinants of adaptive strategies among farming households

Ordered probit was used to determine the factors influencing adaptation strategy among farming household in the study area. The ordered probit model is specified according to Green (1987) as below:

Let

$$Y_i^* = X^i \beta_i + \varepsilon \qquad \dots (4)$$

The latent variable (household resilience) in this study will exhibits itself in ordinal categories which will be coded as 0, 1, 2…, j. The response of category j is thus observed when the underlying continuous response falls in the j-th interval as,

$$Y^* = 0 \; if \;\; Y^* \leq \delta 0 \qquad \dots (5)$$

$$Y^* = 1 \text{ if } \delta 0 < Y^* \leq \delta 1 \qquad \dots (6)$$

$$Y^* = 2 \; if \; \delta 1 < Y^* \leq \delta 2 \qquad \dots (7)$$

Where, Y* (i = 0, 1, 2) are the unobservable threshold parameters that will be estimated together with other parameters in the model. Green (1987) noted that when an intercept coefficient is included in the model, Y_0^* is normalised to a zero value and hence only j-1 additional parameters are estimated with Xs. Like the models for binary data, the probabilities for each of the observed ordinal response, that is household level of resilient will have three (3) responses which could be least, less and most with ordinal values of 0, 1, 2 was given as,

$$\text{prob}(Y=0) = P(Y^* \leq 0) = P(\beta^i X + \varepsilon i \leq 0) = \emptyset(-\beta^i X) \quad \ldots (8)$$

$$\text{prob}(Y=1) = \emptyset(\delta 1 - \beta^i X) - \emptyset(-\beta^i X) \quad \ldots (9)$$

$$\text{prob}(Y=2) = 1 - \emptyset(\delta 1 - \beta^i X) \quad \ldots (10)$$

where, 0<Y 1*<Y 2*<...<Y*j-1.... n is the cumulative normal distribution function such that the sum total of the above probabilities is equal to one.

The specification of the Ordered Probit Model in this study is as follows.

Let Yi denote the level of vulnerability to climate change:

Low level of adaptation (0 = Yi),

Moderate level of adaptation (1 = Yi)

and High level of adaptation (2 = Yi).

They will be determined in the maximum likelihood estimation procedure for the ordered Probit. The likelihood for adaptation of the individual households is:

$$L = [\Phi(0 - X_i\beta)]^{z_{i1}} [\Phi(\mu_1 - X_i\beta) - \Phi(0 - X_i\beta)]^{z_{i2}} [1 - \Phi(X_i\beta - \mu_1)]^{z_{i3}} \quad \ldots (11)$$

$$Z_{ij} = \begin{cases} 1 \; if \; y_i = j \\ 0, otherwise \; for \; j = 0,1 \; and 2 \end{cases} \quad \ldots (12)$$

where for the *i*th individual, y_i is the observed outcome and X_i is a vector of explanatory variables. The unknown parameters βj are typically estimated by maximum likelihood.

where Y=0 (Low adaptation), 1 (Medium Adaptation) or 2 (High Adaptation)

X_1 =Gender of the farmer (D=1 if male, 0 if otherwise)

X_2=Age (Years)

X_3= Marital status (D=1 if married, 0 if otherwise)

X_4= Household size (number)

X_5= Level of education (years)

X_6= Farming experience of the respondents (Years)

X_7=Farm size (Hectares)

X_8=Number of farms

X_9=Credit access (Naira)

X_{10}=Extension access (D=1 if Yes, 0 if otherwise)

ε_i = Error term

The marginal effects of the regressors X on the probabilities are not equal to the coefficients. The marginal probabilities could therefore be calculated from the Probit model as:

$$\frac{dprob[Y_j]}{dx_j} = [\emptyset(\delta_{j-1} - \beta^i X_j) - \emptyset(\emptyset_j - \beta^i X_j)]\beta \qquad \text{… (13)}$$

where, ø is the normal density function, j the threshold parameter and Xj the j the explanatory variable.

Table 2: A priori Expectations with respect to Factors Influencing Choice of Adaptation Strategies

Variable names	**Types of Measure**	**Expected Sign**	**Empirical Evidence**
Sex	Dummy	+	Oyekale, 2008 Apata *et al.*, (2009), Ajibola, (2011)
Age	Continuous	+/-	Haddad and Ahmed, (2003), Imai *et al.*, (2009)
Household Size	Number	+/-	Apata *et al.*, (2009), Ajibola, (2011)
Marital Status	Categorical	+	Ozor *et a*l., (2010) Apata *et al.*, (2009), Ajibola, (2011)
Year of Education	Continuous	+/-	Apata *et al.*, (2009), Ajibola, (2011)
Income	Continuous	+	Ogunleye (2013), Apata *et al.*, (2009),
Farm Size	Continuous	+	Emaziye *et al.*, (2012), Ajibola, (2011)
Access to Extension	Dummy	+/-	Apata *et al.*, (2009), Ajibola, (2011)
Farming Experience	Continuous	+	Falaki *et al.*, (2013), Apata *et al.*, (2009), Ajibola, (2011)
Access to Credit	Dummy	-	Muyanga *et al.*, (2007), Omonona 2001
Numbers of farms	Continuous	-	Onyimonji, 2012, Ajibola, (2011), Apata *et al.*, (2009),

Source: Author (2015)

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Socioeconomic Characteristics of the Food Crop Farmers

The socio-economic characteristics of the respondents helps to identify or describe the social and economic conditions of the respondents from which the data been analysed is generated, thus, giving a background information on the sampled respondents. The result of the socio-economic characteristics of these households in terms of age, household size, farming experience, farm size, is presented in Table 3.

The age distribution of the respondents reveals that most of the farmers are between 46 - 60 years old, with 40.1percent, while 35.6percent of the respondent's range between 30 - 45 years' old. However, 6.8percent and 1.2percent of the farmers are below 30 years and above 75 years old respectively. The mean age of the respondents in the study area is 50years, which implies that most of the respondents are in the productive years. Majority of the respondents are male, with 76.1percent, while female food crop farmers are just 23.9percent. This means that majority of food crop farmers in the study area are male.

The distribution of marital status shows that majority of the respondent in the study area are married, with 86.6percent, while others are single, divorced, widowed, or separated. This implies that majority of the respondents are married. This have a great influence as majority of them have family responsibility and climate change affecting crop yield have great influence on household food availability and income. The majority of the respondents have secondary education (39.3percent), 36.0percent has primary education, while farmers with no formal education and tertiary education are 10.12percent each. Average year of educational attainment was found to be 8.43. This suggests that literacy level of most of the farmers was high with 75percent having formal education and with minimum of 8 years of schooling which is expected to influence their knowledge about change in climate and adaptive methods available. This is supported by the findings of Ayanwuyi *et al.* (2010), who reported more than 75percent had between various levels of formal education in their study.

About half of the respondents (48.9percent) and 46.9percent had family size range between 1-5 and 6-10 members respectively. The mean household size of respondents was found to be 6. This implies that the respondents will not have enough family labour to carry out farm activities and will have to rely more on hired labour. This is mirrored in the distribution types of labour engaged by the farmers in the study area as almost half (48.5percent) of the respondents depends on hired labour, while 36.0percents uses both family and hired labour for their farm activities. Most (80.9percent) of the respondents have more than 10 years of farming experience. The average age of farming is 22 years, which implies that farmers in the study area will be able to manage the trials of climate change during the course of their farming enterprise. This conforms to the findings of Adeloye and Sotomi (2013), which reported in their study that 70.0percent of farming households, had more than 10 years of farming experience.

Distribution of farm size shows that 75.3percent of the respondent have a farmland between 0-3ha, with the mean farm size around 3.0ha, it means the respondents are mainly small-scale farmers. However, 35.2percent of them resides between 1 to 2kms away from their farmland. The average farm distance is 3km. This implies that the farmland is not far from the homestead and crops could be properly taken care of. Majority (92.7percents) of the respondents in the study area engage in crop farming as their primary occupation, with more than half (55.1percent) of the respondents acquired their farmland by inheritance. Just a minority (0.8percent) acquired their farmland on lease.

Table 3: Socio-economic Distribution of the Respondents

Variable	Frequency (N=247)	Percentage (100)
Age (years)		
Less than 30	17	6.88
30-45	88	35.63
46-60	99	40.08
61-75	40	16.19
75 and above	3	1.21
Gender		
Male	188	76.11
Female	59	23.89
Marital status		
Single	8	3.24
Married	214	86.64
Divorced	6	2.43
Widowed	17	6.88
Separated	2	0.81
Educational level		
No formal Education	25	10.12
Adult education	11	4.45
Primary education	89	36.03
Secondary education	97	39.27
Tertiary education	25	10.12
Household Size		
1-5	121	48.99
6-10	116	46.96
11-15	8	3.24
15 and above	2	0.81
Mean household size	**6**	
Farming Experience		
1-10	58	23.48
11-20	92	37.25
21-30	50	20.24
31-40	21	8.50
Above 40	26	10.53
Farm Area (hectares)		
Less than 1 hectare	76	30.77
1-3	110	44.53
3-5	31	12.55
Greater than 5	30	12.15

Variable	Frequency (N=247)	Percentage (100)
Average farm size	3 hectares	
Farm Distance (km)		
0-1	75	30.36
1-2	8	35.22
2-3	35	14.17
3-4	18	7.29
5 and above	16	6.48
Average farm distance	3	
Primary Occupation		
Artisan	5	2.02
Civil Servant	7	2.83
Driving	4	1.61
Farming	229	92.71
Trading	2	0.81
Type of Labour		
Family	38	15.38
Hired	120	48.58
Both	89	36.03
Land Acquisition		
Inheritance	136	55.06
Purchase	33	13.36
Rent	76	30.77
Lease	2	0.81

Source: Field survey, 2015

4.2 Perceived Effect of Climate Change Indicators between 2010 -2014

The results of the farmers' perception of the effects of climate change indicators are presented in Table 4. The results reveal that in 2010 most (36.1percent) of the farmers observed climate change caused extremely high temperature, however, 16.6percent perceived the temperature to be extremely low. About 19.1percent of them thinks there is delay in the commencement of rainfall, whereas 14.6percent observed delay in rainfall stopping. Furthermore, 10.1percent and 5.7percent thinks there was too much rainfall and too stormy rainfall respectively as a result of climate change.

On the contrary, in 2011, most framers (18.6percent) observed that climate change caused an extremely low temperature, with the second highest (17.8percent) perceived effect of climate change being delay in rainfall commencement, and delay in rainfall stopping being the least perceived effect of climate change.

From 2012 to 2014, the perceived effect of climate change with the highest percentage is extremely high temperatures with 28.3percent, 41.7percent, and 38.5percent respectively, while the farmers' perception of the effect of climate change with the lowest percentage are delay in rainfall stopping (14.6percent), too much rainfall (18.2percent), and too stormy rainfall (15.8percent) within same period respectively.

Thus, the result shows that the main perceived effect of climate change is extremely high temperature and too much rainfall. This is in line with the work of Adesina and Odekunle (2011) that ascribed the change in climate impact to the variability in rainfall and temperature regimes.

Table 4: Perceived Effect of Climate Change Indicators among Farmers

Climate change indicators	2010	2011	2012	2013	2014
Extremely high temperature	36.03	15.79	28.34	41.70	38.46
Extremely low temperature	16.60	18.62	20.24	20.24	23.48
Too much rainfall	10.12	10.93	22.67	18.22	37.65
Delay in rainfall commencement	19.03	17.81	17.00	24.70	24.70
Delay in rainfall stopping	14.57	9.72	14.57	21.46	30.76
Too stormy rainfall	5.67	11.34	23.08	18.62	15.79

Source: Field survey, 2015

4.3 Vulnerability Distribution of Household based on Observed Climate Changes

Farmers were classified into their vulnerability statuses based on observed climate changes. The distribution is shown in Table 5. It was indicated that 171 (69.23%) of the respondents are vulnerable to observed Climate Changes while 76 (30.77%) were non-vulnerable to observed Climate Changes. Also, the Mean, Standard Deviation, Minimum and Maximum values for vulnerable households were 0.00259, 1.7738, 1.6094 and 7.9170 respectively, while that of the non-vulnerable households was 0.0804, 1.7119, 1.5492 and 4.6209 respectively.

Table 5: Vulnerability Distribution of Household based on Observed Climate Changes

Vulnerability Status of the Household	Frequency	Percent
Vulnerable	171	69.23
Non-vulnerable	76	30.77

Source: Field Survey, 2015

4.4 Vulnerability Profile of Crop Farmers

The distribution of vulnerability status with respect to the respondents' socio-economic characteristics and their climate change adaptability capacity is presented in Table 6. The results of vulnerability with respect to farmers' gender shows that male farmers were more vulnerable to climate change, with the highest mean of 0.02. This might be due to the family structure of the Nigerian family system which stipulates the man as the head of the family by default, hence, placing responsibilities on their shoulders as against their female counterparts that enjoy support from their own husbands. Vulnerability to climate change with respect to farmers' level of education shows that farmers having tertiary education with regimented knowledge on weather and climate and difficulty to adjust were most vulnerable to climate change while farmers with secondary education were least vulnerable to climate change.

Vulnerability to climate change due to farmers' marital status shows that widowed farmers were most vulnerable to climate change. Their level of vulnerability is followed by that of the divorced category of respondents. The married respondents are least vulnerable to climate change. Age plays an important role in vulnerability of the farmers to climate change. The most vulnerable were those between 61-75 years of age. This may be due to the fact that they may not be in line with more recent innovations and technologies to adapt to climate changes. This level of vulnerability was followed in magnitude by that of respondent that were less than 30 years of age. This may be due to lack of experience in what the weather changes are, while the results of vulnerability with respect to farmers' farming experience shows that farmers between 31 to 40 years of farming experience were found to be most vulnerable above all others. This might imply that the higher the years of farm experience, the older the farmer would be, and might not be aware of recent development of expertise to adapt seamlessly to climate change.

Vulnerability to climate change with respect to farmers' access to extension services shows that farmers that had no access to extension services were found to be more vulnerable. Access to extension services keep the farmers aware about climate change issues and inform them about new findings which may make adaptation to climate change better and hence, reducing their vulnerability to changes in climate. The results of vulnerability with respect to farmers' farm distance from their homes shows that farmers who resides 3-4km away from their farmland were found to be the most vulnerable to climate change.

Vulnerability to climate change with respect to farmers' access to credit show that farmers that had access to credit were more vulnerable to change in climate compared to their counterparts who had no access to credit. Vulnerability to climate change due to farmers' household size shows that households with six to ten members were found to be the most vulnerable above all other categories. This result contradicts the findings of Adepoju *et al.* (2011), which revealed that vulnerable households are mostly large-sized.

Vulnerability to climate change with respect to farmers' farm size shows that majority of the farmers were small scale land cultivators with fewer than 5 hectares of territory utilised for cultivation. However, farmers having more than 5 hectares of land were found to be the most vulnerable to climate change in the study area.

Table 6: Vulnerability Profile of the Farmers to Climate Change due to Socio-Economic Characteristics

Variable	Vulnerability	Mean	Std. dev.
Gender			
Male	188	0.0235	1.6913
Female	59	-0.0749	1.651
Level of Education			
None	25	0.7186	1.8066
Adult Learning	11	0.3319	2.2461
Primary	89	-0.2222	1.5148
Secondary	97	-0.3794	1.2219
Tertiary	25	1.4766	2.4860
Marital Status			
Single	8	-0.5714	1.2004
Married	214	0.0099	1.7221
Divorced	6	0.0661	1.2102
Widowed	17	0.1869	1.5819
Separated	2	-0.5634	0.7967
Age			
Less than 30	7	0.07913	1.0224
30-45	88	-0.1157	1.5611
46-60	99	0.05301	1.7785
61-75	40	0.1673	1.7979
Farming Experience			
1-10	58	0.0159	1.8444
11-20	92	-0.1902	1.5029
21-30	50	0.0145	1.3618
31-40	21	0.7889	2.8462
Greater than 40	26	-0.0277	0.9965
Extension Access			
No	60	0.1960	1.5720
Yes	180	-0.0720	1.7270
Farm Distance			
0 – 1	75	0.0930	1.6158
1.01 – 2	87	-0.1308	1.6099
2.01 – 3	35	-0.1976	1.6589
3.01 – 4	18	0.5747	2.3660
4.01 – 5	16	-0.1853	1.4316
5.01 – 6	16	0.2468	1.7714

Variable	**Vulnerability**	**Mean**	**Std. dev.**
Credit Access			
No	97	-0.0543	1.3765
Yes	150	0.0351	1.9392
Household Size			
1-5	121	-0.3255	1.2810
6-10	116	0.3384	1.9943
11-15	8	0.2501	1.2505
Greater than 15	2	-0.9324	0.2095
Farm Size			
0 – 1	76	-0.4276	1.0747
1.01 - 3	110	0.1359	1.8367
3.01 – 5	31	0.0866	1.7703
Greater than 5	30	0.4951	2.0489
CCA Score			
Low	22	-0.0207	1.0843
Moderate	138	-0.4510	1.0180
High	77	0.5804	2.3241

Source: Field Survey, 2015

4.5 Factors Influencing Farmers' Vulnerability to Climate Change

The Tobit regression was used to examine the susceptibility of the farmers to transformation in climate and the result is presented in Table 7. It is regressed on socio-economic variables (age, household size, marital status, and years of education), farm size, farm distance, farming experience e.t.c. The result shows that age, farm size, occupation, income, drought, rainfall and temperature were found to significantly affect farmers' vulnerability to climate change. The age of the respondent is found to positively affect vulnerability at 0.05 significance level. This implies that a year increase in the year (i.e. age) of the respondent have the likelihood of farmers being vulnerable to climate change by 1.8percent. Farm size also was found to have positive relationship and significantly affect the probability of farmers being vulnerable to climate change at 0.05 significance level. This implies that farmers with larger farm size are more likely to be vulnerable to climate change than farmers with smaller land size. This is because more input is invested in larger farms which make the monetary value of the loss to be higher for farmers with large farm sizes and this leads to loss of revenue and reduces profitability. This also discourages farm commercialization. This is in line with the findings of Ajibola (2014) who revealed vulnerability level could aggressively affect Nigeria's agricultural sector if not properly managed and it could lead to loss from 2 to 11percent of the nations' GDP by 2020.

Having other occupation significantly affects the probability of vulnerability of farmers to climate change. That is, the fact that the respondent is involves in other occupation apart from farming reduces the probability of vulnerability in climate change by 3.1percent. This implies that the shock of climate change is reduced if the respondent is involved in other occupation. This is in line amid the reports of Ifeanyi-Obi *et al.* (2012) who found out that diversification into other areas reduces the probability of vulnerability to climate change.

Drought, flood and temperature are found to positively and significantly affect the probability of farmers being vulnerable to change in climate at 0.01 significant levels. This implies that a degree increase in the temperature of the environment will lead to a probability of 58.8percent increase in vulnerability of farmers to climate change. In the same vein, units increase in flood increases the probability of farmers' vulnerability to climate change by 167.9percent. Likewise, a unit increase in drought will increase the probability of farmers.

Table 7: Tobit Regression Estimates of Factors Influencing Farmers' Vulnerability to Climate Change

Dependent variable	Coefficient	Standard Error	T	p>/z/
Age	0.018	0.0088	2.05	0.058**
Household Size	0.0126	0.024	0.52	0.603
Years of Education	-0.0021	0.022	-0.10	0.924
Farming Experience	-0.0066	0.0091	-0.72	0.477
Farm Size	0.0847	0.3221	2.63	0.041**
Farm Distance	0.0179	0.0338	0.53	0.599
Diversification	-3.1835	0.3653	-8.72	0.000***
Marital Status	0.4161	0.2374	0.62	0.224
Improved Varieties	0.1466	0.2888	1.44	0.540
Income	5.53e-07	3.12e-07	1.77	0.095*
Extension Service	0.5074	0.2817	8.46	0.900
Credit Access	0.2098	0.1959	1.07	0.311
Drought	2.3844	0.2877	2.04	0.000***
Flood	1.6799	0.3472	4.84	0.000***
Temperature	0.5882	0.2877	2.04	0.000***
Rainfall	2.7237	0.3135	8.69	0.180
Constant	1.0729	0.6349	1.69	0.092
Number of obs = 240				
LR $chi^2(10)$ = 40.85				
Prob > chi^2 = 0.0000				
Log likelihood = -225.96542				
Pseudo R^2 = 0.0829				

****, **, * implies significance at 1%, 5% and 10% respectively.*

Source: Field Survey, 2015

4.6 Adaptation Strategies Adopted by Farmers in Relation to Climate Change

The result of the different strategies adopted by the farmers in response to climate change is presented in Table 8. The result shows that in 2010 and 2011, the major adaptive method adopted by farmers in the study area is diversification into other crops with 31.6percent and 36.4percent respectively. However, from 2012 to 2013, most of the farmers changed their adaptive method to changing the planting and harvesting period with 32.4percent and 40.9percent respectively.

In 2014, majority of the farmers (42.9percent) used diversification into other crops method to adapt to climate change. This shows that diversification into other crops and changing planting and harvesting period is the major adaptive methods used in the study area.

Table 8: Adaptation Methods Used by the Farmers

Adaptation Methods	2010	2011	2012	2013	2014
Diversify more into other crops	31.58	36.44	30.77	34.82	42.91
Diversify into non-farm activities	26.32	24.29	23.89	29.96	27.13
Invest in drying machines	8.10	7.69	7.69	7.69	8.10
Monitor weather change by indigenous knowledge	7.69	8.91	7.69	10.12	10.93
Irrigation	11.34	12.15	7.29	7.29	8.91
Regular spraying	14.17	14.17	17.00	14.98	21.86
Change planting and harvesting time	26.32	25.51	32.39	40.89	38.87

Source: Field survey, 2015

4.7 Adaptive Capacity of Farmers in Relation to Climate Change

The result of the adaptive capacity of the farmers to climate change is presented in Table 9. The table presents the result that shows the adaptive capacity of the farmers to respond to climate change by adopting at least one of the adaptation methods mentioned in Table 8. A farmer was scored ‘one’ if he adopted at most one of the six adaptation strategies, score two if he adopted at most two of the adaptation strategies, scored three if he adopted three or more adaption strategies. Then, the frequency of farmers who adopted at most one adaptation strategy were summed and categorized as ‘Low’, the frequency of farmers who adopted at most two were also sum up and categorized as ‘Medium’, while the frequency of farmers who adopted three or more adaptation strategies were added up and categorized as ‘High’, Hence, the result in Table 9.

The results in Table 9 shows that most (55.9percent) of the farmers responded poorly to climate change by adopting not more than one adaption strategies. About 31.2percent responded averagely to climate change by adopting not more than two adaption strategies, however, just few (4.1percent) of the respondents adopted three or more adaptation strategies as a (high) response to climate change in the study area. This implies that food crop farmers in the study area are ignorant of the array of adaptation strategies available to them to respond to climate change, and with climate change being a serious and continuous global issue, farmers need to be sensitized about various adaption strategies so as to be able to put them in a better position to make informed decision on how best they can respond to climate change going forward.

Table 9: Adaptive Capacity of the Farmers to Climate Change

CCA score	Frequency	Percentage
No	22	8.91
Low	138	55.87
Medium	77	31.17
High	10	4.05
Total	**247**	**100**

Source: Field survey, 2015

4.8 Factors Influencing Choice of Adaptation Strategy of the Farmers

The estimate of the factors influencing the extent of the farmers' adoption strategies is presented in Table 10. The result shows that age, marital status, educational status, number of farm sites, and extension access was found to significantly affect the probability of farmers adopting the high climate change adaptive score.

Respondents' age negatively affects the chance of accepting high climate change strategies at 0.05 significant levels. That is, a year increase in age reduces the prospect of adopting the high climatic change adaptive strategies by 0.2percent. This implies that the younger farming generation will readily adapt new and modern adaptation technologies than older farmers.

Conversely, marital status positively affects the probability of adopting the high climate change strategies at 0.10 significant levels. This implies that the fact that a respondent is married enhances the prospect of adopting the high change in climate adaptive strategies by 21.2percent.

However, educational status of the respondents positively and significantly influences the probability of adopting the high change in climate strategies at 0.10 significant levels. That is, a year increase in schooling increases the likelihood of adopting high transformation in climate strategy by 3.6percent. Training is required to impact the impression of agriculturists on change in atmosphere and improve adjustment of development among ranchers. This is in line with the findings of Enujeke and Ofuoku (2012).

Furthermore, the result shows that number of farms owned significantly affect the possibility of adopting high climate change strategies at 0.05 significant levels. That is, the fact that the farmer has more farms for food production increases the possibility of adopting high climate change strategies. An increase in the number of farm owned for food production, there is 1.5percent probability of adopting high change in climate adaptive strategy. Farmers with more land plot can easily adopt strategies to decrease the impact of change in climate.

Access to agricultural extension services also considerably advances the likelihood of adopting the high change in climate strategies at 0.05 significant levels. This implies that the fact that a farmer has access to extension services increases the probability of adopting high change in climate adaptive strategies by 5.9percent.

Table 10: Factors Influencing Farmers Adaptation Strategy

Predictor Variables	Coefficient	Standard Error	p>/z/
Gender	-0.0096	0.190	0.562
Age	-0.0015	0.0061	0.032**
Marital Status	0.2124	0.131	0.080*
Household Size	0.0025	0.022	0.215
Educational Status	0.0364	0.168	0.059*
Farm Experience	0.0005	0.008	0.521
Farm Size	-0.0012	0.023	0.573
Number of Farm Sites	0.0159		0.005***
Credit Access	-0.0071	0.162	0.622
Access to Extension Services	0.0589	0.181	0.047**
Number of obs.	225		
LR chi^2(33)	73.44		
Prob > chi^2	0.0001		
Log likelihood	-194.72325		

*** = significant at 1%, ** = significant at 5%, * = significant at 10%

CHAPTER FIVE

SUMMARY, CONCLUSION AND POLICY RECOMMENDATIONS

5.1 Summary of Major Findings

The research aimed and was designed to add to knowledge on the perceived effect of climate change indicators between 2010 to 2014, level of awareness of adaptive strategy among the farmers in relation to climate change in the study area and factors influencing the choice of adaptation strategy by the farmers. The vulnerability status in the rural households and determining the factors influencing farmers' vulnerability to climate change were also assessed.

The study is focused on the vulnerability of food crop farmers to change in climate in Osun state. It was shown that 76.1percent are male, 86.6percent are married while less than half, 39.3percent have secondary education. About 44.5percent have farm size of between one and three hectares. The study also revealed that 35.2percent has farm distance to the homestead to be between one and two kilometers. About 92.7percent have crop farming as their primary occupation as this increases their vulnerability to climate change. Distribution of source of labor revealed that 48.6percent depended on hired labour, 15.4percent depended on family labour, while 36.0percent depended on hired and family labour. This shows a very high vulnerability level amidst the food crop farmers as increased expenses incurred on labour, one of the important elements of input, add up to increased vulnerability of the farmers. More than half, 55.1percent acquire their land through inheritance and this could probably reduce the economic impact of climate change.

The study revealed that in 2010 most (36.1percent) of the farmers observed climate change caused extremely high temperature, however, 16.6percent perceived the temperature to be extremely low. About 19.1percent of them thinks there is delay in the commencement of rainfall, whereas 14.6percent observed delay in rainfall stopping. Furthermore, 10.1percent and 5.7percent thinks there are too much rainfall and too stormy rainfall respectively as a result of climate change. On the contrary, in 2011, most farmers (18.6) observed that climate change caused an extremely low temperature, with the second highest (17.8percent) perceived effect of climate change being delay in rainfall commencement, and delay in rainfall stopping being the least perceived effect of climate change. From 2012 to 2014, the perceived effect of climate change with the highest percentage is extremely high temperatures with 28.3percent, 41.7percent, and 38.5percent respectively, while the farmers' perception of the effect of climate change with the lowest percentage are delay in rainfall stopping (14.6percent), too much rainfall (18.2percent), and too stormy rainfall (15.8percent) within same period respectively. Thus, the result shows that the main perceived effect of climate change is extremely high temperature and too much rainfall.

The major adaptive method adopted by farmers in the study area is diversification into other crops with 31.6percent and 36.4percent respectively. However, from 2012 to 2013, most of the farmers changed their adaptive method to changing the planting and harvesting period with 32.4percent and 40.9percent respectively. In 2014, majority of the farmers (42.9percent) used diversification into another crops method to adapt to climate change.

As regard the adaptive capacity of the farmers, the study revealed that majority (55.9percent) of the farmers responded poorly to climate change by adopting not more than one adaption strategies. About 31.2percent responded averagely to climate change by adopting not more than two adaption strategies, however, and just few (4.1percent) of the respondents adopted three or more adaptation strategies as a (high) response to climate change in the study area.

Furthermore, in light of the factors influencing choice of adaption strategy, the study revealed that age (negative) and access to extension services (positive) were found to significantly (at 0.05 significance level) affect adopting high adaption strategy to climate change, while number of farm sites (positive) was found to have a significant (at 0.01 significance level) effect adopting high adaption strategy to climate change. Marital status and educational status were found to have a positive and significant (at 0.10 significance level) effect on the probability of farmers adopting the high change in climate adaptive index.

The study also revealed the vulnerability status of the rural households in the study area and the result showed that that male farmers were more vulnerable to climate change; farmers having tertiary education with regimented knowledge on weather and climate and difficulty to adjust were most vulnerable to climate change; widowed farmers were most vulnerable to climate change; farmers between 61-75 years of age are vulnerable to climate change than other age groups; farmers' with 31 to 40 years of farming experience were found to be most vulnerable to climate change than others; farmers who had no access to extension services were found to be more vulnerable to climate; farmers who resides 3-4km away from their farmland were found to be the most vulnerable to climate change; farmers who had access to credit were more vulnerable to change in climate compared to their counterparts who had no access to credit, and lastly, farmers having more than 5 hectares of land were found to be the most vulnerable to climate change in the study area.

The result of factors influencing the vulnerability of food crop farmers in Osun state to climate change showed that age of the respondent ($p = 0.05$), and farm size ($p = 0.041$) were found to positively affect vulnerability at 0.05 significance level, with coefficients of 0.018 and 0.0847 respectively. Drought ($p = 0.000$), flood ($p = 0.000$) and temperature ($p = 0.000$), were found to have a positive and significant effect on vulnerability to climate change in the study area, with coefficients of 2.3844, 1.6799, and 0.5882 respectively. However, having another occupation is negative (-3.1835) and significantly ($p = 0.000$) affect the vulnerability of farmers to climate change at 0.01 significance level. Income of the farmers was revealed to have a positive (5.5307) and significant ($p = 0.095$) effect of vulnerability to climate change at 0.10 significance level.

5.2 Conclusion

The study concludes that main perceived effect of climate change in the study area is ‘extremely high temperature and too much rainfall’. The key adaptive strategies adopted by farmers in response to climate change are to divert into other crops and change the planting and harvesting period. However, majority of the farmers in the study area have low adaptation capacity to climate chance in the study area.

Furthermore, the study concludes that access to extension services; number of farm sites, marital status and educational status all had positive effect on adopting high adaptive strategies to climate change, while age of the farmers had a negative effect on adopting high adaptive strategies to climate change in the study area.

Male farmers; widowed farmers; farmers with tertiary education; middle aged farmers, farmers with no access to extension services were all found to be vulnerable to climate change effects in the study area.

Lastly, age of the farmers, farm size, income of the farmers, drought, flood and temperature were all found to increase the possibility of farmers’ vulnerability to climate change in the study area, while having secondary occupation would reduce the possibility of farmers’ vulnerability in the study area.

5.3 Recommendations

This study made the following recommendations based on its findings

- Access to credit at minimal interest rates should be encouraged and rural banks should be strengthened to make famers access available credit facilities with minimal collateral with education on proper use of the credit.
- Youth farmers should be encouraged and channeled towards adaptive farming methods by the government and possibly the introduction of green house farming to reduce the level of vulnerability of farmers of food crop to change in climate impact.
- The relevance of irrigation farming amidst food crop farmers cannot be overemphasized. Therefore, subsidized irrigation facilities should be introduced and encouraged to reduce the climate-change related problem that food crop farmers face periodically.
- Adaptations to change in climate in Nigeria will be greatly improved if the early warning signals on change in climates can be communicated on to farmers effectively and in time.
- Agricultural extension systems in Nigeria need to be re-evaluated and re-packaged in tune with realities of today's challenges in respect to Climate change.

5.4 Suggestions for Further Study

- It will be important to scrutinize the consequence of change in climate on household productivity level of farming.
- Also, further study could be carried out on the food security status of the farming household disaggregated by the level of use of adaptation schemes to abridge effects of climate change.

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APPENDIX

Annex I: Table of Analysis of Objectives

Objectives	Data Requirement	Analytical tools
1. Profile perceived effect of change in climate indicators between 2010-2014	Farmers discernment of transformation in climate indicators over the years; 4years (2010-2014) such as rainfall, temperature, sunshine, humidity, etc.	Measures of dispersion using Mean analysis, Standard deviation and Likert scale measurement.
2. Assess the vulnerability status in the rural households	Exposure indicators (change in climate variables, extreme climate events) Sensitivity indicators (Fatalities, Income structure), indicators of adaptive capacity (Human Assets, Physical Assets, Financial Assets, Natural Assets, Social Assets)	Principal Component Analysis.
3. Determine the factors influencing farmers' vulnerability to climate change.	Age, Sex, Education, Household size, Income, Farm size, Marital Status, Flood, household experiencing temperature change, non-farm activities,	Tobit Regression
4. Analyse adaptive strategies adopted in relation to change in climate in the study area	Adaptability methods i.e. land use strategies adopted such as mixed cropping, crop rotation etc.	Change in Climate Adaptive Index (CCAI)
5. Examine the factors influencing choice of adaptation strategies by the farmers	Age, Sex, Education, Household size, Income, Farm size, Marital Status, Flood, household experiencing temperature change.	Ordered Probit Regression

Annex II: Vulnerability Indicator variables

No	Definition	Classification into shocks	Conceptual Basis
1	Perceived Temperature change (yes=1, no=0)s	Covariate	Sensitivity
2	Rainfall change in previous season (Yes=1 , no =0)	Covariate	Sensitivity
3	Cropping household	Idiosyncratic	Exposure
4	Other form of agricultural practices	Idiosyncratic	Exposure
5	Household size	Household characteristics	Adaptive capacity
6	Respondents education level	Household characteristics	Adaptive capacity
7	Age of the respondents	Household characteristics	Adaptive capacity
8	Gender of the respondents	Household characteristics	Adaptive capacity
9	Engagement in non-farm activities	Household characteristics	Adaptive capacity
10	Engagement in research	Household characteristics	Adaptive capacity
11	Total credit amount	Household characteristics	Adaptive capacity
12	Total value of production assets as at time of purchase	Household characteristics	Adaptive capacity
13	Involvement in agricultural extension activity	Household characteristics	Adaptive capacity
14	Distance to the nearest town	Household characteristics	Adaptive capacity
15	Member of group association	Household characteristics	Adaptive capacity
16	Access to credit facilities	Household characteristics	Adaptive capacity
17	Distance to market	Household characteristics	Adaptive capacity

Source: Ajibola, (2014)