

**THE ROLE OF INDIGENOUS KNOWLEDGE ON CLIMATE CHANGE
ADAPTATION IN AGRICULTURE IN SABO GARI LOCAL GOVERNMENT
AREA, KADUNA STATE, NIGERIA.**

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**A DISSERTATION SUBMITTED IN PARTIAL FULFILLMENT OF
THE REQUIREMENT FOR THE DEGREE OF MASTERS OF SCIENCE IN
MANAGEMENT OF NATURAL RESOURCES FOR SUSTAINABLE
AGRICULTURE OF SOKOINE UNIVERSITY OF AGRICULTURE.
MOROGORO, TANZANIA.**

ABSTRACT

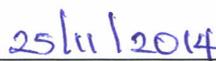
Africa is one of the most prone continents to climate change impacts because of its dependence on climate sensitive sectors including rain-fed agriculture. Recent studies predicted that global agricultural share to GDP could shrink by 4 percent due to climate change by 2100. Hence, the study examined the role of indigenous knowledge on climate change adaptation in agriculture in Sabo Gari LGA, Kaduna State, Nigeria where little documentation has been done. Using a cross-sectional design, five villages were purposively selected whereby 30 households were randomly selected from each village making 150 respondents in total. Household surveys and key informant interviews were used in data collection. Both qualitative and quantitative data were collected. Quantitative data were analysed through a Statistical Package for Social Sciences. Both descriptive and inferential statistical analyses were done whilst, qualitative data were analysed through content analysis. The study showed a high level of climate change awareness among the farmers. Negative effects of climate change include drought, irregular rains, crop pests and diseases. Indigenous adaptation strategies used in the study area include crop rotation, application of farmyard manure, irrigation, mixed cropping, wood ash application and intercropping whereby, application of farmyard manure ranked highest strategy for climate adaptation but mainly for poor households. Farmers also have the ability to use their indigenous knowledge to predict weather conditions. Marital status significantly enhanced the use of FYM while age of the farmer significantly constrained the use of farmyard manure. In conclusion, indigenous practises are very effective in adapting to climate change and still being practised by farmers in the study area in improving their agricultural productivity. Therefore, it is recommended that research institutions and policy makers, should promote the use of indigenous adaptation strategies.

DECLARATION

I, Mary Oiza Chatta, do hereby declare to the Senate of Sokoine University of Agriculture that this dissertation is my own original work and that it has not been nor is concurrently being submitted for a higher degree award to any other institution.



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(M.Sc. Candidate)

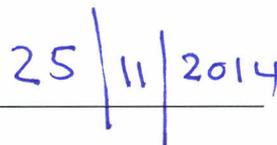


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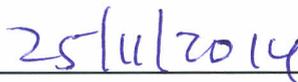
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DEDICATION

This work is dedicated to God the Almighty, my father (late) Mr. James Chatta, and my mother Mrs. Elizabeth Chatta, who laid the foundation of my education and for all the support and sacrifices. May God Almighty bless and prosper you.

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LIST OF ABBREVIATIONS

AAI	Action Aid International
CFCs	Chlorofluorocarbons
DDT	Dichloro Diphenyl Trichloroethane
FAO	Food Agriculture Organisation of the United Nations
FEMA	Federal Emergency Management Agency
FYM	Farmyard Manure
GDP	Gross Domestic Product
GHGs	Green House Gases
IFAD	International Fund for Agricultural Development
IFOAM	International Federation of Organic Agriculture Movement
ILEIA	Information Center for Low-External-Input and Sustainable Agriculture
IPCC	Intergovernmental Panel on Climate Change
LEISA	Low External Input and Sustainable Agriculture
LGA	Local Government Area
MoEF-GPPB	Ministry of Environment and Forestry- Government of the Peoples' Republic of Bangladesh
NIMET	Nigeria Meteorological Agency
NSTA	National Science Teachers Association
SPSS	Statistical Package for Social Sciences
UNFCCC	United Nations Framework Convention on Climate Change
UNICEF	United Nations Children Education Fund
WHO	World Health Organization of the United Nations
USGCRP	United States Global Change Research Program

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background

The impacts of climate change are felt in both developed and developing countries. However, Africa is one of the most prone continents to climate change impacts (Thornton *et al.*, 2002). The poor communities are being superimposed on existing vulnerabilities (FAO, 2007) because of their dependence on climate sensitive sectors such as rain-fed agriculture, livestock rearing, fisheries, and forest products extraction (IPCC, 2007; Stern, 2007) thus, affecting their livelihoods and economic development. Furthermore, it poses a serious risk to poverty reduction and threatens development efforts (IPCC, 2001). Current global projections predict sea level rise of between 18 and 59 cm by 2090-2099 with an accompanied consequences or impacts such as fiercer weather, increased frequency of fires and increased intensity of storms, floods, hurricanes and droughts (George, 2012) thus, decreasing economic growth, increasing poverty and malnutrition and negative changes in health status.

The sector mostly impacted by climate change is agriculture, which is the major contributor to the economies of many developing countries especially in Africa (Kurukulasuriya and Rosenthal, 2003) with contribution ranging from 10 to 70 percent of most of the African countries' GDP (Mendelsohn *et al.*, 2000). Agriculture accounts for 34 percent of Sub-Saharan Africa's GDP and employs 64 percent of the labour force in the region (World Bank, 2008) with an average of 6 percent increase, reversing the trend of the preceding two decades (Badiane, 2008). According to IPCC fourth assessment report of 2007, climate change can reduce rain-fed agricultural yields by as much as 50 percent with global loss in GDP ranging from 1 to 5 percent for a 4°C warming and

regional loss could be substantially higher. Furthermore, approximately 65 percent of the land area in Africa is dry (Gnacadjia, 2010) with erratic rainfall that makes rain-fed agriculture even more vulnerable (Conway and Waage, 2010). The amount of rainfall intensity and distribution are characteristics being affected by climate change and the uncertainties surrounding global warming (Adefolalu, 2006).

Agriculture is an important sector that bolsters economic development in Nigeria, provides livelihoods for more than 70 percent of her population and contributes about 40 percent to the national GDP. However, agriculture in Nigeria depends highly on climate whereby, temperature, water, and light are the main drivers of crop growth and yield (George, 2012). According to Ishaya and Abaje (2008), Kaduna state is experiencing a decline in rainfall every year, increased incidences of drought and floods as well as crop pest and diseases, which has resulted in reduced agricultural yields especially for smallholder farmers. According to George (2012), the impacts of climate change are inescapable especially to the poor in rural areas in Nigeria. Nevertheless, there are a number of indigenous farming communities in Nigeria that have managed to survive, and in some cases even thrived by exploiting natural resource bases as their forebears who used them for generations (Reijntjes *et al.*, 1992). In addition, through the process of innovation and adaptation, local farmers have developed numerous indigenous farming systems finely tuned to many aspects of their environment (LEISA, 2000).

According to Doss and Morris (2001), the perspective of the indigenous people, the way they think and behave in relation to climate change as well as their values and aspirations, have a significant role in adapting to climate change. Local farmers in Sub-Saharan Africa have developed several adaptation strategies that have enabled them to reduce vulnerability to climate variability and extremes. One important step in reducing the

vulnerability to climatic hazards is through development of early warning systems for the prediction or forecast of the events. There is a wealth of indigenous knowledge based on prediction of weather and climate change. Ajani *et al.* (2013) posits that, the study of weather knowledge in various parts of Sub-Saharan Africa reveals a wealth of knowledge that farmers possess. These farmers have developed intricate systems of gathering, predicting, interpreting and decision-making in relation to weather. Farmers also make decisions on cropping patterns based on local predictions of climate and decisions on planting dates based on complex cultural models of weather prediction. The systems of climate forecast have been very helpful to the farmers in managing the vulnerability to climate change to a great extent.

1.2 Problem Statement and Study Justification

1.2.1 Problem Statement

Recent studies predicted that global agricultural share of GDP could shrink by 4 percent due to climate change by 2100 (Mendelsohn *et al.*, 2000). North Central of Nigeria, which is the food basket of the nation has suffered flood episodes of diverse magnitudes of recent. This has resulted into loss of lives, farmlands, and other properties worth millions of Naira (Olanrewaju and Fayemi, 2012). In Sabo gari LGA farmers, have recorded losses in agricultural produce. Farmers who relied only on farming for income now have to supplement with other manual jobs as a result of climate change effects (floods, droughts e.t.c). However, in order to survive climate change negative effects, adaptation strategies in the agricultural sector are essential. A study conducted on the role of indigenous knowledge on climate change adaptation by Anthony (2011), in Teso region in Uganda showed the effectiveness of indigenous knowledge on climate change adaptation in agriculture. Studies by Shukurat *et al.* (2012) and Lawal (2013) conducted in Nigeria, also showed the effectiveness of indigenous knowledge to climate change

however, information on how smallholder farmers in Sabo gari LGA are surviving this impact of climate change is not documented. However, studies elsewhere have shown that these vulnerable smallholder farmers are developing indigenous strategies independently. According to Nyong *et al.* (2007), indigenous knowledge is very important for designing climate change adaptation strategies. Unfortunately, adaptation strategies advocated by scientists have not considered indigenous knowledge, as it is seen to be a non-knowledge; though, it is widely acknowledged that farmers have over the years developed a number of adaptation strategies based on their indigenous knowledge. Hence, this research aimed at examining the role of indigenous knowledge on climate change adaptation in agriculture in Sabo Gari Local Government Area (LGA), in terms of adaptation measures embarked upon to combat the negative effects of climate change.

1.2.2 Study Justification

The major challenge being faced by governments, research institutions, civil society organisations and donors is inability to present opportunities for sharing adaptation strategies with large numbers of people, many with limited literacy in rural areas (Alu, 2011). Thus, information obtained from this study will be documented and made available to policy makers and researchers at local, national and international levels. This work therefore, will go a long way to providing vital information on what the rural communities are doing to adapt to the effects of climate change in order to reduce agricultural losses, since their livelihood depends on agriculture. Thus, information on the effect and indigenous knowledge strategies to climate change used by the rural dwellers of Sabo gari LGA to cushion the effects of climate change on their livelihoods, especially as the area is most prone to climate change effects will be identified and properly documented. The need for such baseline information, especially relating to designing appropriate strategies for adaptation to climate change effect on agriculture, cannot be

overemphasized. According to Ancha (2004), one of the promising methods to design socially benign and culturally appropriate adaptation policies is to document and understand local strategies to adapt to climate change

1.3 Objectives

1.3.1 Main Objective

To assess the role of indigenous knowledge on climate change adaptation in Agriculture in Sabo Gari Local Government Area of Kaduna State, Nigeria.

1.3.2 Specific Objectives

This study centered on the following specific objectives:

- i. To assess the level of farmers awareness on climate change in the study area;
- ii. To assess the negative effects of climate change on farming systems in the study area;
- iii. To identify indigenous adaptation strategies used by farmers in adapting to the negative effects of climate change;
- iv. To assess indigenous indicators for predicting weather conditions; and
- v. To determine socio-economic factors influencing key indigenous adaptation strategy.

1.3.3 Research Questions

- i) What is the level of awareness of the farmers on climate change in terms of indicators, causes, observations and perceptions in the study area?
- ii) What are the negative effects of climate change on the farming community?
- iii) What are the indigenous climate change adaptation strategies used by the farmers in the study area?

- iv) What are the indigenous indicators for predicting weather conditions in the study area?
- vi) What are the socio-economic factors enhancing and constraining the use of key indigenous climate adaptation strategy?

1.4 Conceptual Framework

This study assessed the negative effects of climate change because, it compromises the livelihoods of the people. Climate change is already having significant negative effects, and the effects are expected to increase in the future (NASPA, 2011). Some of the negative effects include low rainfall, irregular rainy seasons, heavy rainfall, occurrence of floods, and erosion leading to low yield of crops, crop failure, crop pests and diseases outbreaks thus, affecting peoples' livelihoods and leads to food insecurity. The negative effects of climate change are inescapable especially by the poor people in the rural areas of Nigeria. However, in order to reduce the negative effects, farmers have developed indigenous adaptation strategies to which have proven to be effective in their social settings. The indigenous strategies have either been enhanced or constrained by a number of socio-economic factors as shown in Figure 1.

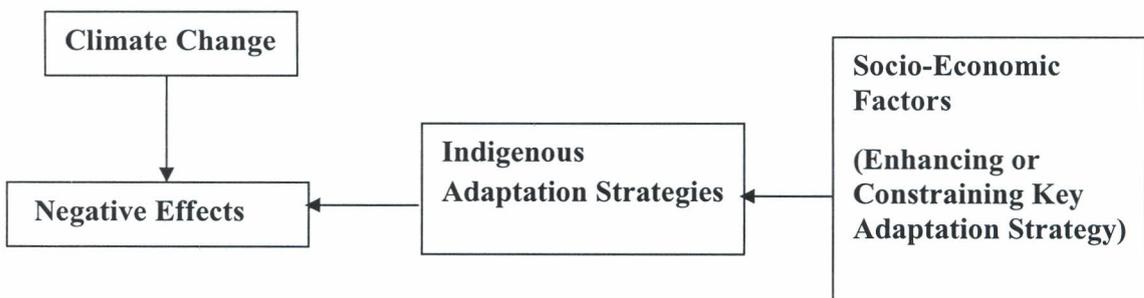


Figure 1: Conceptual Framework Underlying the Study

1.5 Limitations of the Study

i) High level of illiteracy

The majority of farmers in the study area are illiterates thus, the researcher had to translate the questions into the local language for easy comprehension. This made data collection process tedious and time consuming.

ii) Reluctance of farmers to give information

Some of the selected farmers were reluctant to give information especially about household income. Thus, the researcher had to select other farmers who were ready to give out information for the study. This made the process time consuming.

iii) Social insecurity in Northern Nigeria

The study was conducted during the morning time because of the social insecurity in Northern Nigeria. Thus, the researcher did not meet some of the farmers at their respective homes but at their farmlands. However, the researcher had to wait until they had finished their work before interviewing them. Therefore, a lot of time was spent making repeated visits in order to get all the information needed for the study.

1.6 Organisation of the Study

This dissertation is organised into five chapters, including this introductory chapter. The second chapter reviewed empirical literature on climate change, indigenous adaptation strategies and socio-economic factors influencing indigenous adaptation strategies. Chapter three presents research methodology. Chapter four presents research results and discussion whilst chapter five, provides conclusion and recommendations.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Definitions of Key Terms

2.1.1 Climate Change

In the context of environmental policy, the term climate change refers to the rise in average surface temperature known as global warming (Ezekiel *et al.*, 2012). NASPA (2011) defined climate change as any change in climate over time, whether due to natural variability or due to human activities. UNFCCC (1992) defines climate change as change attributed directly or indirectly by human activities that alter the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable period of time. Generally, climate change refers to long-term alterations in global weather patterns including rise in temperature over time, rainfall fluctuations and storm activities evolved from the potential consequences of the greenhouse gases effect and continuous deforestation (Ezekiel *et al.*, 2012).

2.1.2 Indigenous Knowledge

Kajembe *et al.* (2010) defines indigenous knowledge as a body or stock of skills and experiences resulting from a long tradition of direct interaction between the local people and their environment. According to Ajibade and Shokemi (2003), indigenous knowledge describes the knowledge systems developed by a community as opposed to the scientific knowledge generally referred to as modern knowledge. Robinson and Herbert (2001) argues that indigenous knowledge is the basis for local level decision making in many rural communities and has value not only for the culture in which it evolved from, but also for the scientists and planners striving to improve conditions in rural areas. Generally, indigenous knowledge for mitigation or adaptation to climate change may be

described as knowledge unique to a given culture or society, acquired through accumulation of experiences of the local people (farmers, landless labourers, women, rural artisans, herders, etc.) through informal experimentation and intimate understanding of the natural systems stressed by climate change and socio-economic development (Ancha, 2004).

2.1.3 Adaptation and Mitigation

NASPA (2011) defines adaptation as longer-term strategies, which deal with climate change (in contrast to short-term coping strategies) and it is an adjustment in natural or human systems, which moderates the harm or exploits beneficial opportunities associated with climate change. Adaptation is usually a longer-term livelihood activity and is a continuous process that sustain results. It uses resources efficiently and sustainably, involving planning, combines new and old strategies and knowledge, and is focused on finding alternatives. IPCC (2001) defines adaptation to climate change, as an adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities.

IPCC (2007) defines mitigation as an anthropogenic intervention to reduce the sources or enhance the sinks of greenhouse gases. FEMA (2014) defines mitigation as an effort to reduce loss of life and property by lessening the impact of disaster or any action taken to permanently eliminate or reduce the long-term risk and hazards of climate change to human life and property. Mitigation is also taking action now before the next disaster to reduce human and financial consequences later.

2.1.4 Effectiveness

The business dictionary defines effectiveness as the degree to which objectives are achieved and the extent to which targeted problems are solved (<http://www.>

businessdictionary.com/definition/effectiveness.html). Wikipedia also defines effectiveness as the capability of producing a desired result. When something is deemed effective, it means it has an intended or expected outcome, or produces a deep, vivid impression (<http://www.wikipedia.org/wiki/effectiveness>).

2.2 Causes of Climate Change

WHO (2003), Odjugo (2010) and UNFCCC (1992), asserts that climate change is caused by both natural and anthropogenic activities, especially those that alter the balance of gases in the atmosphere thus, leading to global warming and results into significant impacts. According to Gyampoh *et al.* (2009), climate change and global warming is caused by buildup of greenhouse gases (GHGs); such as carbon dioxide, nitrous oxide, chlorofluorocarbons (CFCs) and methane in the atmosphere.

- Carbon dioxide is produced when coal, oil, and natural gas (fossil fuels) burn to produce energy used for transportation, manufacturing, heating, cooling, electricity generation, and other applications. Fossil fuel currently accounts for 80 to 85 percent of carbon dioxide being added to the atmosphere. Clearing land for logging, ranching and agriculture, also leads to carbon dioxide emissions. In addition, current global concern focus on climate change resulting from human activities and specifically from the release of carbon dioxide and other greenhouse gases to the atmosphere. The burning of fossil fuels, clearing of forests and other human activities are major sources of greenhouse gas emissions (Ezekiel *et al.*, 2012).

2.3 Climate Change Impacts on Agriculture

According to IFAD (2009), increase in temperature increases plant tissues and thus reduce the digestibility and rate of degradation of plant tissues. However, high

temperature hastens plant maturity, especially in crop species, shortens growth stages during which pods, seeds and grains can absorb photosynthetic products. Low temperature also reduces the yield of wheat, corn and barley, which are cereal grains that forms the foundation of most world's diet by 40 million metric tons (Lorraine, 2007).

Nasiru (2012) reported that climate change already has significant impacts in Nigeria. There are increases of incidence of diseases on crops, declining agricultural productivity, and a rising number of heat waves. There is glaring evidence that climate change is not only happening but it is changing our lives. Declining rainfall in already desert-prone areas in Northern Nigeria is causing increasing desertification, the former food basket in central Nigeria is now empty, and people in the coastal areas who used to depend on fishing have seen their livelihoods destroyed by the rising waters.

In Nigeria, some areas like the Niger Delta region receive more than normal rainfall, while some areas in the Northern region receive almost no rainfall, as a result growing seasons are changing, ecological zones are shifting, and rainfall is becoming more unpredictable and unreliable both in its timing and its volume (Brett, 2009). Too much precipitation can cause disease infestation in crops, while too little can be detrimental to crop yield leading to decline in agricultural productivity (IPCC, 2007), especially if dry periods occur during critical crop development stages. For example, moisture stress during flowering, pollination, and grain-filling stages is very harmful to maize, soya beans, wheat and sorghum even rice which feeds more than half of the world's population (Lorraine, 2007).

According to Brett (2009), 75 to 250 million Africans are projected to be exposed to an increased water stress due to changes in rainfall patterns, and the amount and availability

of water stored in the soil which is a crucial input to crop growth will be affected by changes to both precipitation and seasonal annual evaporation and transpiration. Agricultural productivity yields and access to food in many African countries and regions is projected to severely decrease because of climate variability and change in precipitation. The area suitable for agriculture, the length of growing seasons and yield potential, particularly along the margins of semi-arid and arid areas, is expected to decrease. In some countries, yields from rain-fed agriculture will be reduced by up to 50 percent by 2020 (Brett, 2009).

2.3.1 Climate Change Impacts on Livelihoods

The impacts of climate change cannot be overemphasized. According to National Science Teachers Association (NSTA, 2010), the 2010 floods in Pakistan describes the worst ever scenario in that country's history, affecting 20 million people. In the same year, floods in Colombia displaced over 400,000 people; and extreme weather conditions locked Russia in the worst heat wave and drought in its documented history, with hundreds of wildfires burning out of control, destroying a quarter of Russia's crops and prompting a ban on grain exports. NSTA further reported that in 2014, drought, extreme heat and wildfires have increased in California with the Californian State government proposing to impose a fine of \$500 a day for wasting water.

Drought-induced famine and locusts and an increase in the number of extreme heat days, have also affected Niger Republic and northern Nigeria (NASPA, 2011). Between 1941 and 1970, only patches of Nigeria in the northeast, northwest, and southeast experienced late onset of rains. However, from 1971 to 2000 late onset of rains did spread to most parts, leaving only a narrow band in the middle of the country with normal rainfall patterns (NASPA, 2011).

2.4 Awareness About Climate Change

The awareness on climate problems and the potential benefits of taking action is an important determining factor of adoption to agricultural technologies (Hassan and Nhemachena, 2002). Maddison (2006) argued that farmers' awareness on climate change attributes (temperature and precipitation) is important to adaptation decision making. Anita and Julie (2007) posit that, lower awareness is evident in the Middle East and North Africa, Asia, and Sub-Saharan Africa regions. Slightly more than half of adults in the Middle East and North Africa and Asia regions report basic awareness on climate change. Awareness is lowest among adults in sub-Saharan Africa, where 44% of adults report knowing at least something about the concept of climate change. While in Europe and America, more than 8 out of 10 adults of the population said they know at least something about climate change. In addition, these two regions have the greatest percentage of adults who report knowing a great deal about the concept of climate change and its impacts.

Eurobarometer survey conducted in 2007 found that around 90% of British citizens were concerned about climate change, which means they were aware of climate change. However, climate change continues to be a low priority issue for most people when contrasted with other societal issues such as the economy, education, or the threat of terrorism (Upham *et al.*, 2009). In recent years, the level of reported concern about climate change has fallen somewhat, accompanied by an increase in the number of people expressing uncertainty about the reality of human influence on the climate (BBC, 2010; Leiserowitz *et al.*, 2010; Pew Research Centre, 2009; Whitmarsh, 2011).

Anita and Julie (2007) had the opinion that the majority of the world's adult populations are aware of the concept of climate change, but a substantial minority are not aware. Furthermore, those who are aware are more likely to say climate change poses a serious

threat to themselves and their families. Results vary by region and among each of the top five greenhouse gas-emitting countries (United States, Western Europe, China, Eastern Europe and Russia), underscoring the challenge leaders face in reaching a global climate agreement.

2.5 Indigenous Adaptation Strategies to Negative Impacts of Climate Change

Richards (1986), studying the Mende farming systems in Sierra Leone demonstrates how farmers use sophisticated agronomic practises to mediate poor rainfall. Watts (1983) pointed out that in Northern Nigeria, farmers used multiple cropping and varietal experimentation to mitigate against uncertain precipitation and high rates of evaporation. Guthiga and Newsham (2011) argues that, the Nganyi community of western Kenya, use traditional methods of weather forecasting including the behaviour of ants, bird songs and timing of tree flowering to decide when to prepare lands and sow seeds. Gyampoh *et al.* (2009) showed that the people in the rural communities in Ghana realized that water shortage is a major threat to their survival and have developed several strategies to adapt to this phenomenon. One is to reuse water, for example from washing clothes or utensils to irrigate backyard gardens and nurseries. Households also ration water, trying to reduce the water use per person per day but abandon this strategy as soon as the rains begin. This strategy needs to be part of a behavioural changes and not applied only during periods of water shortages.

Ajibade and Shokemi, (2003) reported that farmers in Nigeria are able to use knowledge of weather systems such as rainfall, thunderstorms, windstorms, harmattan (a dry dusty wind that blows along the north-west coast of Africa) and sunshine to predict future weather. Indigenous methods of weather forecasting are known to complement farmers planning in Nigeria. In the Northern part of Nigeria, if there is prolonged heavy rain

season in a particular year then one is able to predict that the harmattan period for that particular year will be intense.

Altieri and Nicholls (2004) asserts that wide varieties of traditional and innovative rainwater harvesting systems are found in Africa's Sahel zone. In semi-arid areas of Niger Republic, small-scale farmers use planting pits to harvest rainwater and rehabilitate degraded land for cultivation of millet and sorghum. The technology improves infiltration and increases nutrient availability on sandy and loamy soils leading to significant increase in yields, improves soil cover and reduces downstream flooding thus, enabling farmers to harvest water from rooftops and divert water from natural springs into tanks. This ensures that they have a substantial amount of water stored.

In the case of a drought, the stored water is able to sustain them for about five months depending on the volume of the tank. The water is thus, used for supplementary irrigation of vegetables and other crops. Some farmers dig infiltration pits along contours to collect water in the pits during rainy periods. When the weather becomes dry due to short periods of rainfall, the water infiltrates underground and it is used by the plants. Crops can grow up to maturity by using this conserved moisture. Farmers experience shows that even if there are only five days with rains in the complete rainy season, the crops reach maturity using conserved and harvested water in the pits. Farmers practising dry season agriculture, harvest rainwater and conserve it in basins or wells. In the dry season, the water conserved in the wells and basins is used for irrigation. Combinations of indigenous and scientific techniques have the potentialities of contributing to productivity and sustaining the farming systems (Alteiri and Nicholls, 2004).

ILEIA (1992) and Goodell (1984) asserts that, indigenous techniques used for pest control include use of hoes for weeding, intercropping, rotation patterns and pest resistant seed varieties. At germination stage, indigenous technique being used to control weeds is hoe while at later stages the use of pest control chemicals is a norm. The implications of integrated pest management techniques are that the costs and side effects of pest chemicals is minimal. The use of integrated techniques for pest management help to overcome the limitations, which results from using indigenous and scientific techniques separately.

FAO (2010) reported that crops grown under a range of water management regimes, from simple soil tillage aimed at increasing infiltration of rainfall, to sophisticated irrigation technologies and management has increased crop yield for more than 50 percent. However, about 80 percent of the estimated 1.4 billion ha of crop land worldwide is rain-fed and accounts for about 60 percent of global agricultural output. Under rain-fed conditions, water management attempts to control the amount of water available to a crop through opportunistic deviation of the rainwater pathways toward enhanced moisture storage in the root zone. However, rainfall pattern and not the farmer, determines the timing of water application.

Schmuck-Widmann (2001) points out that, char dwellers in Bangladesh build mounds and construct their dwellings to minimize damage from floods and plant catkin reed (*Saccharum spontaneum*) to protect chars from erosion. Catkin reed, grows with the water level and survive floods as well as promote the stabilization of new land through fixing fine fertile sediments. In addition, it serves as the most important fodder during the monsoon season, fuel and building material. To prepare for a rise in the water level, the char people pay attention to signals given by climatic conditions and their bodies. They

expect a water level rise in about a week after they observe clouds piling up like treetops, then flattening out in the following days and moving with strong winds for at least three days from South to North. In addition, char-dwellers report body feelings such as heavy sweating like fever, rheumatic pains and extraordinary exhaustion just before floods.

Kangalawe *et al.* (2011) reported that in Kilolo Tanzania, some farmers practise fallow where they abandon their farms for a while to allow for natural fertility regeneration and to control crop pests and diseases. However, it is those with large land areas who do this. Some practise crop rotation, while others plant their crops e.g. maize very early in the season, soon after they harvest beans because they normally plant beans three times a year (in March or April, July or August and in September). To assure themselves against crop failure they do mix various crops together, such as maize and beans with vegetables and sweet potatoes. Because of the prevalence of new crop pests around Kilolo, farmers who grow maize have to use pesticides such as DDT, Super Actellic and Thiodan. However, there are also traditional pesticides in this area, locally known as “*Lingategeta*”, a tuber like plant, that is dug from the ground, dried up, pounded and the powder is soaked in water and used to spray on the crops.

2.6 Socio-Economic Factors Influencing Indigenous Adaptation Strategies.

Different socio-economic factors influence indigenous strategies. Land tenure and fragmentation systems could limit the capacity of farmers to adapt to climate change using indigenous based knowledge. Among most African people, farmland is not owned but held in trust by the present generation on behalf of their future generations. It could be held by individual families, extended families or entire village communities and then fragmented to individual farmers, who only enjoy user rights. Outright purchase of farmland is not common, but rental for a certain period could be possible (Nweke and Enete, 1999). This limits the level of individual farmer’s investment in the development

of a farmland, since the user right could be withdrawn anytime. In addition, the fragmented nature of farmland could hamper the farmers capacity to adopt innovative farming practises that may be necessary for climate change adaptation. IFAD (2010) reported that, smallholder farmers who cultivate small plots of land usually less than 1 hectare of land per household produce about 90 percent of Nigeria's food.

According to Anyanwu and Agu (1996), sex is a factor that limits the woman folks from adapting to climate change. Despite women's increasingly prominent role in agriculture, they remain severely disadvantaged in terms of their access to productive resources. African culture generally discriminates a lot against women especially in areas of inheritance of land. For instance, in places where women do not own or inherit land, difficulties are being experienced in expanding farming activities and reaping the benefits of innovation. FAO (2010) survey showed that female farmers receive only seven percent of all agricultural extension services worldwide and that only 11 percent of extension agents are women.

Eboh and Ogbazi (1990) also observed that, women are rarely organised into agricultural cooperative societies or other functional associations while agricultural extension programmes and other supporting services have traditionally concentrated more on educating male farmers; hence, women still largely depend on their husbands for farm related information (Raffety, 1998).

Apata *et al.* (2010) reported that capital, land and labour serve as important factors for coping with adequate adaptation. Stressing that lack of these factors as well as choice of suitable adaptive measures constitute severe challenge to agricultural adaptation. Onyeneke and Madukwe (2010) reported that, lack of finance hinders farmers from

getting the necessary resources and technologies that facilitate adapting to climate change. This is consistent with Deressa *et al.* (2008) who reported that, adaptation to climate change is costly, and the need for intensive labour use exacerbate this cost. Onyeneke and Madukwe (2010) identified other barriers to include lack of information on appropriate adaption options, poor access to market and shortage of farm labour.

Nzeh and Eboh, (2011) further asserts that lack of awareness and knowledge of climate change is perhaps the biggest obstacle to effective agricultural adaptation. The study by Enete and Amusa (2010) identified six major challenges to climate change adaptation. These include hunger and poverty, poor agricultural funding for research and technology development and traditional agricultural practises. Others are trade liberalization and market development, weak policies, institutions, and inadequate information and human capital.

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1 Study Site

3.1.1 Location

The study was carried out in Sabo Gari Local Government Area of Kaduna State in Nigeria (Figure 2). Sabo Gari is located in the Northern Guinea Savannah Zone of Kaduna State. The local government area is located at about 700m above sea level and located between $11^{\circ}3'$ and $11^{\circ}15'$ N of the equator and between $7^{\circ}30'$ and $7^{\circ}45'$ E of the Greenwich meridian (Mortimore, 1970). According to the 2006 census, the population of the area was 286,871 (Federal Republic of Nigeria, 2007) and over 65 percent of the population is made up of rural dwellers.

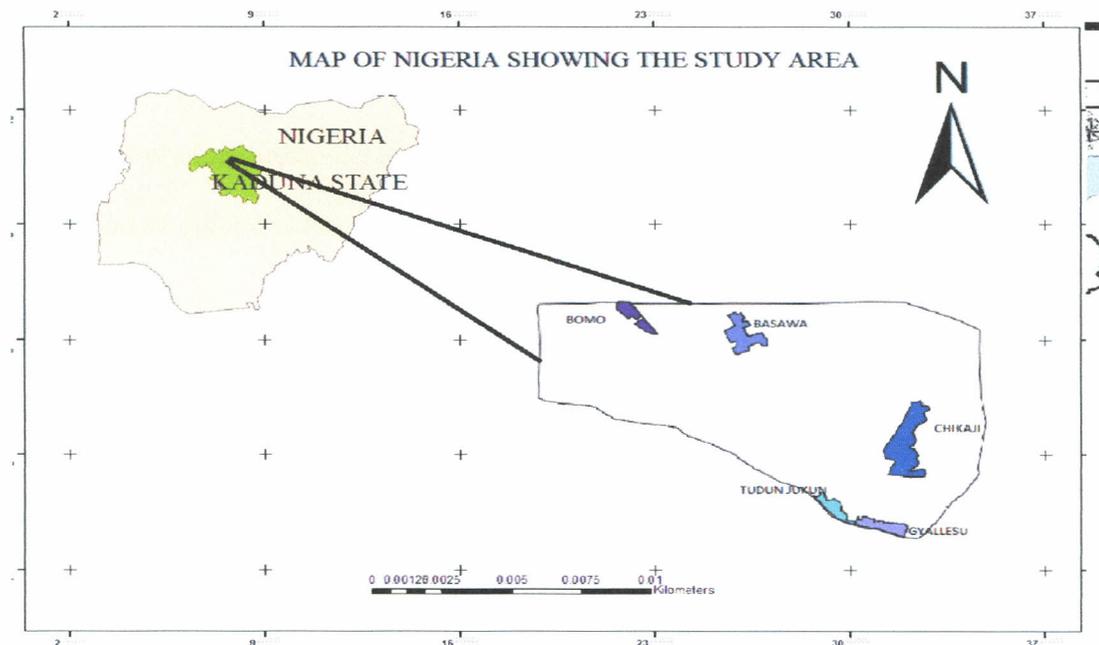


Figure 2: Map of Sabo Gari Local Government Area

Source: Adapted and modified from the administrative map of Kaduna State/Google Maps, 2014

The predominant language is Hausa and the majority of the populace are Muslims. However, development has led to intermingling of Igbos and Yorubas especially in the urban centers. The composition of the population is made up of about 20% of each major Nigerian tribes such as Igbo, Anga, Hausa, Yoruba, Bajju, Tiv, Fulani and Ikulu. Even people from neighbouring countries including Niger Republic, Cameroon, Togo, Ghana, and Benin Republic are found in the area; hence, this area is regarded as “mini Nigeria” (Ibrahim *et al.*, 2012).

3.1.2 Topography and Climate

The area has a characteristic tropical continental climate, marked by distinct wet and dry seasons. The dry season begins in October and ends towards March and early April and rainfall extends from April to October and ranges between 100 and 1000 mm with a mean temperature ranging from 27.20° to 35°C. Dry season is characterised by dust cold dry wind of the harmattan, towards late November to February. The rainfall sometimes come with heavy down pour, which lead to collapse of buildings. Generally, northern Kaduna has a relatively low precipitation with average annual rainfall of about 127 mm and the peak period of rainfall is August-September (Ibrahim *et al.*, 2012).

3.1.3 Vegetation

The vegetation is savanna where trees, shrubs and grasses are scattered over the area. Trees have characteristic thick bark and hard leaves to enable them survive the harsh environment. Trees found in the area include baobab, silk cotton and Shea-butter. Shrubs include *Isobertina doka* and *Parkia biglobosa* (Yusuf and Ukoje, 2013)

3.1.4 Socio-Economic Activities

The major socio-economic activities carried out in the study area include crop cultivation and livestock production. The major crops grown in the area include millet, groundnut,

cowpea, yam, sugarcane, rice and vegetables such as tomatoes, onions and pepper. The major livestock kept include goats, sheep, cattle and poultry. Simple farm implements such as hoes and cutlasses are used and human labour is being used for farming activities alongside small size and fragmented land holdings (Ibrahim *et al.*, 2012)

3.2 Research Design

The study was based on a cross-sectional design because of its nature, which involved collecting data from a selected population at one point in time. Saunders *et al.* (2007) defines cross sectional survey as a method of collecting data at one point in a time from a selected sample of respondents.

3.3 Sampling Design

Five villages in Sabo Gari LGA were purposively selected for the study based on their involvement in agricultural production. Random sampling technique was used to select 30 households from the five villages making a total of 150 respondents. United States Census Bureau (USCB) (2004) defines a household as being maintained by a householder who is in a family and includes any unrelated people (unrelated sub-family members and /or secondary individuals) who may be residing there. Bailey (1995) argued that 30-sample size of the total population is reasonable for statistical analysis.

3.4 Data Collection Methods

3.4.1 Primary Data Collection

Primary data including both qualitative and quantitative were collected. Structured questionnaire with closed and opened ended questions was administered to household heads or their representatives in order to meet the objectives of the study. In addition, key informant interviews were used to supplement the information.

3.4.1.1 Household Survey

Questionnaire (Appendix 1) was administered to respondents in 5 villages of Bomo, Basawa, Tudun jukun, Chikaji and Gyallesu. Furthermore, the questionnaire was written in English language but was translated into the local language of the area (Hausa) for easy data collection and comprehension by the household heads or their representatives. The researcher personally administered the instrument to respondents with the help of research enumerators.

3.4.1.2 Key Informant Interviews

A checklist (Appendix 2) was used to collect additional information from well-informed and knowledgeable people. Key informant interviews are qualitative in-depth interviews with people who are aware of what is going on in the community. It is face to face and resembles a conversation among acquaintances, allowing for a free flow of ideas and information (USAID, 1996). Key informants were selected on the basis of being born and raised in the area and had spent more than 30 years in the study area. 20 key informants (village leaders and elders) were used in the study.

3.4.2 Secondary Data Collection

Additional information from different sources such as Sokoine University library, internet to obtain journals specifically from Nigeria Meteorological Agency (NIMET), articles and other relevant publications were collected to compliment and enrich the study.

3.5 Data Processing and Analysis

Data processing and analysis were conducted at the Institute for Agricultural Research, Zaria, Kaduna State, Nigeria. The data was sorted, coded and summarised before analysis. The analysis was done using the Statistical Package for Social Sciences (SPSS Version

16.0). Both descriptive and inferential statistical analyses were done whilst, qualitative data were analysed through content analysis. Data for objectives 1 and 2 were analysed using descriptive statistical analysis to obtain frequencies and percentages. Data for objective 3 was analysed using descriptive statistical analysis to obtain frequencies and percentages also, content analysis was also used. The indigenous adaptation strategy with the highest percentage of been very effective will be used as the key indigenous adaptation strategy. Data for objective 4 was analysed through content analysis.

Data for objective 5 used the General Multiple Regression Equation for inferential statistical analysis as given by:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \dots + \beta_i X_i + \varepsilon$$

Where,

Y= the level of effectiveness of the use of farmyard manure (FYM)

(i.e 1-not effective, 2- less effective, 3- effective, 4- very effective)

X_1 to X_i = independent variables

X_1 = Age

X_2 = Sex

X_3 = Educational level

X_4 = Household size

X_5 = Income per annum

X_6 = Extension services

X_7 = Marital status

β_0 = intercept at Y-axis (dependent variable)

Beta₁ to Beta_i = independent variable coefficients

ε = random disturbance error.

$i = 1, 2 \dots n$ where 'n' is the total number of variables

Multiple regression assumes that

- a) The underlying relationship between variables was linear;
- b) The errors were independent;
- c) There was constant variance; and
- d) The errors were normally distributed.

Table 1, shows independent variables and their expected signs of Beta values.

Table 1: Independent Variables and their Expected Signs of Beta values

Variables	Description	Assumptions
X ₁	Age of household head	As farmers increase in age, their use of FYM decreases because of its bulkiness and it is strenuous during application. Thus, older farmers tend to use less FYM as compared to younger farmers (- Beta).
X ₂	Sex of household head	Male farmers are more acquainted with strenuous farm activities. Based on FYM application method more males are likely to be involved in the use of FYM than their female counterparts (+ Beta). In addition, more female farmers in the village will lead to decrease in the use of FYM (-Beta).
X ₃	Educational level	As the educational level of farmers increases, it is expected that their use of FYM tend to decrease because the higher the educational level the more exposed they will be to modern agricultural technologies (-Beta).
X ₄	Household size	It is assumed that large households use more of FYM because there is more available labour required for its application compared to small household size with less labour (+ Beta).
X ₅	Income per annum	It is expected that poor farmers, use FYM because it is easy to come by and at a cheaper price compared to inorganic fertilisers (-Beta).
X ₆	Access to extension services	Extension workers promote agricultural technologies such as the use of chemical fertilisers and not FYM (-Beta).
X ₇	Marital status	It is assumed that married farmers will have more cheap labour required for application of FYM than unmarried farmers (+ Beta).

CHAPTER FOUR

4.0 RESULTS AND DISCUSSION

4.1 Awareness on Climate Change

4.1.1 Farmers' Who Have Heard the Concept of Climate Change in the Study Area

The findings on farmers' awareness on climate change showed that, 68% of the farmers said they have never heard the concept of climate change and the rest (32%) said they have heard the concept (Figure 3). Those who said they have heard the concept pointed out that they heard it from different sources including from extension officers, educated friends, schools and the media. A study by Anslem *et al.* (2011) in the southeastern part of Nigeria revealed a higher percentage (96%) of those who said they have heard the concept of climate change. Another study conducted in Oyo state, southwestern Nigeria by Adetayo (2012), also revealed results with high percentage (87.5%) of respondents who have heard about the concept of climate change. These differences might be because the rural people in the southeastern and southwestern parts of Nigeria are more exposed and educated than the rural farmers in the northern part of Nigeria (UNICEF, 2005).

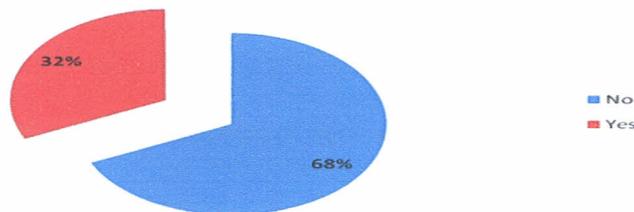


Figure 3: Farmers who have heard the Concept of Climate Change

This study showed that 40% of the respondents had secondary school education, 24.7% had no formal education whilst, 6.7% had tertiary education (Figure 4). A study by UNICEF (2005) reported that northern Nigeria's level of education is the lowest in the country. Bartle (2002) argued that, education has the capability to enlighten people and make people aware of their environment in development activities.

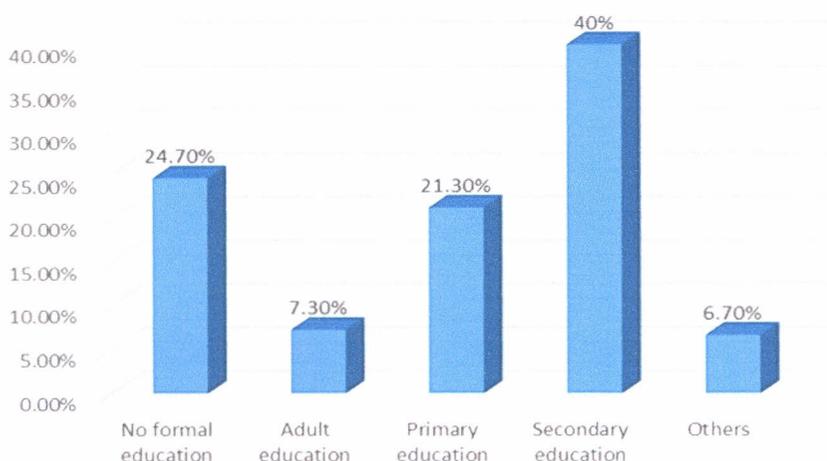


Figure 4: Educational Level of Farmers in the Study Area

According to UNICEF (2005) 40% of Nigerian children, aged 6 to 10 do not attend formal education with the northern region having the lowest school attendance rate. Bartle (2002) had the opinion that proper knowledge is required to face climate change impacts because education broadens individuals' understanding and physical abilities or skills in the pursuit of life and it thus, equip people to face challenges. Rogers (2003) argues that education has influence on the adoption of agricultural technologies.

4.1.2 Farmers' Awareness on "Climate Change" Indicators

Table 2 shows that farmers in the study area were aware of "climate change" in terms of changes in droughts incidences, floods, coldness, heat, crop pests and disease incidence.

wind speed, crop yields and rainfall patterns however, the majority of farmers were not able to correlate the observed changes to “climate change” concept. The changes observed by farmers are the same indicators considered by scientists to be climate change. From these result it is evident that farmers in the study area do not share the same concept of climate change or meaning with scientists but both observe the same changes.

Table 2: Farmers’ Awareness on “Climate Change” Indicators (n = 150)

Climate change indicators	VA (%)	A (%)	NA (%)	Percentage (%)
Increased drought incidences	66.7	24.7	8.6	100.00
Increase in crop pests and diseases incidences	64.7	28.7	6.6	100.00
Short duration of rains	58.0	35.3	6.7	100.00
Decreased crop yield	55.0	40.7	4.3	100.00
Irregular rains	53.3	42.0	4.7	100.00
Extreme heat	52.0	37.3	10.7	100.00
Early onset of rains	51.3	38.0	10.7	100.00
Delayed onset of rains	48.7	39.3	12	100.00
Increased flood incidences	46.0	34.7	19.3	100.00
Extreme cold	45.3	40.7	14.0	100.00
High wind speed	44.7	41.3	14.0	100.00
Long duration of Rains	41.3	40.0	18.7	100.00

VA- very aware, A- aware, NA- not aware

The distribution of responses show that 66.7% of the farmers were very aware of “climate change” indicators in terms of increased drought incidences; 64.7% in terms of increased incidences of crop pests and diseases; 58.0% in terms of short duration of rains; 55.0% in terms of decrease in crop yield. Furthermore, 53.3% reported being very aware of “climate change” in terms of irregular rains and 48.7% in terms of delayed onset of rains. While, 52.0% and 44.7% of the farmers indicated extreme heat and high wind speed respectively. This study concur with that of Adebayo *et al.* (2013) whereby a high level of climate change awareness was recorded in Adamawa state, Nigeria. However, it

contradicts the study by Anita and Julie (2007) whereby they reported 28% awareness level in Nigeria. During the discussions, key informants reported being very aware of high wind speed especially during the rainy season because it causes serious havoc including stem and root logging, which results into destruction of crops on the field as well as destroying buildings.

Farmers reported irregular rains and temperature fluctuations in the study area over the years. The findings concur with that of Obasi and Ikubuwaje (2012) who found that rainfall and temperature in Sabo Gari LGA have been irregular as Figs. 5 and 6 indicates. From 1953 to 1960, the annual mean rainfall was above the long term mean. However, from late 1960s to early 1990s the rainfall was below the long-term mean. The rainfall started increasing from late 1990s up to 2002 (Figure 5). Figure 6 shows the trend in temperature and rainfall for 35 years such that with temperature increase there is a corresponding increase in rainfall. The rainfall of the remaining years nearly approximates the long-term mean. The study by Ati *et al.* (2009) in some of the northern states of Nigeria showed a decreasing amount of annual rainfall.

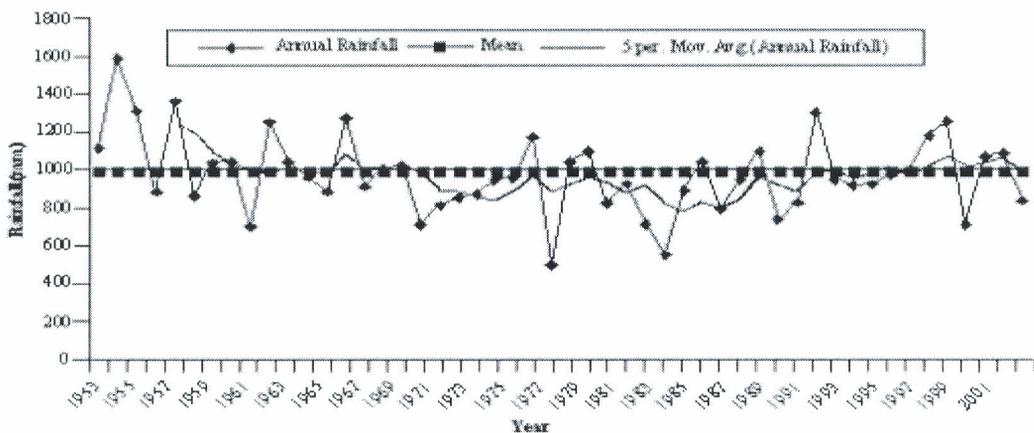


Figure 5: Rainfall for Sabo Gari LGA (1953-2002) Source: Obasi and Ikubuwaje (2012)

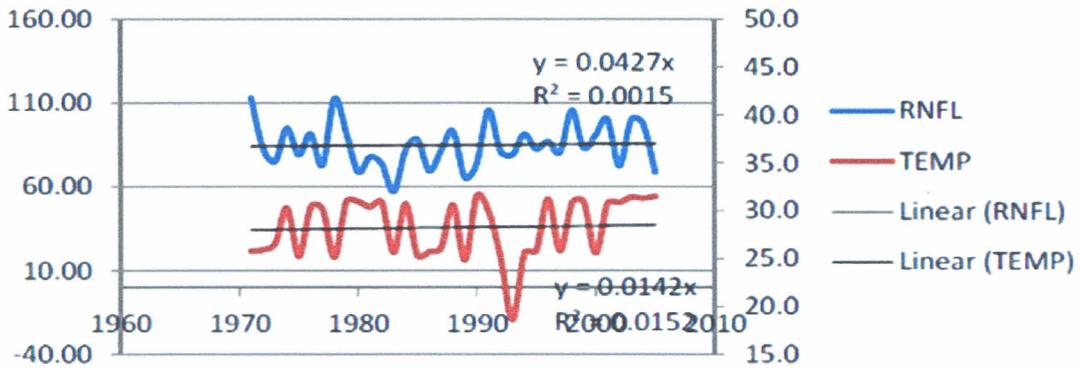


Figure 6: Annual Mean Rainfall and Temperature for Sabo Gari LGA (1971-2005)
Source: Obasi and Ikubuwaje (2012)

4.1.3 Farmers' Observations Related to "Climate Change" Trends Over Different Periods

Table 3 presents the farmers' observations on "climate change" trends. The study showed that 51.3% of the farmers observed increased drought incidences; 47.5% of the farmers observed high wind speed; 43.3% of the farmers observed increased incidences of crop pests and diseases; 38.7% of the farmers observed irregular rains while, 36.7% of the farmers observed short duration of rains, for more than 10 years.

Table 3: Farmers' Observations Related to "Climate Change" Trends Over Different Periods (n = 150)

Climatic events	≥ 10 years (%)	Last 5 years (%)	Last 2 years (%)	2013 (%)	Percentage (%)
Increased drought incidences	51.3	32.0	16.0	0.7	100.00
High wind speed	49.0	22.9	22.9	5.2	100.00
Increased crop pests and disease incidences	43.3	32.7	18.0	6.0	100.00
Long duration of rains	43.3	26.0	28.7	2.0	100.00
Extreme heat	40.7	28.0	25.3	6.0	100.00
Early onset of rains	39.3	33.3	18.0	9.4	100.00
Irregular rains					
Short duration of rains	38.7	32.7	18.0	10.6	100.00
Increased flood incidences	36.7	29.3	21.3	12.7	100.00
Extreme cold	36.0	37.3	24.7	2.0	100.00
Decreased crop yield	34.7	39.3	19.3	6.7	100.00
Delayed onset of rains	32.0	36.0	24.0	8.0	100.00
	27.3	45.4	16.0	11.3	100.00

Yet, 45.4% of the farmers observed delayed onset of rains; 37.3% of the farmers observed increase flood incidences while, 36% of the farmers observed a decrease in crop yield in the last five years. Few farmers (5.3% and 2%) observed high wind speed and incidence of flood in 2013 respectively. This implies that the majority of the farmers observed climate change in the study area for more than 10 years. This further reveals that indigenous knowledge has been in existence for more than 10 years because as the climate changes indigenous people experimented on ways to adapt to their changing environment in order to sustain their livelihoods that is the reason they still remain in such locations.

4.1.4 Farmers' Perception on the Causes of "Climate Change"

Table 4 shows farmers perception on the causes of climate change. The study revealed that farmers and scientists perceive the causes of climate change differently. Farmers

perceived the causes of climate change as follows; in which 81.3% of the farmers perceived increased incidences of crop pests and diseases; 80.7% of the farmers perceived increase drought incidences; 76.7% perceived irregular rains and 69.3% perceived early onset of rains, as only a natural event. However, Gyampoh *et al.* (2009), revealed that climate change is caused by the build-up of greenhouse gases such as carbon dioxide and methane in the atmosphere. In addition, a study by UNFCCC (1992) asserts that climate change is caused by both natural and anthropogenic activities, especially those that alter the balance of gases in the atmosphere.

Table 4: Farmers' Perception on the Causes of "Climate Change" (n = 150)

Climatic events	Natural event (%)	Punishment from god (%)	Human Activities (%)	Do not know (%)	Percentage (%)
Increased incidences of crop pests and diseases	81.3	7.3	5.4	6.0	100.00
Increased drought incidences	80.7	10.7	5.3	3.3	100.00
Long duration of rains	76.7	8.7	8.0	6.6	100.00
Irregular rains	76.7	8.0	6.0	9.3	100.00
Short duration of rains	74.6	11.4	8.0	6.0	100.00
Delayed onset of rains	71.3	10.0	7.4	11.3	100.00
Increased flood incidences	71.3	9.4	14.0	5.3	100.00
Extreme heat	71.3	6.7	13.3	8.7	100.00
Decreased crop yield	70.7	8.0	16.0	2.0	100.00
Early onset of rains	69.3	12.7	9.3	8.7	100.00
Extreme cold	68.7	10.0	15.3	6.0	100.00
Increased wind speed	66.0	11.3	14.0	8.7	100.00

This study showed that less than 20% of the farmers perceive climate change as been caused by human activities while the remaining 80% said it's a natural occurrence, a punishment from god and others said they do not know. Some farmers reported that the climate is changing because god was angry about all the evil atrocities perpetrated by man. A study conducted by Brett (2009) in Nigeria argued that only 35% of the

respondents believe human activities are the main causes of climate change. A study conducted in Tanzania by Philip (2010) revealed that, 46% of the respondents were aware that the main agent of climate change is human activities. Low awareness that human activities contribute to climate change in the study area could be ascribed to lack of adequate education and inadequate extension services to farmers.

4.2 Negative Effects of “Climate Change” on Farming Systems

Table 5 shows farmers perception on the negative effects of climate change. The majority of the respondents, 67.3%, 56.0% and 53.3% perceive irregular rains, temperature (high and low) and increased drought incidences respectively as being very seriously affected by these effects of climate change. Furthermore, 38.7% and 35.4% of the farmers perceived increased wind speed and increased flood incidences respectively as being seriously affected by them.

**Table 5: Farmers’ Perception on the Negative Effects of “Climate Change”
(n = 150)**

Negative impacts	Very seriously affected (%)	Seriously affected (%)	Not seriously affected (%)	Percentage (%)
Irregular rains	67.3	27.4	5.3	100.00
Temperature increase	56.0	32.7	11.3	100.00
Increased drought Incidences	53.3	38.7	8.0	100.00
Increased wind speed	53.3	38.7	8.0	100.00
Increased flood Incidences	41.3	35.4	23.3	100.00

During the discussions with key informants, it was revealed that the intensity of rains vary from one rainy season to another. Farmers said at times, rainfall begins much earlier and it ceases suddenly (short duration) while in some cases the period of rainfall is extended (long duration). Other effects of climate change in the study area includes decreased crop yield, water shortage, lack of fodder for animals and decline in soil fertility. Some key informants said, of recent it has become difficult to confidently say that rains will begin in

April and end in October. In addition, during bad cropping seasons, they are forced to replant for about three times. As a result, some farmers may incur additional costs of fertiliser and hiring labour.

Nasiru (2012) reported declining rainfall in already desert-prone areas in Northern Nigeria, causing increasing desertification. The former food basket in central Nigeria is now empty, and people in the coastal areas who used to depend on fishing have seen their livelihoods destroyed by the rising waters. Key informants revealed that during the period of short rains, the majority of the farmers' water sources for animals and domestic purposes tend to dry up. Thus, affecting the health status of the people because they tend to drink whatever water is available not minding the condition of the water, as long as it satisfies their thirst. Animals are also being affected by low rainfall due to inadequate feed and water .

Inadequate rainfall for crop growth usually lead to poor grain quality; leading to low pricing and consequently low income and hence, low standard of living. Harsh weather conditions affect food crops including rice, maize and sorghum, which are not adapted to harsh weather conditions. This study is in line with that of MoEF-GPPB (2005) and Action Aid International (AAI) (2006) which showed that irregular rainfall, temperature (high and low) and drought affects yield levels of crops. A study by Abaje and Giwa (2007) also concur with this study which revealed that the most devastating adverse impacts of climate change in subtropical countries include frequent droughts, increased environmental damage and increased infestation of crop pests and diseases.

Increased temperature also creates a good environment for crop pests and diseases to thrive and can also make certain crops which were previously resistant to certain pests

and diseases to become susceptible. Research has shown that host plants such as wheat and oats become more susceptible to rust diseases with increased temperature (Coakley *et al.*, 1999). USGCRP (2009) argued that many weeds, pests and fungi thrive under warmer temperatures, wetter climates, and increased CO₂ levels. These cause new problems for crops previously unexposed to these species and as a result of the increased incidences of crop pests and diseases, farmers use strategies such as crop rotation that is rotating a susceptible crop with a resistant crop.

4.3 Indigenous Adaptation Strategies to “Climate Change” Negative Effects

Table 6 shows indigenous adaptation strategies to climate change’s negative effects in the study area. The results showed that the use of indigenous knowledge in adapting to climate change is still existing especially among smallholder farmers in the rural areas of Sabo gari LGA. The results further showed that of all the 150 farmers sampled, 80.0%, 78.6% and 74.7% reported that FYM application, crop rotation and intercropping respectively are strategies which were very effective. While, 66.6% and 60.7% reported that irrigation and mixed cropping respectively were very effective strategies. Farmyard manure was used as key adaptation strategy as it ranked highest on very effective (80.0%) compared to other strategies. FYM alone was used as the key strategy because this study was based on examining only one strategy.

Table 6: Indigenous Adaptation Strategies and their Level of Effectiveness to Climate Change Effects. (n = 150)

Indigenous practices	Very effective (%)	Effective (%)	Less effective (%)	Not effective (%)	Percentage (%)
Application of FYM	80.0	19.3	0.7	0	100.00
Crop rotation	78.6	20.0	0.7	0.7	100.00
Intercropping	74.7	19.3	4.7	1.3	100.00
Irrigation	66.6	32.0	1.4	0	100.00
Application of wood ash	62.7	36.6	0.7	0	100.00
Mixed cropping	60.7	38.6	0.7	0	100.00
Mulching	38.0	33.3	2.7	26.0	100.00
Contour ridging	6.0	4.7	0	89.3	100.00
Cover cropping	5.3	1.3	0	93.4	100.00
Shifting cultivation	0.7	0.7	0	98.4	100.00
Bush fallow	0.7	0	0.7	98.4	100.00

FYM – as Key Adaptation Strategy

Increased temperature, increases the rate of evaporation especially when the soil is left bare during the off seasons (dry season), which is a normal practise in the study area. As the rate of evaporation increases due to the increase in temperature, the moisture level in the soil is depleted thereby, increases the pore spaces between the soil particles, leading to a decrease in the soil water table resulting in the disintegration of the soil particles and loss of nutrients. With the soil been directly exposed to sunlight and the large pore spaces between soil particles, carbon being attached to the organic matter in the soil is released into the atmosphere, same also with methane which causes climate change. To reduce the emission of carbon and methane into the atmosphere, the disintegrated soil particles are made compact again with the application of organic manure and reduces the pore spaces between soil particles. Thus, the rate of evaporation is reduced and moisture level in the soil is increased and the soil is replenished of its lost nutrients.

Intercropping is also another indigenous practise used by the farmers to control crop pests and diseases whereby a susceptible crop is intercropped with a resistant crop between

rows (ridges) or within rows. Naturally, mulches moderate soil temperature, extreme weather conditions, suppress diseases and harmful pests and conserve soil moisture.

Mixed cropping was also a practise that majority of the farmers use as an assurance against crop failure brought about by irregular rains. Farmers in the study area no longer practise monocropping due to irregular rainfalls and the indigenous practise used is, mixed cropping. Crops such as maize, cowpea and sorghum are mixed together on the same farmland. Farmers said that, mixed cropping increases harvest and thus, brings about an increase in financial returns. It also help control crop pests and diseases, nourishes the soil and reduces the use of nitrogenous fertiliser especially when mixed with leguminous crops. Practise like shifting cultivation was no longer being used by the majority of the farmers in the study area because of inadequate fallow lands and insufficient income to acquire more land. Majority of the farmers perceive shifting cultivation as a waste of time and resources, leaving a soil bare without cultivating it when they could just add fertilisers to the soil to increase nutrients.

Furthermore, the study showed that 62.7% of the respondents reported that wood ash application is very effective. It serves as manure and controls crop pests. Furthermore, 38% of the respondents said mulching was very effective especially for vegetable production. Vegetable crops are known to be very succulent and tender in nature; hence, requires good amount of water especially at seedling stage. Thus, mulching material is spread on the emerging seedlings to prevent being destroyed by human beings, animals, birds and to reduce evapo-transpiration. According to the farmers, organic fertiliser is very effective because of its ability to retain moisture, increase productivity and enrich the soil. Before the advent of chemical fertilisers, local farmers largely depended on organic farming, which is also capable of reducing GHG emissions (Ajani *et al.*, 2013).

Crop rotation and intercropping were practised to help control crop pests and diseases. At germination stages, hand hoes are used to control weeds and at later stages, pest control chemicals are used as the crop grows. The advantage of integrated pest management techniques is that the costs and side effects of pest control chemicals are being minimised (ILEIA 1992 and Goodell 1984). During the discussions, farmers gave other reasons for the use of these practises. Farmers said they apply wood ash in their farms because it adds nutrient to the soil (as organic manure because it contains nutrients such as potassium) and controls crop pests such as maggot which attacks onion and used in storing cowpea (in traditionally made clay pots). Farmers apply FYM extensively in their farms because it boosts yield of crops thus, increasing productivity, makes especially vegetable crops fresh and succulent, increases returns, retains moisture in the soil, prevents soil leaching and can keep the soil nourished for up to two years.

Cover cropping is being abandoned by 91% of respondents because it is strenuous but being practised by only 9% of farmers in the study area. The farmers also said that migration was another adaptation strategy to climate change especially in periods when the drought is severe, the young men move to the urban areas to engage in trading, auto mechanics, as guards and bus conductors.

IFOAM (2007) had the opinion that at farm level; the practise of organic agriculture is one of the most important measures for adaptation to climate change by farmers. Organic agriculture is a holistic production management system, which enhances agro-ecosystem health. It prevents nutrient and water loss through high organic matter content and soil covers, thus making soils more resilient to floods, droughts and land degradation processes. In organic agriculture, soil fertility is maintained mainly through farm internal inputs (organic manures, legume production, wide crop rotation), rejection of energy

demanding synthetic fertiliser and plant protection agents with less or no use of fossil fuel (FAO, 2008).

Furthermore, this study revealed that other strategies used by the farmers include varying planting and harvesting dates, increasing use of irrigation to help against irregularity of rainfall, shortening the length of the growing seasons, planting of drought resistant crops and engaging in non-farm activities. This study agrees with the study of Benhin (2006), that some strategies that serve as an important form of insurance against rainfall variability include increasing diversification by planting crops that are drought tolerant and/or resistant to temperature stresses, taking full advantage of the available water and making efficient use of it. It could be argued that, growing different crop varieties on the same plot or on different plots reduce the risk of complete crop failure since different crops respond differently to climate change impacts. Such farm-level adaptation aims at increasing productivity and dealing with existing climatic conditions and draw on farmer's knowledge and farming experience.

The study by Brussel (2009) posits that, possible short to medium term adaptation practises to climate change by farmers include (i) adjusting the timing of farm operations such as planting or sowing dates and treatments. (ii) Choosing crops and varieties better adapted to the expected length of the growing season and water availability and more resistant to new conditions of temperature and humidity. (iii) Improving the effectiveness of pest and disease control through for instance better monitoring, diversified crop rotations, or integrated pest management methods, (iv) Using water more efficiently by reducing water losses, improving irrigation practises and recycling or storing water.

4.4 Indigenous Indicators for Predicting Weather Conditions

Farmers testified to the effectiveness of indigenous weather prediction as an adaptive strategy to climate change. During the discussions with the key informants, it was clear that farmers were able to categorise the four seasons as follows: rainy season (*Damina*), cold season (*Sanyi*), Dry season (*Rani*) and hot season (*Bazara*). However, a study by Shukurat *et al.* (2012) revealed that farmers in their study area categorised the seasons into 5 which include *Damina*, *Sanyi*, *Rani*, *Bazara* and *Kaka* (harvesting season). The four seasons are based on wind direction, sunlight intensity, odour of the wind, behavioural patterns of some animals and birds and the physical changes associated with some tree species. According to the farmers, they have been able to develop varieties of indigenous indicators for predicting weather conditions in order to make good farming decisions. These prediction indicators have evolved through observations and experience, passed down from generation to generation. Islamic scholars (Mallams) act as local weather experts, and the farmers ascertained that it works for them (Shukurat *et al.*, 2012).

When there is a delay in rainfall, farmers gather together under the leadership of the mallams to make prayers for forgiveness to God which goes along with procession and shouts saying “God is Great” and he should forgive them and send down the rain. The farmers use the following indigenous indicators for seasons of the year as follows:

Hot season, which is referred to as *Bazara* is characterised by increased temperature or humidity; wind smells like sand, which has just being sprinkled with water; increase in sunlight intensity; change in wind direction towards the east in May indicating rainfall within 2 weeks. The indigenous indicators include: Appearance of wild duck-like birds (Shamua) and vultures; shedding of leaves of *Gawo* (*Faidherbia albida*) tree indicating

commencement of rainy season; Baobab tree (*Adansonia digitata*) tree flowers at the start of rainy season; guinea fowl also starts laying eggs at the onset of rains and lays daily when rains are fully established.

Rainy season which is referred to as *Damina* is characterised by reduced temperature; increase in sunshine intensity during the day; increased cloudiness and dark moon. The indigenous indicators include: crickets digging holes; loud chirping courtship calls; appearance of adult termites; termites' nuptial flights; appearance of algae growth on walls of residential buildings; continuous croaking of toads inside the wells, under trees or in stagnant water bodies. Goats flapping their ears is an indicator that rains may likely fall because increased humidity causes uneasiness and sweating of goats. Movement of black ants in a row is an indicator of commencement of rains because increase in humidity makes the ants carry their eggs to safe places. Movement of dragonflies is an indicator of imminent rainfall whilst, ripening of fruit trees such as *Mangifera indica*, *Tamarindus indica*, *Adansonia digitata* and *Vitex doniana* indicates the possibilities of heavy rains as shown in Table 7.

Table 7: Tree Species Used As Indicators for Forecasting Rainfall

Scientific Name of Tree	Time of Ripening	Indicator
<i>Adansonia digitata</i>	June-August	Abundance of fruiting indicates heavy rainfall
<i>Tamarindus indica</i>	May-June	Abundance of fruiting indicates heavy Rainfall
<i>Vitex doniana</i>	May-June	Abundance of fruiting indicates heavy rainfall
<i>Mangifera indica</i>	April-May	Abundance of fruiting indicates heavy rainfall

After all these indigenous indicators, planting of high value and drought sensitive and cash crops (maize, soybean, cowpea, groundnut and cassava) commences. However,

drought tolerant crops like millet and sorghum, are planted at the onset of rains. Farmers reported that the use of these indigenous indicators was only effective for forecasting onset of rains and planting seasons but not drought and rainfall distribution. Farmers now use early maturing crop varieties because of the shortened period of the rainy season and irrigation is now a choice practise. Sugar cane is one of the major crops planted during the dry season and usually intercropped with vegetables. Proceeds from the vegetable crops are used for the paying costs for sugar cane cultivation. This brings more profit than the vegetable crops though, stays on the farm for more than 8 months before it reaches full maturity.

Cold/Dry season which is referred to as *Sanyi/Rani* is characterised by cessation of rains; dusty cloud; harmattan wind; low air temperatures; harmattan haze/dusts and dry skin. Indigenous indicators include; appearance of locust is an indicator for drought and appearance of chameleon on cultivated fields after rainfall begins indicates a period of drought. Farmers also pointed out that, if there is prolonged heavy rain season in a particular year, one is able to predict that the harmattan period for that particular year will be intense.

Lawal (2013) pointed out that, the appearance of migratory birds, e.g. the *Cilkowa* from the north to the south indicates the commencement of the rainy season, and its movement from south to north is an indicator for the end of the rainy season. Furthermore, the movement of *Shamuwa*, a long neck bird from east to west is also an indicator for the approach of rainy season. The squeaking of owls is an indicator of imminent rainfall. Farmers believe that even though the owl is blind, it is sensitive to humid conditions. The fear and feeling of increasing humidity and heat released by clouds instigate restlessness among owls. Hence, their squeaking sound, which many farmers believe to be an indication of an imminent rainfall. Climatic factors (rainfall distribution, air humidity,

wind direction and temperature) and site conditions are the most important determinants of the presence of foliage and fruits on the woody plants of West African semi-arid region (Breman and Kessler, 1995).

The most popular and reliable method of predicting possibility of onset of the rains within a week, according to farmers is based on changes in wind direction from west towards east. If it rains before the wind changes direction, this rain is considered to be a pseudo one, and so the farmers do not plant no matter the intensity of the rainstorm and if rain begins much earlier, they never plant until they have been able to see the physical signs of rain being fully established. Farmers use these indicators for land clearing and other agronomic practises but ridging starts after the second heavy rain. According to Lawal (2013), some farmers are now using exotic trees, such as neem (*Azadirachta indica*) as weather indicator, i.e. full bloom of a neem tree in summer indicates an approaching rainfall season. In addition, the drying of leaves of the neem tree (*Azadirachta indica*) in summer is an indicator of a coming drought.

Results have shown that indigenous knowledge plays a significant role in adapting to climate change. Robinson and Herbert (2001), reported that incorporating indigenous knowledge into climate change policies leads to effective adaptation strategies that are cost-effective, participatory and sustainable; which this study has shown.

4.5 Socio-Economic Factors Influencing Use of Farmyard Manure as a Key

Indigenous Adaptation Strategy

4.5.1 Socio-Economic Factors Influencing Use of FYM

Table 8 shows that multiple regression analysis was used to show age, marital status, education, household size, source of income, sex and extension services influencing the

application of FYM (farmyard manure: poultry, cow dung and household refuse) as a dependent variable. The coefficient of determination R^2 was 0.55, which means that the independent variables used in the model explains about 55% of the variation in the dependent variable.

Table 8: Socio-Economic Factors Influencing the Use of FYM

Variables	B	Std error	Beta	T	Sign t
Age	-.138	.064	-.245	-2.752	.002*
Sex	-1.356	.657	-.455	-2.063	.317
Educational level	-2.183	.6209	-.058	-.681	.497
Household size	2.398	.439	.402	.713	.659
Income per annum	-2.106	.000	-.025	-.309	.769
Extension services	-.191	1.080	-.075	-1.140	.256
Marital status	2.104	8.003	.208	.254	.004*

$R^2 = 0.55$ * = significant at 5%

4.5.2 Factors Enhancing the Use of FYM

i) A Factor Significantly Enhancing Use of FYM

Marital Status

Table 8 shows that marital status has a positive relationship (Beta = 0.208) with the use of FYM and was statistically significant. This shows a direct relationship between marital status and farmers' use of FYM. The result showed that 91.3% of farmers were married. Thus, married farmers are more likely to use more of FYM than single farmers. A study by Ekong (2000) reported that the majority of farmers involved in agricultural activities in Nigeria rural areas were married.

ii) A Factor Not Significantly Enhancing Use of FYM

(b) Household size

Table 8 shows that household size has a positive relationship (Beta = 0.402) with the use of FYM and was statistically not significant. This shows a direct relationship, as household size increases, farmers' use of FYM increases and a unit increase in household size; increases the use of FYM by 0.402 units. In addition, in terms of labour required for the application of FYM, large household size will have more required labour compared to small household sizes. This study results showed that 44% and 16% of the farmers had large household size (above 30 family members living together) and small household sizes (between 11 to 20 family members living together) respectively. The study by Pfister *et al.* (2005) recorded a positive relationship between household size and the use of organic manure and was statistically significant.

4.5.3 Factors Constraining the Use of FYM

i) A Factor Significantly Constraining Use of FYM

(a) Age

Table 8 shows that age has a negative relationship (Beta = -0.245) with farmers' use of FYM and was statistically significant at 5%. This means that there exist an inverse relationship between ages of farmers and the use of FYM and a unit increase in age of the farmer; decrease his/her use of FYM by -0.245 units. Thus, as the age of a farmer increases, his/her use of FYM as an indigenous strategy decreases. The application of FYM is strenuous; thus, older farmers might tend to engage in less strenuous soil nourishment practises rather than the use of FYM. Thus, since FYM strategy requires physical efforts, young farmers are more likely to use FYM than their older counterparts. The study showed that 53.4% and 38.7% of the farmers were within the age groups of 19 to 38 and 39 to 58 years respectively. Whereas, 7.3% of the farmers were within the age

groups of 59 to 78 years. The study by Peter (2008) showed a negative relationship between age and the use of organic manure and argued that, older farmers planning horizon shrinks and so the incentives for them to invest in future productivity of their farms tend to diminish.

ii) Factors Not Significantly Constraining Use of FYM

(b) Extension services

Table 8 shows that extension services has a negative relationship (Beta = -0.075) with the use of FYM and was statistically not significant. This implies that there is an inverse relationship between extension services and farmers' use of FYM. This means that extension services in the study area tend to decrease farmers' use of FYM. One of the roles of extension workers is to introduce and promote new agricultural technologies to farmers, and one of the technologies is the use of chemical fertilisers. That means that, as farmers adopt the use of inorganic fertilisers, their use of organic fertiliser might decrease. The study showed that, 62% of the farmers had no access to extension services while 38% argued that they had access to extension services. This might be the reason why the majority of the farmers still practise organic farming. However, based on the statistical significance, it could be said that extension services have a constraining effect on the farmers' use of FYM. The study by Adesope *et al.* (2010) concur with the results of this study, in which they recorded a negative relationship between farmers' adoption of organic manure and extension visits.

(c) Household Income per Annum

Table 8 shows that household income per annum has a negative relationship (Beta= -0.025) with farmers' use of FYM and was statistically not significant. This implies that there is an inverse relationship between household income per annum and the use of FYM, which means a unit increase of household income; decrease the use of FYM by -

0.025 units. The study results showed that farmers (39.9%) in the study area reported earning \geq N300,000 per annum. Chambers (1989) built his theory of vulnerability and adaptation on numerous case studies of poor small-scale farmers. He concluded that poor people usually seek to reduce vulnerability not by maximizing income, but by developing and diversifying their portfolio of capital assets. Chambers found that most poor people do not choose to put all their eggs in one basket and thus, tradeoffs exist between security and income (Chambers, 1989).

(d) Educational level

Table 8 shows that educational level of the farmers has a negative relationship (Beta = -0.058) with farmers' use of FYM and was statistically not significant. This means that educational level has an inverse relationship with farmers' use of FYM and a unit increase in educational level of a farmer; decrease his/her use of FYM by -0.058 units. This implies that as farmers acquire more education; their use of FYM tend to decrease. The study showed that 40.0% of farmers had no formal education, which implies that in the study area farmers with low educational level were the majority and thus might be the reason why indigenous knowledge and FYM are still being used extensively in the study area. Plausible reasons could be 1) Educated farmers are financially buoyant compared to the illiterate farmers thus; they can afford to purchase enough inorganic fertilisers for their farms. 2) Educated farmers find inorganic fertilisers more easy to handle compared to FYM which is bulky with bad smell. Kajembe and Luoga (1996) argues that education creates awareness, positive attitude, values and motivation to stimulate self-confidence and self-reliance.

(e)Sex

Table 8 shows that sex of farmers has a negative relationship (Beta = -0.455) with farmers' use of FYM and was also statistically not significant. This means that there is an inverse relationship between the sex of household head and the use of FYM. This implies that female farmers are more likely to use FYM than their male counterparts. The study showed that 98.7% and 1.3% were males and females respectively. This means that male farmers are not in favour of using FYM. The study by Peter (2008) recorded a positive relationship between sex and farmers use of organic manure and was statistically not significant.

CHAPTER FIVE

5.0 CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

This study examined the role of indigenous knowledge on climate change adaptation in Sabo Gari LGA. The study assessed the awareness level of the farmers on climate change; it revealed that farmers' awareness on "climate change" was rather high (based on the changes in rainfall, drought amongst others which farmers in the study area have observed to note the changes). Farmers in the study area were able to indicate awareness with respect to "climate change" and climate change indicators (rainfall, drought amongst others). However, when asked if they had heard of the concept of climate change the majority of the farmers said they have never heard climate change as a concept.

The study assessed the effects of climate change on farming systems. It was obvious that the negative impacts of climate change on agricultural production cannot be overemphasized. The study showed that irregular rains, temperature, drought and increase in crop pest and disease incidences were the major climate change indicators observed by the farmers as the negative effects of climate change which pose threats directly on crop productivity and hence, farmers livelihoods. It is evident that the people of Sabo gari LGA are faced with a lot of climate change effects but have been able to survive by drawing from a well of indigenous knowledge practises which they have learnt from their fore bearers.

The adaptation strategies being practised by the farmers in the study area include application of farmyard manure (FYM), crop rotation, intercropping, irrigation, wood ash application and mixed cropping were mentioned. Whereby farmyard manure, ranked

highest. Farmers were seen to have the ability to predict weather conditions including wind direction, odour of the wind, sunlight intensity, behavioural patterns of some animals and birds and physical changes associated with some tree species. These indicators are used by farmers to predict planting periods so as to avoid crop failure due to false rain. It was evident that farmers had been practicing adaptation strategies even before the concept of climate change became a topical issue in development policy discussions. As a result, indigenous knowledge should be strengthened by merging modern practises to adaptation with indigenous practises. Thus, such knowledge will offer a greater opportunity for resilience and adaptation to changing conditions and circumstances. In this way, indigenous knowledge will be valued and spread across a wide section of interest groups including the general public, scientists and policy makers.

The study identified socio-economic factors influencing farmers' use of FYM whereby, age of the farmer was significantly constraining farmers' use of farmyard manure while marital status was seen to enhance the use of FYM but significantly. Farmyard manure was not only used because it is cheap and easy to access but most importantly, it helps to reduce the emission of carbon and methane into the atmosphere to help reduce the effects of climate change. The indigenous indicators for weather prediction shown in this study might be indigenous to the study area or the northern parts of Nigeria and might be different in other parts because of the different climatic conditions.

In addition, local farmers see the effects and causes of climate change differently from the way scientists see the causes and effects of climate change. Farmers in the study area had the opinion that climate change is a natural phenomenon or is a punishment from god but scientists are of the opinion that climate change is majorly caused by anthropogenic activities which result in an imbalance of greenhouse gases in the atmosphere. This shows

that local farmers and scientists do not share the same meaning of “climate change”. The study concludes by pointing out that extension workers, researchers and civil society organisations have a lot to learn from the farmers in Sabo Gari LGA and at the same time, farmers also have a lot to learn from the professionals.

5.2 Recommendations

5.2.1. The need to create more awareness on climate change

Enlightenment programmes should be developed right down to the grass root levels with the media helping to disseminate climate change information and create more awareness about causes and consequences of climate change.

5.2.2. The need to improve extension services

There should be at least one extension agent per village in Kaduna state. Extension agents should be provided with motorcycles especially in areas where cars cannot easily access for quick dissemination of information.

5.2.3. The need to organise trainings for farmers

There is need to conduct trainings especially on cover cropping as an adaptation strategy to climate change in northern Nigeria. Cover cropping is a practise being abandoned by the majority of the farmers in the study area but it is an effective practise to mitigate against climate change. Extension agents should teach and physically demonstrate this practise on farmers’ field for them to see and observe the effects cover cropping has on the soil and how it could help reduce the emission of carbon dioxide and methane.

5.2.4. The need for further studies on indigenous strategies to climate change

It is also recommended that more studies should be done on indigenous adaptation strategies and indigenous indicators for predicting weather conditions for accuracy and reliability of these strategies especially the indigenous indicators for prediction weather. Information on indigenous knowledge should be properly and adequately documented in order to help support farmers in adapting to climate change.

5.2.5. The need to involve farmers in developing adaptation policies

Rural farmers have been known to be custodians of indigenous knowledge for effective climate change adaptation strategies in the agricultural sector. Thus, the government of Nigeria should create a platform whereby farmers can air their voices on adaptation strategies and indigenous prediction skills and should not be left out in creating adaptation policies to climate change effects.

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APPENDICES

Appendix 1: Structured questionnaire

INTRODUCTION

I am CHATTA Mary Oiza, a student at Sokoine University of Agriculture, Morogoro, Tanzania. Am Pursuing a Masters of Science Degree in Management of Natural Resources for Sustainable Agriculture (MNRSA), and carrying out a research on the role of indigenous knowledge on climate change adaptation. The information to be obtained from this study will be very useful to you, to Nigeria and the world at large. Please, am requesting for your full support and cooperation. Thanks.

HOUSEHOLD QUESTIONNAIRE

VILLAGE..... HOUSEHOLD.....
 NUMBER..... DATE OF INTERVIEW.....
 NAME OF INTERVIEWER.....
 NAME OF HOUSEHOLD HEAD.....

HOUSEHOLD DATA

Socio-Economic Characteristics (Please tick where appropriate)

1. What is your age in years.....
2. Sex a) Male () b) Female ()
3. Marital status a).Single () b) Married () c) Divorced () d) Widowed ()
4. Level of education
 - a)No formal education b)Adult education c)Primary education d)Secondary education
 - e)others (specify).....

5) Number of years in school. a) No formal education () b) 1-6 years () c) 7-12 years ()

d) 13 years and above ()

6) Number of wife a) 1 () b) 2 () c) 3 () d) 4 above

7) Number of children a) 1- 5 () b) 6-10 () c) 11 -15 () d) above 15

8) Source of income? A) Farming () b) Civil servant () c) Craftsman () d) Trading () e) Transporter () f) Others.....

9) Income per annum (Naira)

a) $\leq 10,000$ ()

b) 10,000 – 100,000 ()

c) 100,001 – 200,000 ()

d) 200,001 – 300, 000 ()

e) $\geq 300,001$ ()

10) Are you a resident of this village?

a) Yes () b) No ()

11) How many years have you spent in this village?

a) 1-5 years () b) 6-11 years () c) 12-16 years () 17 years above ()

12) Are there extension officers in this village?

a) Yes () b) No ()

13) If your source of income is agriculture, have any of your family members visited an extension officer?

a) Yes () b) No ()

14) How many minutes does it take you to walk from the farm to the market place?

a) 1- 5 minutes () b) 6 to 10 minutes () c) 11 to 15 minutes () d) above 15 minutes ()

15) What social organization do you belong?

a) Age grade ()

b) Farmers council ()

c) Age group ()

OBJECTIVES

2 Objective one: Assessment of awareness level on climate change

Please use the number to indicate your view.

I. What is the level of awareness on the following issues/events?

Issues/events	Level of awareness. 1=very aware 2=aware 3=not aware	When was the changes first observed? 1=10years above 2=in the last 5years 3=in the last 2years 4-this year	Cause of these issues. 1=natural occurrence 2=a punishment from the gods 3=human activities 4=don't know 5= God's will
a) Drought			
b)Floods			
c) irregular rains			
d) Increase in disease incidence in human			
e) High wind speed			
f) Decrease in crop yield			

g) Extreme heat			
h) Early onset of rains			
i) Increase incidence of insect pests on Crops and livestock			
j) Extreme cold			
k) Delayed onset of rain			
l) Longer duration of rains			
m) Shorter duration of rains			

IIb) Have you ever heard of the concept “climate change”?

1) Yes () 2) No ()

3 Objective two: Negative impacts of climate change on farming systems

III. What are the negative impacts of climate change?

c) Which of these impacts listed above, has really affected you. Please indicate below in order of importance or rate the impacts based on how you have been impacted.

Climate change effects	1= very seriously affected 2= seriously affected 3= not seriously affected
a) Drought	

b) Floods	
c) Temperature	
d) Strong wind speed	
e) Irregular rains	
f) Others	

IIIb) In your opinion, who do you think is affected more by these impacts?

a) Men () b) women () c) children ()

4. Objective three: Indigenous based knowledge adaptation strategies

a) Do you know of any indigenous based adaptation strategy (ies) to adjust to these impacts mentioned above?

a) Yes () b) No ()

b) If yes, answer the questions below

Practices	Level of effectiveness. 4=very effective 3=effective 2=less effective 1=not effective	Reason(s) for the level of effectiveness. 1) easy to use 2) readily available 3) cheap to use 4) modern methods are expensive 5) others	Constraints. 1) Labour intensive 2) inadequate resources 3) other factor (s)
a). Cover-cropping			
b). Contour ridging			
c) Bush fallowing			

d) Crop rotation			
e) Irrigation			
f) Mulching			
g). Mixed cropping			
h) Application of wood ash			
i) Application of FYM			
j) Shifting cultivation			
k) Intercropping			

Appendix 2: Checklist for Focus Group Discussions for Key Informants

This interview aimed at collecting information on indigenous adaptation practises of key informants in the study area. The key informants comprised of those who were born and bred in the study area and had lived in the area for more than 30 years.

1. What are the impacts of climate change been experienced by you in the study area?
2. Are there any indigenous ways of detecting drought incidences and when it's going to rain?
3. What are the adaptation strategies used in farming systems?
4. Are there indigenous prediction indicators for predicting weather, which you are aware of?