DECLARATION

I, AGBOR, YVONNE NKAN with Registration Number Geo/M.Sc./16/016 hereby declare that this thesis titled "Climate Change Awareness and Adaptation Strategies of Farmers in Rural Communities of Etung Local Government Area, Cross River State" is the product of my own research effort under the supervision of Prof. I. J. Ekpoh and has not been presented elsewhere for the award of a degree or certificate. All sources have been duly acknowledged.

Signature:...

Date: 8/4/2021..

CERTIFICATION

This is to certify that this thesis titled: **CLIMATE CHANGE IMPACT ON YAM AND CASSAVA PRODUCITIVITY IN ETUNG LOCAL GOVERNMNT AREA OF CROSS RIVER STATE, NIGERIA** and carried out by **AGBOR, YVONNE NKAN** (Reg. Number: **GEO/M.Sc/16/016)** has been examined and found worthy of the award of the Master of Science Degree in Geography and Environmental Science **(Climate and Society)**.

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ABSTRACT

Climatic elements such as rain, temperature and relative humidity aid in explaining the climate of a given area. The understanding of climate change is necessary in the creation of awareness and formulation of adaptation strategies. The study aimed at investigating climate change awareness and adaptation strategies of farmers in rural communities of Etung Local Government Area of Cross River State, Nigeria. The study design adopted was ex-post factor and cross sectional survey. A total of 380 copies of questionnaires were administered while secondary data were sourced from NIMET offices. The analytical tools used are Regression Model and Pearson Product Moment Correlation Model. The results from the Regression analyses on the relationship between climate and agricultural productivity for cassava in the study area indicated that there is a significant relationship between rainfall and cassava yield in the study area. The results from the Regression analysis on the relationship between climate and agricultural productivity for yam in the study area indicated that there is a significant relationship between rainfall and yam yield in the study area. The relationship of the multiple regression is positive. The Pearson correlation result on the relationship between the effect of climate change awareness on crop yield and the level of adaptive measures adopted by farmers' in the study area indicated that there was a strong correlation (r=0.818 or 66.9 percent) and a statistical significant relationship (p=0.007, <0.005). The relationship of the Pearson correlation is positive. The mean variance for yam and cassava yield were 69269.44 tons and 225698.8 tons, temperature 0.612507^{0}C, rainfall 46189.51 and relative humidity 1.025641% respectively. The changes in the climate variance for yam and cassava implies a serious condition of the climate. The study therefore recommends that there is need for consistent training and sensitization of farmers in Etung LGA by the government, and concerned Civil Society Organizations on innovative adaptive strategies to combating climate change effects on yam and cassava productivity.

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CHAPTER ONE

INTRODUCTION

1.1 Background to the study

The understanding of climate change is necessary in the creation of awareness and formulation of adaptation strategies mostly by farmers in developed and developing world, and in order to discuss the subject of climate change holistically, atmospheric elements must be taken into consideration. Climate connotes the mean atmospheric condition of a place over a long period of time say 35 years. The average weather condition within a noticeable time frame is referred to as season, while a season is a division of the year that is differentiated by changes in weather, ecology and amount of day light (Khavrus & Shelevytsky, 2010). Climate change is any long-term change in the patterns of average weather of a specific region or earth as a whole, it is often seen to be natural or human-induced (Ekpoh, 2009). Further, climate change due to global warming is likely to have significant impact on society, and environment, while the consequences have already started to manifest in the higher frequency of extremes of unusual weather patterns in Nigeria (Ekpoh & Ekpenyong, 2011).

Climatic elements such as rain, wind, temperature, relative humidity and sunshine, aids in explaining the climate of a given area, as there is always interaction among the climatic elements which in turns defines the type of climate prevalent in such area and at the same time impact on the socio-economic activities of man. Climate change is arguably the most severe challenge facing our planet during the 21st century. Human interference with the climate system (mainly through the emission of greenhouse gases and changes in land-use) has increase the global and annual mean air temperature at the earth's surface by roughly 0.8C since the 19th century (IPCC, 2013). This scenario will have adverse effect on agricultural activities globally and Nigeria which is known for agricultural cultivation would be affected. Hence, there is need to create an awareness and formulate practical adaptation strategies for farmers who engaged in either subsistence or mechanize agriculture to enhance food security.

The problem associated with tackling food insecurity is global, and the developing countries is mostly affected. This is due to the fact that Africa economy is dominated by agricultural activities. In Nigeria just like in many sub-Saharan African countries, agriculture is the largest sector of the economy and this assertion plays out in Cross River State and Etung L.G.A in particular which is for mechanize and subsistence system of agriculture. It is therefore pertinent to evaluate farmers awareness of climate change and examine their adaptation strategies in curbing with it without a reduction in food production.

In East and Southern Africa, the vulnerability of food security to climate change remains a major concern. Further, declining soil fertility due to the climate change is a significant issue in the region, leading to poor crop performance. In Nigeria, the impact of climate change is visible in different agricultural zones, most particularly as it happened in Cross River State, and rural communities of Etung local government area. There is growing concern over the impact of climate change on agricultural activity mostly in Cross River State, which is known for its vast engagement in farming activities. Food security is a global issue and food production is mostly affected by climate change challenges, threatening food supply from meeting up with the demand from rising population, therefore there was need to embark on awareness campaign and design adaptive strategies to increase crop yield despite the prevalence of climate change challenges.

A study conducted by the Central Bank of Nigeria between 1971 to 2000 shows that hunger-related death rate in Nigeria is set at 1.65% as a result of poor farm-level adaptations to climate change (Apata, 2008). Research has it that farmers' slow change to cultivation practices, continuous deforestation, dependency on rain-fed agriculture and lack of requisite adequate information, education and orientation are the challenges to climate change adaptation in Nigeria (Enete & Amusa, 2010).Cross River State as a whole shows a weak level of compliance to adaptations of farmers to climate change. A study revealed farmer's ability to adapt to technological developments was 40 percent while the level of skill acquisitions were 13 percent (Eta & Angba, 2107). While human populations in Nigeria keep increasing daily, food production is on the reverse. This is because food production is negatively impacted by climate change and primarily influenced by ignorance on the part of farmers to be aware of the situation and also to adapt strategies that can ameliorate the situation.

When considering the importance of agricultural resources, as they are abundant in Etung Local Government Area of Cross River State, it is very crucial to ascertain the level of adaption of farmers to climate change in the area, knowing so well, that economic crops of high importance such as cocoa, plantain, cassava, oil palm, maize, coconut, banana, yam, okro and cucumber are predominantly cultivated in the area and they are liable to face serious climatic challenges that negatively affect the yields of such crops. A study of this kind is expected to emphasize awareness and adaption strategies to climate change in order to boost agricultural output to equilibrate demand and supply of food, enhance sustainable agricultural practices by farmers within the study vicinity.

1.2 Statement of the research problem

Variations among climatic elements such as rainfall, temperature and solar radiation basically impact negatively on agriculture, especially in a developing country like Nigeria. Rural communities who at large bear the greatest brunt of climate change issues find it difficult to make a sustainable living as poor yields often occur in their cultivation. Although it is evident that rural communities lack technological ability to confront climate change issues, it is pertinent to ask if there is awareness as to what constitutes a climate change. A typical traditional African society believes that yields are determined by the gods; therefore, any outcome could be endured and tolerated. This belief-system goes in contrary to scientific explanation that climate determines yield and not the gods, hence a research of this kind.

A study conducted in Etung Local Government Area on the impact of rainfall regime on cocoa production revealed that there was a significant decrease in rainfall amount in the study area and since there was a significant relationship between rainfall duration intensity and cocoa production, farmers were to adapt to tolerable species and improved technologies (Okongor, Afangideh & Obong, 2013). With the above information, the rural dwellers in Etung may not be aware of issues of climate change due to the mode of information dissemination and orientation and therefore may not likely adapt to its recommendations.

Most of agricultural achievements are basically acquired through farmers participation in multipurpose organizations and the employment of agricultural extension workers to render their immense service to farmers. Itina (2017) recommended that farmers need not sit idle and expect everything be done for them either by NGOs or the Government. Farmers who have high expectations in their cultivation business need not stay isolated, devoid of information, training and orientation on the skills, technology and cultivation practices required to meet their agricultural yield demands. It is already a recurrent problem that farmers in Nigeria, especially those from Etung L.G.A in Cross River State, are unaware of the vagaries of climate change, isolated from information and orientation; as well as, from multi-purpose organizations on suitable adaptation strategies to continue in farming (subsistence or mechanized) practices despite climate change.

Further, the awareness level and ineffective adaptation strategy of farmers in the study area to climate change could be highly influenced by inefficient orientation, inadequate knowledge, lack of data base on past and current trend in climate change. Most developing economies lack records of input and output even at the farm level, let alone at the NGO's and government levels. It becomes a worry issue if a set of policies are formulated and are not effective to tackle climate change challenges due to lack of adequate climatic information. Studies have predicted that in the next 50years or so, climate change may likely be responsible for global famine and other disruptions on agricultural system (Apata, 2008) especially in low-income countries where climate is the primary determinant of agricultural productivity and adaptive capacities are low. Several questions are formulated by the researcher with the hope to answer them in the course of the study which would address certain critical aspect of the study. Such as; what system of farming is mostly practiced in the study vicinity? What are the basic challenges of climate change on farming practices and farmers in the area? Are the farmers aware of climate change? Is there any noticeable impact of climate change in the area farm land? What adaptation strategies do farmers adopt in the area? Are such strategies effective? From the foregoing therefore, there is need to investigate the level of awareness and adaptation strategies of farmers to climate change in Etung L.G.A of Cross River State, Nigeria.

1.3 Aims and objectives

This study was aimed at investigating the level of awareness and adaptation strategies of farmers to climate change in Etung L.G.A and the specific objectives are to:

1. Examine the socio-economic characteristics of farmers in Etung LGA
2. Determine the variance of climate variables from 1992 to 2018
3. Examine the trend of climate change and yield performance of(yam and cassava) from 1992 to 2018 in the study area
4. Examine the level of farmer's awareness to climate change in the study area
5. Assess the adaptation strategies of farmers to climate change in the study area

1.4 Research hypotheses

The following hypotheses were formulated for testing:

1. There is no significant relationship between climate change and agricultural productivity (yam and cassava yield) in the study area
2. There is no significant relationship between the effect of climate change on crop yield and the level of adaptive measures adopted by farmers in Etung LGA

1.5 Scope of the study

This study was restricted to the investigation of the level of awareness and adaptation strategies of farmers to climate change in Etung Local Government Area. This is to model the level of awareness and adaptation in the different communities in the study area. The study addressed the challenges faced by farmers as a result of climate change. For this reason, the awareness and strategies adapted by farmers to cultivate despite climate change in the study area was assessed and efficient recommendations proffered to increase rural farmer awareness and improve their adaptation strategy towards climate change challenges. The study covered selected communities within the study area and information would be obtained from farmers and secondary sources considering a temporal scope from 1997 to 2018.

1.6 Significance of the study

The result of this study will provide baseline information on farmers awareness and adaptive strategies on climate change challenges. The study will not only be limited to policy making but also in implementation of policy in agricultural and academic sectors. It will also proffer modern adaptive techniques for farmers in the study area as well as contributing in existing literature on climate change awareness and adaptation strategies for farmers.

This study will also bridge the gap in literature for further studies in related field and also contribute to the academics.

1.7 The study area

1.7.1 Location and size

Etung Local Government Area is located between latitude 5°48'N and 5°52'N, and latitude 8°46'E and 8°49'E. it shares boundaries with Boki at the North, Ikom on the West and Akampka to the South. The East has an international boundary with Cameroon as shown in Figure 1 and 2. Etung has a total land mass of 815 square kilometers. Etung has 16 clans and over 30 villages including ten political wards.

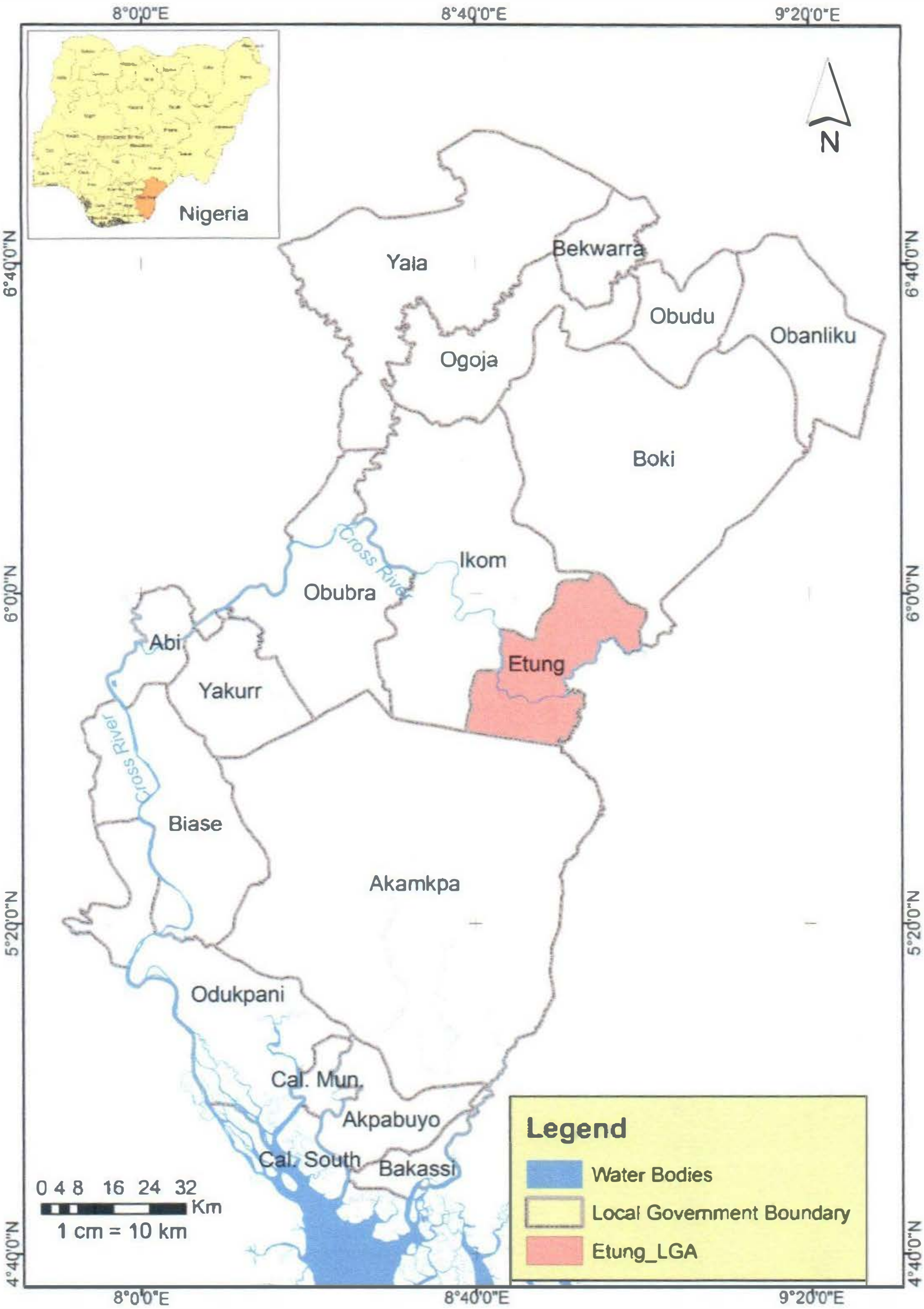

FIG. 1: Map of Cross River State showing Etung LGAs

Source: GIS Unit, Department of Geography and Environmental science, UNICAL (2019)

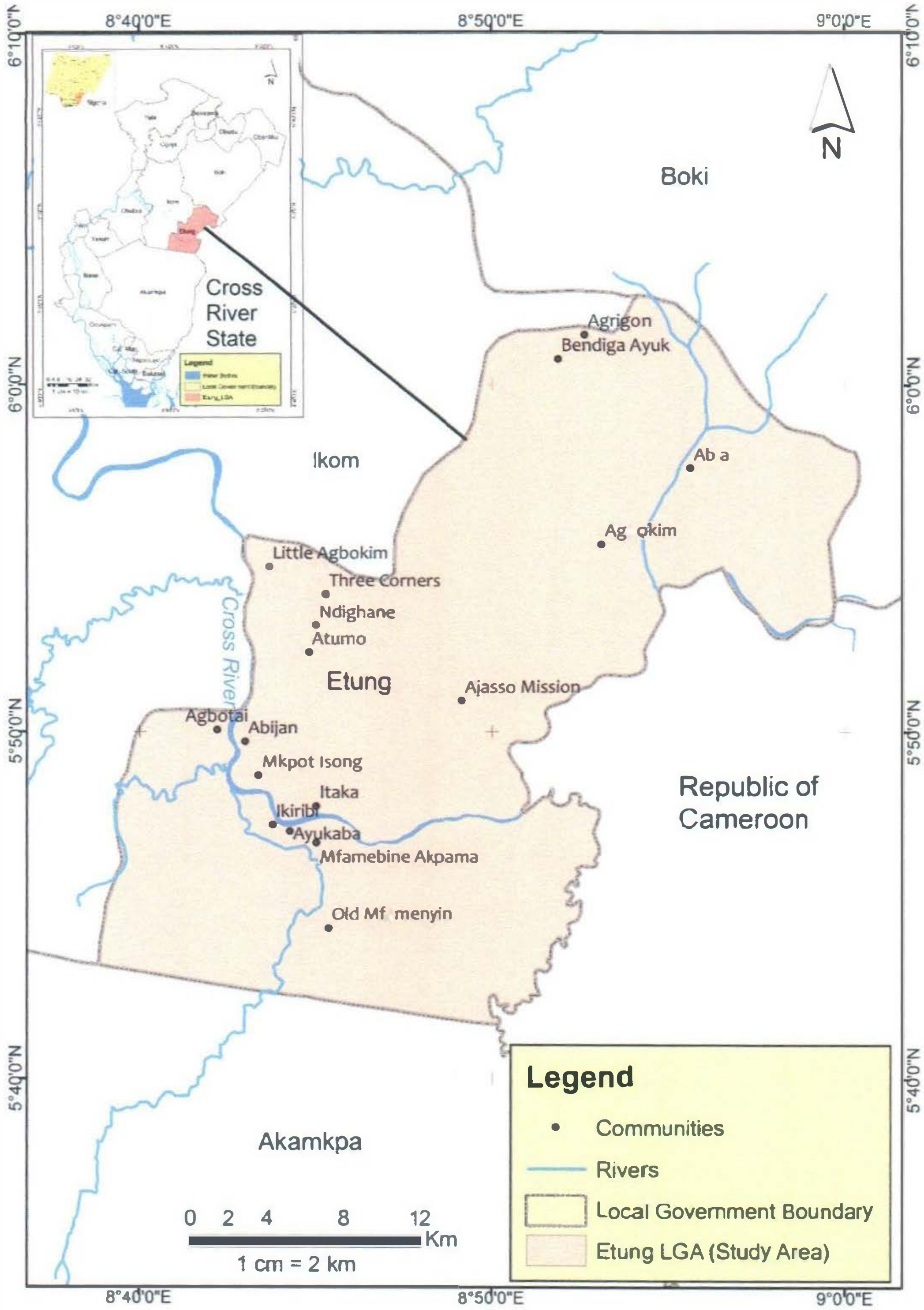

FIG. 2: Map of Etung LGAs showing the study areas

Source: GIS Unit, Department of Geography and Environmental science, UNICAL (2019)

1.7.2 Vegetation

Etung falls within the tropical rainforest zone and it is mainly characterized by deciduous forests of 30 metres and above tall. Recently, intrusion into the forests have created a chance for subsistence and commercial agriculture which now reduce the once thick forests by several percentages. The soil is "white" soils and it is highly acidic, with low effective caution exchange capacity moderate to saturation and requires appropriate application of organic manure or organo-mineral fertilizers to improve agricultural yield (Ajiboye & Olaniyan, 2016).

1.7.3 Topography

Etung has a topography that is influenced by the Oban Massif and Obudu Plateau and Obudu hills. The areas are characterized with elevations reaching 1,600 feet that produce the Agbokim water fall.

1.7.4 Population

The 2006 population and housing census figure for Etung Local Government Area is 80,196 persons with an estimated population of registered farmers standing at about 6000 throughout the 30 communities of Etung (Egbe *et al.*, 2014).

1.7.5 Climate

The climate of Etung Local Government Area is in influenced by two seasons wet (March to October) and dry (November to April). Annual precipitation accounts for about 2200 millimeter while the 32°C and 36°C. Average relative humidity is about 84 percent. In recent times, studies have observed significant shift in both the upper and lower boundaries of the two seasonal conditions (Martinesz, Takahashi, Nunez, Silva, Trasmonte, Mosquera & Lagoos., 2008; Riddell *et al.,* 2008; Rapti-caputo, 2010; Wagner & Zeck-hauser, 2011).

1.7.6 Socioeconomic activities

The study area is predominantly an agricultural area with arable fertile land it produces basic cash crops like cocoa, plantain, cassava, oil palm, maize, coconut, banana, cocoyam, yam, okro, cucumber and pumpkin in commercial quantities. There are fishing activities as well as cottage or processing industries that process most of the farm products into marketable form. The Abia salt from the Ejagham Lake provides raw material for salt product at both local and commercial quantities. The area supports the national park with tourism potentials like the Agbokim waterfalls and preservation of endangered species of plants and animals.

The area offers a wide range of investment opportunities for indigenous, private foreign and cooperate investors. The council initiated a functional and more viable socioeconomic control institution known as the Etung Marketing Authority to guard against the wanton exploitation of the local farmers, provide standardized measurement in the scaling and sale of agricultural products for mutual benefit and understanding among buyers and sellers. As an area that has international border with the Republic of Cameroon, Etung involves in the exportation and importation largely at a local level.

1.7.7 Land use and Land cover

The land use of the area include: roads, residential, commercial, agricultural, religious, recreational and industrial while the land cover of the area is predominantly deciduous forests, agricultural lands, and water bodies with some geomorphic features.

1.7.8 Hydrology

The area has a flow of the Cross River which flows from the Republic of Cameroon as Manyu River in Mamfe through Etung and down to Oron in Akwa Ibom State where it joins the estuary and gradually the Atlantic Ocean. Along its course, the river is characterized of several streams and the most famous Agbokim waterfalls. The Agbokim waterfalls is some 17 kilometers from Ikom and itself consists of seven streams, each cascading over steep cliff which provides seven-faced falls (Adise, 2011). The waterfall is a tourism site in the area and its surrounded by lush greenery, valleys and steep hills which are enveloped in a rainbow-like aura. It is spectacular falling sheet of water that attracts tourists.

1.7.9 Infrastructures

Under the institution category, Etung has a total of 21 primary schools, 9 day-care crèche centres, 6 secondary schools, one technical school and a science college. Others are; eleven Adult education centres and fifteen health care centres. There are well constructed markets, parks, road network and financial institutions like banks. Others include health care centres, security posts/stations, an administrative complex at Effraya, out-board jetty, among others. Unfortunately, major challenges confronting the area include: poor electricity supply, and lack of clean portable pipe-borne water supply network.

1.7.10 Brief history of the study area

Etung Local Government Area is in the central senatorial district of Cross River State. It was carved out from Ikom Local Government in 1996 and has its headquarters in Effraya. The language of the Etung people is the Ejagham. The area has a rich culture and a traditional festival of yams when the Dumdum drums and wooden gongs are played annually. There are title holding societies like the Mgbe to ensure that power and authority is maintained. It is believed those who pass through the Mgbe initiation are warriors in case of war time, political decision making and management of homes or human relations. The Etung people are said to be of the Bantu Race who are believed to have migrated from central Africa to their present abode. The people of the area are very industrious and commits their lifetime mainly to crop cultivation, harvesting, processing, marketing and exportation (CRSG, 2017).

CHAPTER TWO

LITERATURE REVIEW AND THEORETICAL FRAMEWORK

2.1 Literature review

This chapter consist review of several literature which are related to climate change, farmers awareness, and adaptation towards farming practices in the world, Africa, various parts of Nigeria and Cross River State in particular.

2.1.1 Overview of climate change

A careful observation on the ecosystem shows significant changes in climate and the evidence are seen in change of weather, oceans and corresponding effects experienced primarily on agriculture. Farmers bear the brunt of climate change in agriculture as they make excessive input that are contradicted by the challenges of climate change, and thereby yielding little input or none. The situation is worst in third world countries where there is a great dependence on natural climate factors such as precipitation, relative humidity, temperature and soil support for agricultural productivity.

According to the United States Environmental Protection Agency (USEPA), climate change shows multiple of evidence in weather, oceans, ecosystem and more, and are basically induced primarily by human activities and supported by natural activities (EPA, 2017). Human activities such as the operation of engines and machines for the purpose of driving, manufacturing and electricity generation, as well as forest clearing contribute immensely to greenhouse gas emissions and warm the planet. Human activities release billons of tons of carbon dioxide and other heat trapping gases into the atmosphere every year. Scientists have observed that green-house gases increased from between 600 and 900 parts per billion in the year 1500 to about 2000 parts per billion (ppb) in the year 2000 (Melillo, Terese & Gary, 2014). It has been predicted by the EPA that climate change shall continue in the future due to the trending emissions of more greenhouse gases into the atmosphere by industrial activities.

The average temperature of the globe has increased by more than 1.5°F since the late 1800s (IPCC, 2013). It also has been beer reported by the IPCC that two-thirds of the warming has occurred since 1975 at an approximate rate of 0.3°F to 0.4°F per decade (IPCC, 2013) Natural activities such as change in the sun energy, shifts in ocean currents and others affect Earth's climate. It is rather unfortunate that these activities are not solely responsible for the warming that have been experienced in the past fifty years (Melilo *et al.*, 2014).Civilization and urbanization are among the human factors that can change the climate apart from green house gas emissions. Agricultural activities and civil works like road construction are responsible to change the reflectivity of the earth's surface, leading to local warning or cooling. This effect is common in urban centres which are often warmer than surrounding and less populated area (USEPA, 2017); and it is responsible for the non-uniform seasonal fluctuations experienced in agricultural fields and urban areas. Climate change also is responsible for severe environmental problems such as erosion, flooding, corrosion of buildings and monuments, as well as acid rain precipitation.

2.1.2 Socio-economic impact of climate change

Human activities are leading to changes in the global environment at virtually unprecedented rates, with potentially severe consequences to our future life. In the last six decades considerable changes have taken place in Nigeria due to natural processes and human activities, such as increasing energy consumption, industrialization, intensive agriculture, urban and rural development. These modifications may partly lead to a rise in temperature and decrease in precipitation with high spatial and temporal variability in some locations and are reflected sensitively by ecosystems (natural vegetation and landuse pattern) and by considerable alterations in soil formation and degradation processes.

A changing climate will result in considerable changes in natural vegetation and in land use practices. These changes in turn result in a feedback effect on climate: modified albedo, surface roughness, micro-circulation processes, the heat and energy balance of the near surface atmosphere, and the temperature and precipitation pattern considerably influence the field water cycle and soil formation/degradation processes (Harnos & Csete, 2008; Varallyay & Farkas, 2008).

Odjugo (2008) noted that the frequency and magnitude of wind and rainstorms did not only increased, they also killed 199 people and destroyed property worth N85.03billion in Nigeria between 1992 and 2007. Odjugo (2010) shows that climate change has led to a shift in crops cultivated in Northern Nigeria. Farmers in Northern Nigeria had switched from maize, guinea corn and groundnut to the production of millet followed by maize and beans due to increasing temperature and decreasing rainfall amount and duration occasioned by climate change. Another major problem to agriculture in Nigeria due to climate change is the reduction of arable lands and grazing rangelands. Frequent droughts and lesser rains have started shortening the growing season thereby causing crop failure and food insecurity.

Previous studies on the impact of climate change on food security in Nigeria (Bello *et al.*, 2012; Ekpo & Agu, 2014) have enumerated the frequencies of environmental disasters rising in their numbers and their impacts on human health, general wellbeing, income generation, food supply, employment, crisis and war etc. In the Niger Delta region where sea level rising is common leading to massive flooding, agrarian land areas are mostly at risk compared to other regions in Nigeria. The Niger Delta region has experienced its share flooding with the worst in 50 years being the 2012 flood which occurred when Rivers Niger and Benue rose and spilled over, swept away hundreds of farmlands, killed 363 people and displaced over 2million people nationwide (Nwaneke & Chude, 2015).

Climate change affects the level of food production by altering agro-ecological conditions necessary for crop growth and post harvest preservation and indirectly by affecting income distribution in the society. IPPC (2014) made it known that agriculture is one of the most vulnerable sectors to climate change as numerous actors in the entire agricultural food chain are susceptible (crops, horticulture, livestock, rangeland, food processing, storage and distribution etc.) Overdependence of farming on rainfall frequency and amount predispose farmers to frequent episodes of water scarcity resulting in poor yield and dehydration of livestock, extinction of some plant species etc. Moreso, food diversification is an issue in Nigeria, even through a large population of the people are farmers, one cannot entirely grow the food one need to be food secure both in amount and in nutritional quality. Thus many farmers purchase other foods in order to have nutritionally complete balanced and diversified diet, but unfortunately, the prices food in Nigeria is on a continuous rise without corresponding rise in income, thereby leaving a greater part of the population unable to buy nutritionally balance food (Okunol & Ikuomola, 2010).

It has been noted by researchers (Ekpo & Agu, 2014; Edame *et al.*, 2011) that 71.5 per cent of the Nigerian population live in absolute poverty and more than half of the people earn less than 1 dollar/day, poverty and insecurity have perversed the country further making conditions of wellbeingness of the people worse, these have affected their income generation capacity and predisposes additional burden on the family heads and the economy in general. Rising levels of air and waterborne diseases, heat associated mortality and morbidity, environmental epidemics such as cholera, guinea worm, stressed related diseases etc. are discernable. Displacements and migration related issues are in the increase. Stress is likely to be heightened after major disasters, particularly where families are displaced and have to live in emergency or transitional housing. Overcrowding and lack of privacy, and the collapse of regular routines and livelihood patterns can contribute to anger, frustration and violence with both children and adults. Affected local communities are more likely to relocate to other environmental risk prone settlements with serious concomitant worsening health conditions.

2.1.3 Impacts of climate change on agriculture

The study of natural phenomena that reoccurs periodically and how they relate to climate and seasonal changes is known as phenology. Change in crop phenology shows a remarkable evidence to regional climate change. Studies by scientists reveal that a significant advance in phenology observed for agriculture and forestry shows that droughts have been a recurrent problem in the Northern Hemisphere of the earth (Rosenzweig, 2007a; Rosengweig 2007b; Parry *et al.*, 2007; & Dai, 2011). Droughts has been expected to become more frequent in Africa, southern Europe, the Middle East, most of the Americas, Australia and South East Asia (Dia, 2011). Their impacts are triggered due to increased demand for water, population growth explosion and anthropogenic activities such as industrial and agricultural operations (Mishra & Singh, 2011). Drought is the major cause of crop failure and loss of pasture grazing and for livestock (Ding *et al.*, 2011).

Jalgaon district in India has an average temperature range of 20.2°C in December to 29.8°C in May and average precipitation of 750millimeters of rainfall per year and became the world's seventh largest banana producer if it were to be a country and not a district (Institt.NRK.org. Meteorologisk, 2016; Damodaran, 2015). In 2013, the FAO revealed that Brazil and India were by far the world leading producer of sugarcane, with a combined production of over a billion tonnes or over half of worldwide production (FAO, 2015). Between 1990 to 2012 in Nigeria, the average temperature range was between 24.9°C in January to a high of 30.4°C in April and these high temperatures made Nigeria the highest producer of yams in the world by producing over 38 million tones (FAO, 2011 and World Bank, 2016).

Long term climate change could affect agriculture in several ways:

- Productivity: in terms of quantity and quality water use (irrigation) and agricultural inputs such as herbicide, insecticide and fertilizer;
- Environmental effect: in particular in relation of frequency and intensity of soil drainage (leading to nitrogen leaching) soil erosion, reduction of crop diversity;
- Rural space: through the loss and gain of cultivated lands, land speculation, renunciation and hydraulic amenities;
- Adaptation: organisms may become more or less competitive, as well as humans may develop urgency to more competitive organisms, such as flood resistant or salt resistant varieties of rice.

Source (Fraser, 2007 & Simelton *et al.*, 2009).

2.1.4 Climate change and farmers' awareness

Inderberg, Eriksen, O'Brien and Sygng (2015) noted that climate change has serious negative impacts on people, livelihood, belief systems, culture, infrastructures and institutions. There is a rising realization that the social dimensions of vulnerability and adaptation need to be at the centre of development strategies and practices. Development policies and practices germane in addressing climate change must be systematically placed and implemented to incorporate necessary concerns and issues relevant to the socio-political structures and development pathways driving sustainability.

Awareness is a process distinguished from observing and perceiving. Awareness is associated with conscious experience such as feeling or intuition that accompanies the phenomena. It is also the state of being conscious of something and being able to process the information received to bear in the direction of a wide range of behavioural processes.

It is imperative to create awareness on climate change hazards into our daily curriculum and developmental and information melieu. This will make for systematic progress in the effort at preserving the present and securing the future in all developmental pursuits, such a wholistic and integrative approach will make farming more resilient and provide a leeway for easing tensions of climate change adaptation and vulnerability problems, and for taking appropriate actions in the implementation of climate change policies and programmes.

In Nigeria, paucity of climate smart technologies and information over the years encourage the assertion that there had been little or poor awareness profiling amongst farmers at the grassroot. Although, folktales and oral tradition are available ways of recycling local climate change knowledge amongst farmers, the print and mass media is to a point also a potent tool. Mobilizing public awareness on climate change has been a long age challenge especially among vulnerable communities, people and cultures, there is a dire need of a wider range of options and measures to communicate climate change informations for proper understanding and initiation of action by the people. To this effect extension education is necessary and agricultural extension officers should be trained and equipped with requisite tools and techniques to deliver to the local farmers the modalities, approaches and ameliorative techniques of climate change challenges on the health, economy and food security among the Nigerian populace.

People perceive climate change differently around the world. Some understand it to be global warming while others see it as the alternations in seasonal factors of temperature, precipitation and drought. Most people have heard about climate change but find it hard to understand what its all about while a reasonable number of people have never heard nor come across the concept before in their lifetime.

According to Pelham (2009a) developing countries have less awareness than developed ones, with Africa the least aware of climate change. These variations in awareness pose a challenge to policy makers as different countries use different pathways to tackle the issue of climate change (Pughese & Ray, 2009a). Although Africa remains the most vulnerable to the impact of climate change, it even produces least amount of green-house gases, as are compared to the developed countries of the world who suffer less of the impact (Puglieese & Ray, 2009b). Adults in Asia, with the exception of those in developed nations are least likely to perceive global warming as a threat. The western world, however, are the most likely to be aware and perceive it as a very serious threat to themselves and families. Europeans are more concerned about climate change than any part of the world like those in the United State (Crampton, 2007).

A Gallup poll survey conducted in 2014 on 128 countries of the world revealed that one-third of the world's population are not aware of climate change and for the individuals who are aware of the issues, they considered human activities as the primary cause of climate change (Pelham, 2009a). Statistic from the survey reveals that 51 percent of Americans were almost not worried about climate change out of which 25 percent were moderately worried with 24 percent extremely worried about the issues (Gills, 2012 & Fall, 2012). Between the year 2015 and 2017, data had increasingly showed that the effect of global warning are happening in 2017 already, with 62 percent Americans very worried about the situation (Riffkin, 2014 & Gallup Inc, 2017).

The top five countries that produce greenhouse gases in the world are China, United States, India, Russia and Japan; and they also vary in both awareness and concern about the situation (Pugliese *et al.*, 2009a). Statistic from the Gallup poll survey shows that over 85percent of the United States, Russia and Japan are aware of the situation, but Japan shows the greatest concern by translating it into support for environmental policies. China and India had about 60 percent and 33 percent awareness respectively but only China, Russia and the United State shows moderately similar proportions of concerns about the issue. India on the other hand are likely to be concerned but it has the challenge of increasing its energy needs for more than the next ten years (Crampton 2007 and Pugliese *et al.*, 2009a).

Africa remains the least aware of the climate change issues as countries like Nigeria is 28 percent aware; Egypt 25 percent aware; Ghana 26 percent, Liberia 15 percent aware, Niger 24 percent; South Africa 31 percent, Uganda 35 percent, Zambia 27 percent, Burundi 22 percent, and Rwanda 30 percent among others (Hannam, 2015). Despite the low level of awareness by Africans on global warming, a good number of them show concern about the issue as countries like Nigeria and Ghana are 62 percent and 68 percent respectively, concerned about the issues; Uganda and

Burkina Faso are 76 and 79 percent respecting concerned while Ethiopia and South Africa are the least concerned with a statistic percentage of 40 and 45, respectively (Stoke, Wike & Carl, 2015).

Nigeria is one of the ten most vulnerable countries to climate change in the world, according to a 2015 climate change index by the global risk analytic company Verisk Maplecroft and it ranks fourth with the most vulnerable country Bangladesh being Southern Asia; and the least vulnerable being Eritrea in Northern African (Ibrahim, 2017). An interview by IRIN in Godai village in Kaduna revealed that about 60 percent of the villages knew nothing about climate change (Ibrahim, 2017). Other factors that include the information rendered in the local area are reduced rains, increases in pests and soil quality degradation and the respondents accused deforestation as the sole cause of the problem. Obviously, the alacuna between farmers' awareness of deforestation and climate change awareness is cervixed by farmers' misconception of terms as in what is meant by deforestation or what may be meant by climate change. The respondents further ascertained that they have been noticing strange weather, strange and poor crop performances but failed to acknowledge that the strange alterations are indices of climate change (Ibrahim, 2017).

A sample survey on the effect of climate change on Lagos coastal areas in 2014 revealed that climate change has negative impact on the shoreline through coastal erosion increased precipitation and substantial loss of land to the sea due to rise in sea levels (Aledare, Olayiwola & Olasemi, 2014). This means that climate change through the act of high precipitation have induced erosion, flooding and distortion of socioeconomic activities in the southwestern Nigeria.

A study in 2011 aimed at examining the level of awareness in the Niger-Delta region of Nigeria about impact of climate change and to identify and document innovation and practices of adaptation in the area revealed that about 60 percent of farmers in the local communities of Cross River, Rivers and Delta States knew little or nothing about climate change and its related impacts. It was found that the mass media played a major role in climate change awareness (Nzeadibe, Chukwuone, Egbule & Agu, 2011). Unfortunately the Niger Delta Region had suffered so much from climate change due to its fragile ecosystem and the climate change is heavily induced by human activities such as gas flaring (Ugochukwu, 2008 & Ugochukwu *et al.*, 2008).

In Northeastern Nigeria, a study in 2012 was aimed at assessing the awareness, vulnerability and adaptation of farmers to climate change in Adamawa state and the results revealed that majority of the farmers were aware of climate change as more than 96 percent of the respondents claimed awareness about the issue and they also identified the effects as reduced crop yield, shortage of water and biomass for animals due to low rainfall and frequent droughts. They also confirmed that high temperatures, increase in farm pests, and floods are related indices of climate change (Adebayo, Oni, Adebayo & Anyanwu, 2012).

The rural people in Cross River State have been perceived and recognized as knowledge holders on climate variability and change and the key actors for development of policies and effect mitigation. A study in 2014 aimed at assessing the perception level of rural people of Cross River State to climate change was conducted on four communities of Bendeghe-Ekiem and Abia communities in Etung Local Government Area; and Abu and Kanyang communities in Boki Local Government Areas. The results showed that more than 71 percent of the respondents perceived that climate change is prevalent in area; as more than 64 percent claiming that it is observed by long dry seasons and more than 51 percent claimed that the issue delays the onset of rains, early cessation and stormy weather (Egbe, Yaro, Okon & Bisong, 2014). The perceived effects of climate change on farmers in Cross River State were seen on poor crop yields, increase in pest infestation, reduced soil fertility reduced vegetation and pastures increased flooding, poverty and poor food security, and more than 66 percent of the respondents attributed the causes to human induced activities, especially deforestation (Egbe *et al.,* 2014).

2.1.5 Modes of perception of climate change

Perception is a process by which organisms interpret and organize sensation to produce a meaningful experience of the world. Perception is the process by which we receive information or stimuli from our environment and transform it into psychological awareness (Brook, 1999; UNFCCC, 2016). Barber *et al.,* (2003) describe perception as an extremely complex concept which is concerned with the effects of social and cultural factors of cognitive structuring of our physical and structural environment. Ayoade (2003) opined that people infer about a certain situation or phenomenon differently using the same or different sets of information. Knowledge, interest, culture, education, age, occupation and other social processes shapes the behaviour of an actor or perspective of the local farmer the way they think and behave in relation to climate change and the adaption processes.

Elisha, Lawrence and Adekunle (2015) in a study carried out in Zaria city and its environs to analyze public perception of climate change issues using simple random sampling to administer questionnaire in the study area had noticed long-term changes in temperature and precipitation. The study revealed that the public and suggested that a strong government policy on landuse, forestry and alternative livelihood creation and also creation of the agricultural land and climate change management services domiciled in the Federal Ministry of Agriculture will be a step in the right direction. They also suggested that extension services should be made available to grassroot farmers to teach them practical solutions to reducing greenhouse gas emission and climate change adaptation mechanisms.

Nwaneke and Chude (2015) contended that the government should increase the education and health budget to creating nonstop country wide awareness of effects of climate change and viable mitigation and adaptation options made available to the grassroot farmers. They also averred that as mitigation and adaptation plans are put in place, efforts should lean towards social inclusion rather than away from it as was historically the case, since climate change affects the vulnerable group the most, children, women, aging population and the physically challenged, concerted efforts should be put in place to reach this group. Adequate stakeholder consultation should be put in place to curb inequalities, create jobs for the most disadvantaged especially women in land and assets ownership. Furthermore, proper synchronization of mitigation and adaptation actions is required as much as technology is a core part of adaptating to climate change, it certainly needs proper connection to the other different parts of the economy where the farmers are involved in the process of creating utilities and wealth creation (factory, markets, infrastructure, transportation etc.) These components all have to come together uniquely to ensure that the people adapt to their changing climate and achieve maximum economic growths in the process. Elisha, Sawa and Adekunle (2015) in a study of impacts of climate change and adaptation strategies among Graun farmers in Goronyo L.G.A., Sokoto State, Nigeria. The report revealed that farmers are well aware of climate changes, few seem to take steps to adjust their farming activities. The main adaptation strategies are crop rotation, use of improved seed varieties, shifting cultivation, intensification of irrigation or Fadama farming and use of organic and inorganic manure etc. The study also showed that a decrease in rainfall is likely to push farmers to delay their planting dates. They also suggested diversifying income of farmers by integrating into farming activities additional activities such as livestock raising, snail farming, bee farming and other livelihood options, and incooperating the use of seasonal climate forecasting to reduce production risk among most vulnerable farmers and people.

McCarthy, Lipper and Branca (2011) averred that climate change influence food production directly and indirectly through changes in agro-ecological conditions and the growth/distribution of income. Thus, to be able to cope against the negative impact of climate change, farmers need ex-ante and ex-post strategies that are context-specific adaptation strategies to manage climate risk at the farm level. Adaptation strategies may include diversification into off-farm activities as well as a range of on-farm actions. At the farm level, modification of planting dates, use of crop resistant varieties, improvement in soil and water management practices, involving the farmers in non-farm livelihood sources and market development techniques.

Foster and Rosenweig (2010) opined that the logic behind adaptation is that once a decision maker realizes that a change has occurred, he modifies his objective functions taking into cognizance the farm size, the element of risk, technology involved and inputs required. The element of risk is much higher in small farm holders than large farm holders. They also argue that size is a barrier to adoption of new technologies in sub-Saharan African countries as well as the technological package that has to do with extensive learning in the face of their limited adaptive capacity.

This research is limited on using only climate variables and human perception to determine the influence of climate change on yam and cassava in the study area.

2.2 Theoretical framework

This study was based on the contextual influence which was used in explaining climate change events, level of awareness and how climate change initiatives currently being implemented are used to mitigate the current climate change effect.

2.2.1 The contextual influence framework

This framework was designed in 2017 by Ng, Lwin and Pang in Singapore, following the global decision in 2015 to take actions to reduce global warming. The theory seeks to contribute toward this goal by examining the vulnerability of Singapore to climate change impacts and trying to strike a balance between her people's needs, and economic progress with limited resources. The measures taken by this small country could offer policy insights for small states and states without access to alternative energy sources. The theory adopts a system perspective, by integrating insights from key international climate change frameworks with theoretical concepts anchored on the model of pro-environmental behaviour (Huutoniemi & Williamo, 2014; Komiyana & Takeuchi, 2011). The contextual influence framework aims for the international comparison of different climate change initiatives being implemented and measurement of outcomes to encourage more action on climate change mitigation effects.

By adopting the premise of causality between climate change and human actions, the framework posits that stakeholders at various levels, starting from micro level of individuals to the global and societal level will take actions toward environmental sustainability in response to the rapidly deteriorating climate change effects (Tabuchi & Fountain, 2017; Wilson, 2017 & Bromwich, 2017). The framework is design to identify the extrinsic drivers that are inherent in the international and national levels by starting a framework development and by focusing on government as an influencing stakeholders, even though the government can play either a catalytic or a restrictive role in enabling pro-environmental behaviour of companies or individual consumers (Seyfang, 2009; Spaargaren & Van Vliet, 2000 & Banbury *et al.*, 2012).

The assumptions used in formulating the contextual influence framework are discussed under the following sub-themes;

Infrastructure:

One of the most important factors listed under the pro-environmental behaviours is necessary infrastructure that can take care of human activities, example recycling systems. Empirical studies by the Organization for Economic Cooperation and Development have established the importance of government in influencing pro-environmental behaviours through their provision of accessible environmental related infrastructures and services (OECD, 2014). The absence of adequate and necessary infrastructure could deter people from being environmentally conscious. Infrastructural construct comprises buildings, clean air, energy, finance, transportation, water, land, technology and other mitigating and adaptation strategies (Cheng & Tung, 2010).

Political:

The government is seen as the influence agent on pro-environmental behaviours. Political drivers could be drawn from the legal framework that enforces or encourages certain behaviours (UNFCCC, 2016). An example of a legal provision is the United Nations Framework Convention on climate change, which regulates the activities and behaviours of developed countries participating to minimize their greenhouse gas emissions (UNFCCC, 2016). The use of laws involves setting up regulations to directly influence the type of products manufactured or made available for consumption. This is achievable by enforcing producers to make products that fit within certain energy efficiency standards that are not dangerous to the atmosphere and the ecosystem at large. This strategy helps in shaping the behaviours of the individual consumers who could otherwise not find such benefits (Cheng & Tung, 2010). The policy construct could include regulations on buildings, clean air, consumer products, energy, finance, transportation, enforcement on green spaces and biodiversity, as well as international agreement (Ng *et al.,* 2017).

Economic factors:

Economic incentives and income levels are classified as economic factors. It is believed and understood that economic incentives such as grants and subsidies encourage pro-environmental behaviours by defraying costs of taking up the behaviour while economic disincentives such as taxes, deter the current behaviour by adding to the cost of the behaviour (Lin, 2008 & Hertwich, 2005). An example could be found in a study conducted by the Organization for Economic Cooperation and Development (OECD) in 2011, which revealed that consumption tends to be higher from availability of subsidized, less environmentally damaging products like electric cars (Lin, 2008; Antal & Van, 2016; Hertwich, 2005).

Information:

The United Nations endorsed consumer information as one of the initial programs of a-ten-year framework of programs on sustainable consumption and production in its conference on Sustainable Development (Rio + 20) in June, 2012 (UNEP, 2010). Sequel to this are studies which indicates mixed results of information tools such as eco-labeling on environmentally sustainable behaviours. According to Osbaldiston and Schott (2011), information tool serves two purposes which are; (a) justifications: it explains the reason for an action; (b) instructions: it explains the steps to be taken during the action. However, people prefer receiving information on the labels so as to aid them understand and read new ecolabels such as carbon labeling. Such preferences shows that people need more information tools in order to make informed decisions (Atkinson & Rosenthal, 2014; Upham, Dendler & Blenda, 2011).

Campaigns:

A document submitted to the United Nations Framework Convention on Climate Change in 2014 reveals that countries achieved through cooperation on education, training and public awareness of climate change issues (UNFCCC, 2017). Campaigns are proposed as a coding strategy which is separate from information tools like education. studies by the United Nations Environment Program in 2011 reveals that about 65 percent of the respondents who were assessed to understand the varied sentiments of youths today as well as their visions and hopes for tomorrow, claimed that they lack knowledge about their local actions, but adequately receiving information on global actions (UNEP, 2017). This suggests that there is a possible gap in relating global challenges and visions to individual's actions. To bridge the gap, Ng *et al.*, (2017), suggests that more efforts could be taken during a youth's initial years in school as part of national campaigns.

Education:

The United Nations Environment Program places an emphasis on education as the key lever to change current mindsets toward environmentally sustainable consumption behaviours and to empower sustainable consumption decisions (UNEP, 2017). Research shows that knowledge and skills acquisition influences pro-environmental behaviours by shaping one's outlook toward environmental sustainability (Meertens *et al.*, 2002; Tanner & Wolfing, 2003; Evans *et al.*, 2006).

Framework for sustainability

This involves the innovative transformation, both technically and socially on a product as well as the global impact through the life-span of the product (Spangenberg *et al.*, 2010). In essence, achieving the outcome of sustainability depends on the designer of the framework who starts the process by questioning the need for the product and exploring its usefulness in the light of alternatives, before commencing on the product design. The United Nations Environment Program recommends that the entire design for sustainability process be properly monitored from the start of the product design, to the final disposal in order to be able to address environmental sustainability issues (UNEP, 2017b). This is achievable through the inclusion of sustainable Public Procurement Program to its agenda in 2014 (UNEP, 2017c).

The contextual influence framework aims at forming part of the system and each part produces contextual influence on other parts with a goal of achieving environmental sustainability. The influencing linkages are expected to bridge the lacuna between awareness of climate change and its impacts and adaptation strategies employed to cope for environmental sustainability. Just as government and NGOs are stakeholders in the system with the objectives of regulating pro-environmental behaviours, farmers through the forum of cooperative societies could be seen as organizations and as stakeholders who can both influence and benefit from the framework simultaneously.

Applying the contextual influence framework in Etung Local Government Area, on farmers awareness and adaptation climate change can be seen that stakeholders which involves the government (ranging from the federal to the local level), individuals, NGOs, must exercise actions which are filtered by sustainable barriers and eventually produces an outcome which is sustainability, hence the illustration in Figure 2.1.

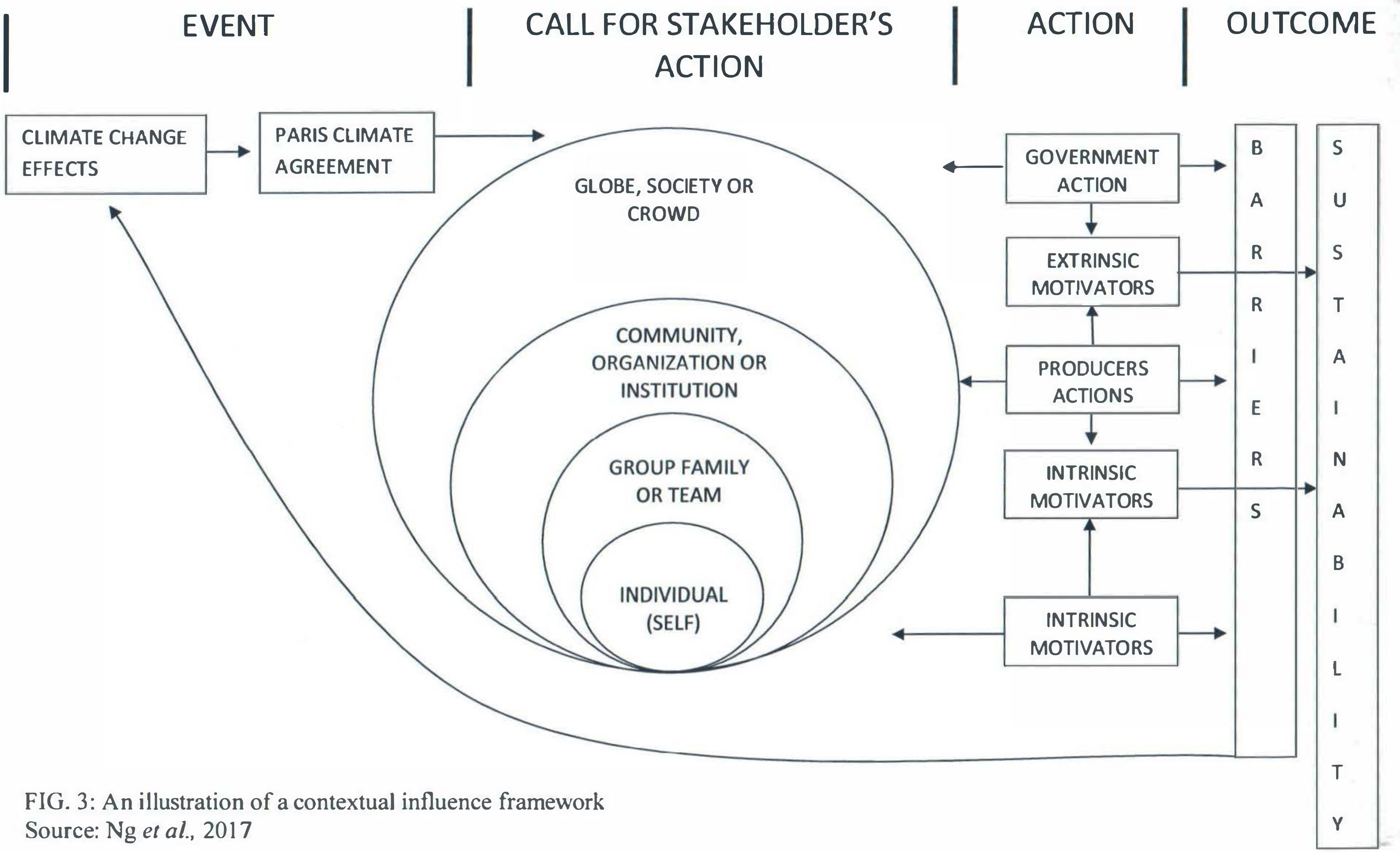

FIG. 3: An illustration of a contextual influence framework
Source: Ng *et al.*, 2017

CHAPTER THREE

RESEARCH METHODOLOGY

The chapter covers research design, types of data, source of data, procedure for data collection, sampling techniques and the statistical tool for data analysis.

3.1 Research design

This study adopted the ex-post facto and the correlational designs. The ex-post facto design was used specifically on data gathering, while correlational design emphasizes on the level of relationship existing between a dependent variable and independent variable(s), and a cross sectional survey design was adopted for questionnaire administration. The cross-sectional survey design is one of the most common and well-known study designs. In this type of research study, either the entire population or a subset therefore is selected, and from these individuals, data are collected to help answer basic questions of interest (Olsen & George, 2004).

3.2 Types of data

The data type used in the study include data on;

- Mean annual rainfall records of Etung from 1992-2018
- Mean annual temperature of Etung from 1992-2018
- Mean annual relative humidity of Etung from 1992-2018
- Yam and cassava productivity output data from Etung yam/cassava farmers,
- Etung's yam/cassava farmers' perception of climate change,
- Etung's yam/cassava farmers' adaptation strategies to climate change.

3.3 Source of data

Data for this study were sourced from both primary and secondary sources.

3.3.1 Primary sources of data

The primary source was questionnaires (Appendix 1). These tools aided to solicit information from respondents in the study area.

3.3.2 Secondary sources of data

The secondary sources of data include maps of the study area which were sourced from Department of Geography and Environmental Science GIS Unit, University of Calabar, Calabar. Similarly, online and journal publications. Also climate data were sourced from the NIMET office at Etung LGA and the crop output data sourced from the Farmers association office at Etung LGA.

3.4 Population of study

The population of the study was calculated based on preliminary facts gathered by Egbe et al., (2014) which gave estimate of farmers at about 200 farmers per community in Etung LGA. Based on this, a total of 6000 farmers were estimated to be in the 30 communities of Etung LGA.

3.5 Sample size

The Taro Yamane (1967) formula was employed to determine the sample size for the study. With a population of 6000 farmers, the formula and sample size calculation is given thus:

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

Where n =sample size

N= population of study

E= significant level of error.

Therefore,

$$n = \frac{6000}{1 + 6000\,(0.05)^2}$$

$$= 375$$

Since non-response and loss of questionnaire is a recurrent problem in social research an average of 5 questionnaires was added which brought the total number of questionnaires to 380.

3.6 Sampling technique

A multi-stage sampling technique was adopted to select the required sample for the study. The first stage was characterized by the purposive selection of Etung Agricultural Zone. The second stage is the purposive selection of Etung Local government area in the zone due to the presence of a lot of farm settlement. The third stage is the purposive selection of 5 communities out of 30 in the area to represent the sampled communities for the study, and they are displayed in Table 3.1. The simple random sampling technique was used to administer the questionnaire in the study area. The last stage is the random distribution of the semi-structured questionnaire to the farmers in the 5 communities at Abia 70, Etomi 82, Bendeghe Ekim 90, Abijang 62 and Nsofang 76 questionnaires respectively. A total of 380 questionnaires were distributed in the study area.

TABLE 3.1

Distribution of respondents in the study area

S/N	Communities	No. of questionnaire retrieved
1	Abia	70
2	Etomi	82
3	Bendeghe Ekim	90
4	Abijang	62
5	Nsofang	76
	Total	380

Source: Author's report, 2019

3.7 Procedure for data collection

The respondents that were considered for this study were residents of the communities that make up the study area (Etung LGA) and basically farmers with age range from 20 years and above, who have been actively involved in farming for at least 5 years were considered. What informed this decision was the fact that the respondents should at least be knowledgeable on the vagaries of climate change. The semi-structured questionnaire was the basic tool that was used to obtain data from respondents in the study area. Research field assistants were recruited and trained on how to politely and reliably gather information from the respondents.

They were experimented upon, to test for their efficiency in the pilot community under the researcher's supervision before they were being deployed to collect the required data with little or no supervision. The field assistants were indigenes of the study area in order to ease communication with respondents who are not formally schooled, the method also aid in identification, reliability and trust on the aspect of the respondents and they were educated people who had either finished secondary schools, enrolled in colleges/universities or are graduates in any higher institution. The reliance on educated research assistants particularly aid in explaining basic questions to respondents who may not have formal education either by using local dialects or pidgin-English language. To this end, the data obtained was highly reliable and dependable to draw inference.

3.8 Techniques of data analysis

The data obtained was analyzed using tables, charts and bar charts, while the inference was drawn from the hypothesis using the multiple regression and Pearson's correlation model in Statistics Package for Social Scientist (SPSS) version 22.

3.9 Statistical techniques

The multiple regression analysis was used to establish the level of relationship between the independent variable and the dependent variable in hypotheses one and the Pearsons correlation technique for hypothesis 2. Thus, the level of relationship between climate change and agricultural output for hypothesis one, and the effect of climate change on crop yield and effectiveness of adaptive measures adopted by farmers in Etung LGA for hypothesis 2.

Hypothesis I

H_o: There is no significant relationship between climate change and agricultural output (yam and cassava productivity) in the study area.

H_1: There is a significant relationship between climate change and agricultural output (cultivation of yam and cassava productivity) in the study area.

This hypothesis was tested using the Multiple Regression Analysis. The multivariate relationship can be explained in an equation given as:

$Y= a + b_1x_1 + b_2x_2 + b_3x_3 + ...b_nx_n + e$..........................(Eqn. 2)

Where: Y= Dependent variable (agricultural output: cassava and yam yield)

a= Intercept of regression constant

$b_1 b_2....b_n$= Regression coefficients of climate change factor

$x_1b_2....x_n$= Independent variable (climate change factors: mean temperature, mean rainfall and mean relative humidity)

e= Stochastic error term.

Hypothesis II

H_0: There is no significant relationship between the effect of climate change on crop yield and level of adaptive measures adopted by farmers in Etung LGA

H_1: There is significant relationship between the effect of climate change on crop yield and level of adaptive measures adopted by farmers in Etung LGA

The Pearson Product Moment Correlation Coefficient was used to test and make inference from hypothesis 2. The significant level of 0.05 was used. The formula is given as:

$$R = \frac{n\sum xy - \sum x\sum y}{\sqrt{n\sum x^2 - (\sum x)^2 . n\sum y^2 - (\sum y)^2}} \quad \text{...................................... } (\textit{Eqn 3})$$

Where:

R = Correlation coefficient

x = Effect of climate change on crop yield

y = Effectiveness of adaptive measures adopted by farmers

CHAPTER FOUR

DATA PRESENTATION, ANALYSIS AND DISCUSSION OF FINDINGS

This chapter dwells primarily with data presentation, analysis and discussions based on the study findings derived from both descriptive and inferential analysis. The presentation is arranged in based on stated objectives and formulated hypotheses.

4.1 Socio-economic characteristics of farmers in Etung LGA

This section centers on the socio-economic attributes of respondents involved in the study and presented on Table 4.1. Information in Table 4.1 shows the gender distribution of the sampled population. From the table as clearly indicated, 24 percent of the sampled population were male, and 76 percent were female. The analysis revealed that a higher percentage of females were sampled for the study. High number of women are engaged in farming than men. From the analysis, 20 respondents, that make up 5 percent fall under the age bracket of between 20-25 years, while 31 respondents represented by 8 percent with the age range of between 26-30 years. Further, 30 respondents represented by 8 percent of the sampled population falls under 31-35 years, while 36-40 years was represented by 40 respondents with 11 percent.

Further, details indicated that 100 respondents with age bracket of 41-45 years have 26 percent, while age bracket of 45 years and above represented 42 percent. This age bracket from the table of analysis has the highest percentage showing that the study area has population composed of youths and vibrant adults. Additional analysis on Table 4.1 shows the marital status of the sampled population and revealed that 179 respondents making 47 percent are married, and 80 respondents with a corresponding 21 percent were single. Further, 22 respondents comprising 6 percent were divorced, while 99 respondents comprising 26 percent were widowed.

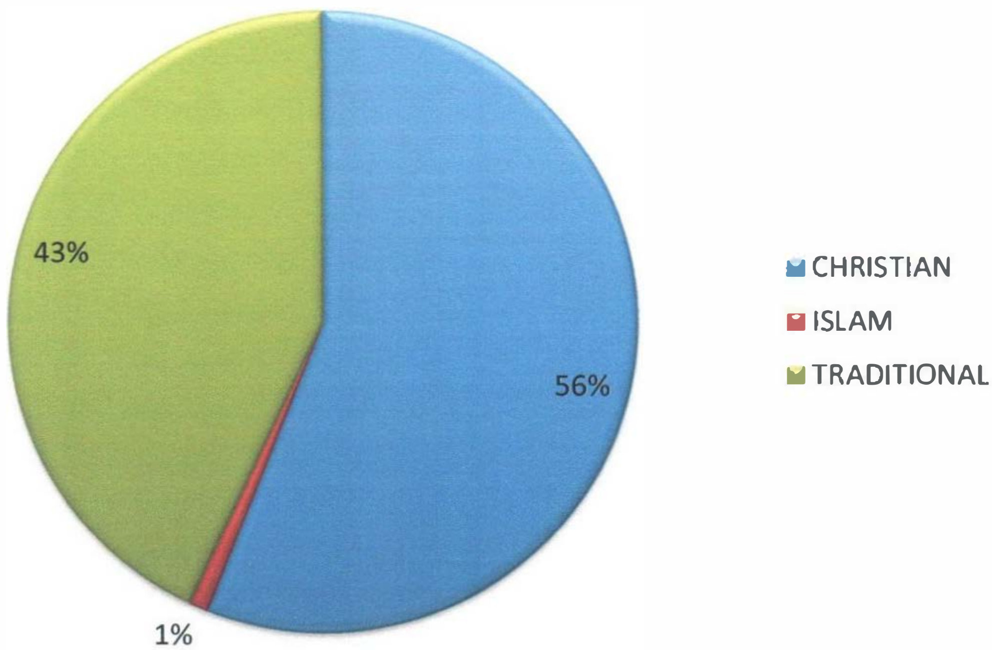

FIG. 6: A pie chart displaying the percentage distribution of religious status in the study area

Source: Author's report, 2019

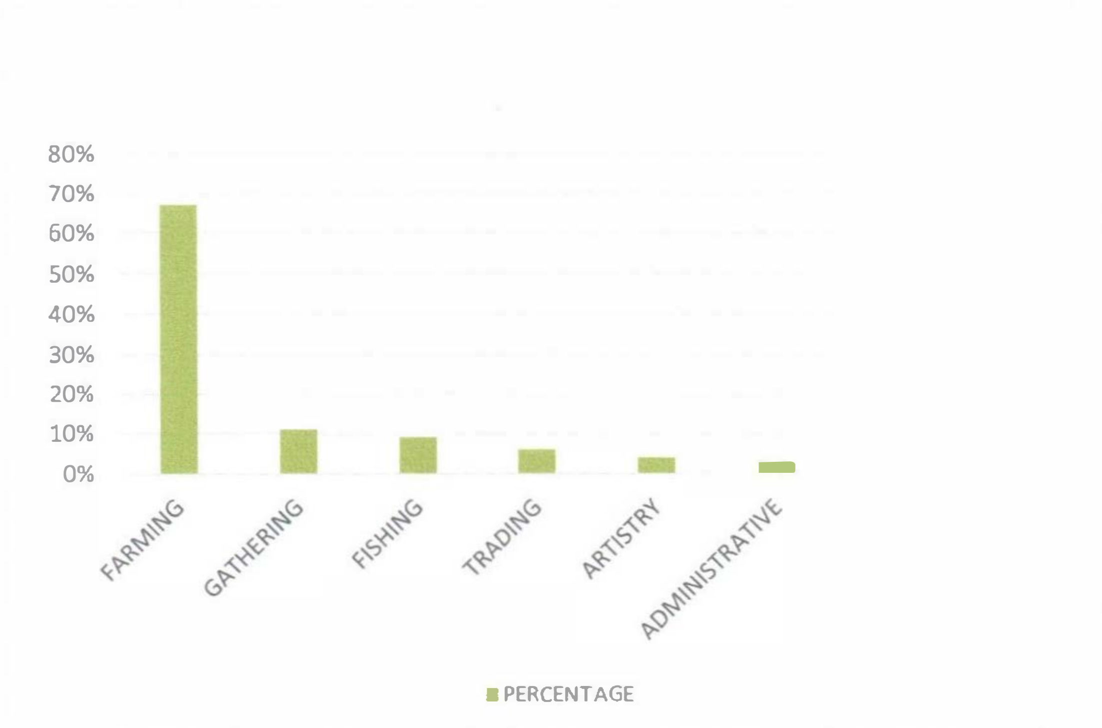

FIG. 7: A bar chart displaying the occupation status of respondents in the study area

Source: Author's report, 2019

that vast numbers of the sampled population were farmers (Table 4.1). Analysis from Figure 8 shows the variation in the earnings of the respondents. A total of 25 percent of the total population earned between 51,000-60,000 naira followed by 20,000-30,000 naira with 24 percent. Further revealed from the table, 21.5 percent earned between 31,000-40,000 naira, while 16 percent earned between 41,000-50,000. Also, 13 percent of the sampled population earned above 60,000 naira. It is therefore, evident to conclude that majority of the sampled population earned between 51,000-60,000 naira per annum.

4.2 Analyses of the variation in climate variables

To address the second objective of the study which state that (table 4.2) shows the mean climate variables for Ikom synoptic meteorological station, yam and cassava output from 1992 to 2018. The average yam and cassava yield from 1992-2018 were 699.8519tons and 635.4815tons, mean temperature 27.04^{0}C, rainfall 2294.385mm and relative humidity of 81.78%. The mean standard deviations for yam and cassava yield were 263.1909 and 475.078, temperature 0.782628, rainfall 214.9174 and relative humidity 1.012739. The mean variance for yam and cassava yield 69269.44tons and 225698.8tons, temperature 0.612507^{0}C, rainfall 46189.51 and relative humidity 1.025641% respectively. The changes in the climate variance, yam and cassava implies a serious condition of the climate.

Table 4.3 shows the decadal period of climate variables from 1992 to 2018. A 27years climate variables were broken into three decades from 1992-2001, 2002-2011 and 2009-2018. The mean annual average temperature from 1992 to 2001 was 26.52^{0}C, rainfall 2263.96mm and relative humidity of 82.6%. Mean standard

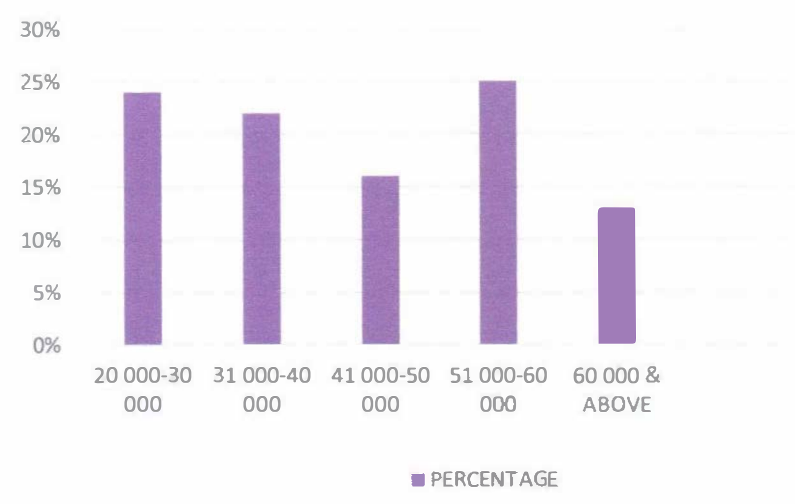

FIG. 8: A bar chart displaying the percentage distribution of income of respondents in the study area

Source: Author's report, 2019

TABLE 4.2

Climatic variables from Ikom Met station and crops productivity from 1992 to 2018

S/n	Year	Mean Rainfall (mm)	Mean Temperature (°C)	Mean Relative Humidity (%)	Yam Output (t)	cassava output (t)
1	1992	2074.5	26.2	83	411	534
2	1993	2092.9	27.6	84	528	732
3	1994	2308.7	26.8	82	335	342
4	1995	2326.1	26.9	82	602	245
5	1996	2299.4	24.2	83	412	578
6	1997	2681.1	25.7	82	523	375
7	1998	2291.6	27.2	83	505	427
8	1999	2203.7	27	82	711	389
9	2000	2399.1	27.7	82	802	1152
10	2001	1962.5	25.9	83	825	1024
11	2002	2216.2	26.7	81	509	253
12	2003	2154.7	27	81	725	611
13	2004	1984.2	27.2	82	825	1011
14	2005	1985.6	27.4	82	657	456
15	2006	2219	27.4	81	557	125
16	2007	2406.5	27.4	82	839	1023
17	2008	2740.4	27.4	82	717	543
18	2009	2215.9	27.6	82	1035	222
19	2010	2499.9	27.3	81	835	432
20	2011	2629.2	27.3	82	915	567
21	2012	2437.5	27.8	81	596	247
22	2013	2679.8	27	81	496	269
23	2014	2301.2	27.1	80	600	325
24	2015	2224.2	27.2	80	320	458
25	2016	2188	27.4	81	1111	1229
26	2017	2074.5	27.7	80	1486	2346
27	2018	2352	28	83	1019	1243
Average		2294.385	27.04074	81.77778	699.8519	635.4815
SD		214.9174	0.782628	1.012739	263.1909	475.0777
Variance		46189.51	0.612507	1.025641	69269.44	225698.8

Source: NIMET and Farmers Association Office, Etung LGA (2018)

TABLE 4.3

Decadal climate and crop production for the period of 1992-2018

Year	Mean Rainfall mm)	Mean Temperature (°C)	Mean Relative Humidity (%)	Yam Output (t)	cassava output (t)
1992	2074.5	26.2	83	411	534
1993	2092.9	27.6	84	528	732
1994	2308.7	26.8	82	335	342
1995	2326.1	26.9	82	602	245
1996	2299.4	24.2	83	412	578
1997	2681.1	25.7	82	523	375
1998	2291.6	27.2	83	505	427
1999	2203.7	27	82	711	389
2000	2399.1	27.7	82	802	1152
2001	1962.5	25.9	83	825	1024
Average	2263.96	26.52	82.6	565.4	579.8
SD	199.9493	1.054935	0.699206	167.7334	301.9065
Variance	39979.74	1.112889	0.488889	28134.49	91147.51
2002	2216.2	26.7	81	509	253
2003	2154.7	27	81	725	611
2004	1984.2	27.2	82	825	1011
2005	1985.6	27.4	82	657	456
2006	2219	27.4	81	557	125
2007	2406.5	27.4	82	839	1023
2008	2740.4	27.4	82	717	543
2009	2215.9	27.6	82	1035	222
2010	2499.9	27.3	81	835	432
2011	2629.2	27.3	82	915	567
Average	2305.16	27.27	81.6	761.4	524.3
SD	256.8411	0.254078	0.516398	161.1122	304.2079
Variance	65967.35	0.064556	0.266667	25957.16	92542.46
2009	2215.9	27.6	82	1035	222
2010	2499.9	27.3	81	835	432
2011	2629.2	27.3	82	915	567
2012	2437.5	27.8	81	596	247
2013	2679.8	27	81	496	269
2014	2301.2	27.1	80	600	325
2015	2224.2	27.2	80	320	458
2016	2188	27.4	81	1111	1229
2017	2074.5	27.7	80	1486	2346
2018	2352	28	83	1019	1243
Average	2360.22	27.44	81.1	841.3	733.8
SD	198.3657	0.323866	0.994429	345.1776	681.5617
Variance	39348.96	0.104889	0.988889	119147.6	464526.4

Source: NIMET and Farmers Association Office, Etung LGA (2018) deviation for temperature 1.055, rainfall 199.9493 and relative humidity 0.6999206. The mean variance for mean temperature 1.113^{0}C, rainfall 39979.74mm and relative humidity 0.4889% respectively. The average temperature from 2002 to 2011 was 27.27^{0}C, rainfall 2305.6mm and relative humidity of 81.6%. Mean standard deviation for temperature 0.254078, rainfall 256.8411 and relative humidity 0.516398. The mean variance for mean temperature 0.064556^{0}C, rainfall 659167.35mm and relative humidity 0.2667% respectively. The average temperature from 2009 to 2018 was 27.44^{0}C, rainfall 2360.22mm and relative humidity of 81.1%. Mean standard deviation for temperature 0.324, rainfall 198.3657 and relative humidity 0.994429. The mean variance for mean temperature 0.105^{0}C, rainfall 39348.96mm and relative humidity 0.9889% respectively. The changes in the variance suggested that there was a serious situation in the climate within 1992 to 2018.

4.3 Trend analyses of changes in climatic variables for yam and cassava productivity from 1992 -2018.

The trend of mean temperature from 1992-2018 is presented in Figure (9 & 10). The mean temperature shows that between 1993 and 1997 there was a downward slide fluctuation from (27.6°C to 25.7°C). In 2000 and 2001 there was also a downward slide fluctuation from (27.7°C to 25.9°C). In 2012 and 2015 there was also a slide downward flux from (27.8°C to 27.2°C) in mean temperature whereas in 1992 and 1993 there was a slide upward flluctuation from (26.2°C to 27.6°C). In 1997 and 2000 there was upward fluctuation from (25.7°C to 27.7°C). 2001 and 2018 there was also a slide flux from (25.9°C to 28°C) in mean temperature.

The trend of rainfall in Figure (9 & 10), shows that there had been a constant fluctuation. The rainfall amount in 1992 and 1997 indicates an upward fluctuation

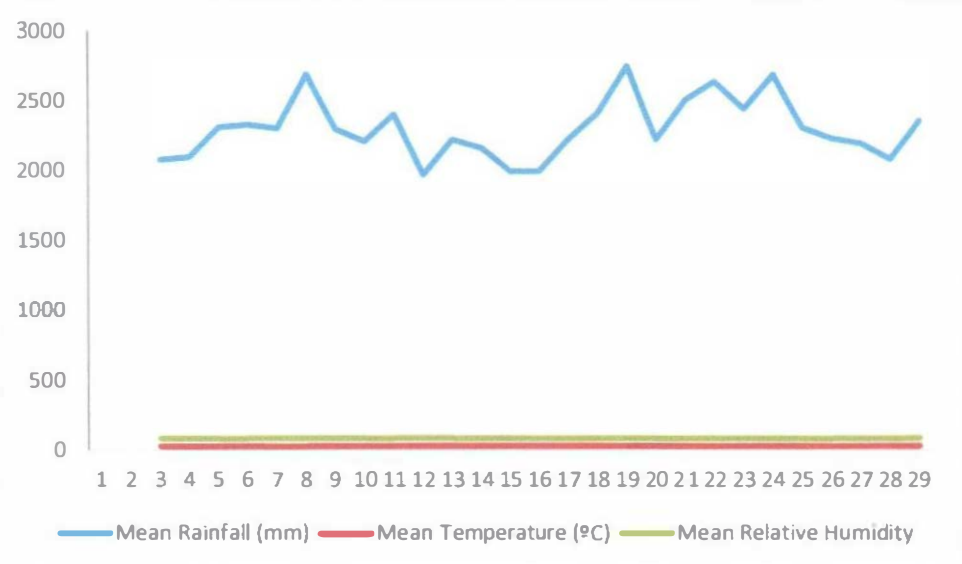

FIG. 9 Climate variable fluctuation

Source: Author's report, 2019

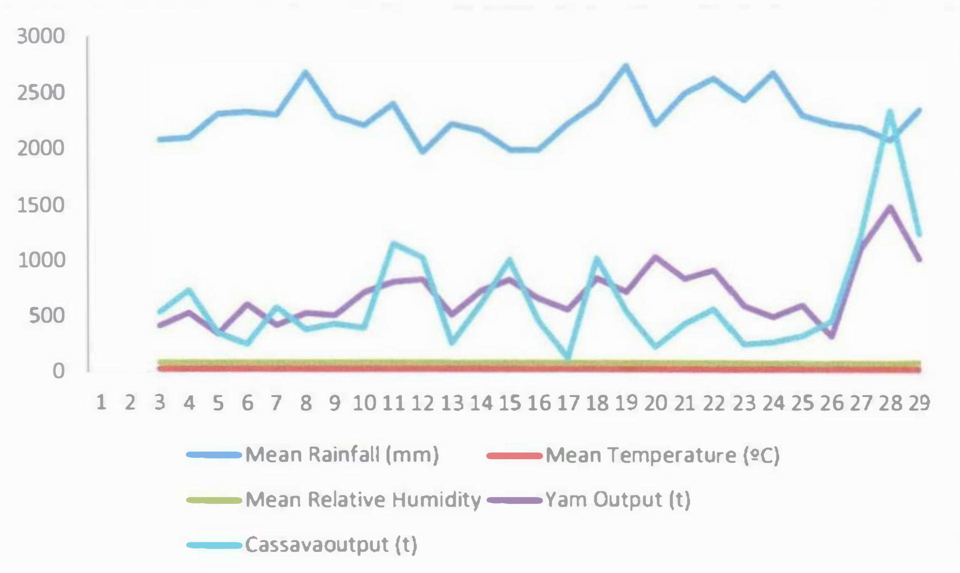

FIG. 10 Climate variables and farm productivity fluctuation

Source: Author's report, 2019

from (2074.5mm to 2681.1mm). In 1998 and 2008 there was an upward fluctuation from (2291.6 mm to 2740.4mm). in 2009 and 2013 there was a flux from (2215.9mm to 2679.8mm). In 1994 and 2001 there was a downward fluctuation from (2308.7mm to 1962.3mm). In 2002 and 2005 there was a downward fluctuation from (2216.2mm to 1985.6mm). In 2008 and 2018 there was downward fluctuation from 2740.4mm to 2352mm).

The trend of relative humidity in Figure (9 & 10) shows the upward and downward fluctuation of relative humidity. In 1992 and 1993 there was an upward fluctuation from (83% to 84%). In 1994 and 2001 there was an upward fluctuation from (82% to 83%). In 2002 and 2018 there was an upward fluctuation from (81% to 83%). The downward fluctuation of relative humidity in 1993 and 2000 was (84% to 82%). In 2001 and 2010 there was a downward fluctuation from (83% to 81%). In 2011 and 2017 there was a downward fluctuation from (82% to 80%).

4.4 Predicting the output performance of yam and cassava productivity from 1992 -2018

Objective three analysis of the effects of changes in climatic variables on yam productivity between 1992 -2018 is shown in Table 4.4. Table 4.4 shows the diagnostics for yam production from 1992-2018. This diagnostic identifies the cases with large negative residuals as the yam productivity underperformance. This means that, based on the expected yam productivity predicted by the regression model, there was underperformance of yam output in 1992(-95.53395 tons), 1993 (-147.60112 tons), 1994 (-112.43067 tons), 1996 (-12.34777 tons), 1998 (-134.21109 tons), 2002 (67.90364 tons), 2005 (-164.63366 tons), 2006 (-149.50030 tons), 2012 (-209.38953 tons), 2013 (-220.63395 tons), 2014 (-176.47976 tons), 2015 (-506.21262 tons) and

TABLE 4.4
Prediction of yam output performance

Case Number	Std. Residual	Yam output	Predicted Value	Residual
1992	-.444	411.00	506.5340	-95.53395
1993	-.685	528.00	675.6011	-147.60112
1994	-.522	335.00	447.4307	-112.43067
1995	.608	602.00	471.0319	130.96806
1996	-.057	412.00	424.3478	-12.34777
1997	.796	523.00	351.6633	171.33675
1998	-.623	505.00	639.2111	-134.21109
1999	.507	711.00	601.8858	109.11419
2000	.893	802.00	609.6139	192.38611
2001	.457	825.00	726.4978	98.50215
2002	-.315	509.00	576.9036	-67.90364
2003	.425	725.00	633.4793	91.52072
2004	.172	825.00	788.0366	36.96341
2005	-.765	657.00	821.6337	-164.63366
2006	-.694	557.00	706.5003	-149.50030
2007	.409	839.00	750.8234	88.17659
2008	.166	717.00	681.2451	35.75486
2009	.811	1035.00	860.4207	174.57934
2010	.559	835.00	714.5801	120.41986
2011	.650	915.00	775.0140	139.98596
2012	-.972	596.00	805.3895	-209.38953
2013	-1.025	496.00	716.6339	-220.63395
2014	-.820	600.00	776.4798	-176.47976
2015	-2.351	320.00	826.2126	-506.21262
2016	.777	1111.00	943.5933	167.40669
2017	2.530	1486.00	941.1882	544.81180
2018	-.488	1019.00	1124.0484	-105.04843

a. Dependent Variable: yam output
Source: Author's report, 2019

2018 (-105.04843 tons). This suggested that the fluctuation of the climate variables may be the major contributing factor for underperformance of yam productivity in the study area.

Objective three analysis of the effects of changes in climatic variables on cassava productivity between 1992 -20118 is shown in Table 4.5. Table 4.5 shows the diagnostics for cassava productivity from 1992-2018. The diagnostic identifies the cases with large negative residuals as the cassava productivity under performance. This means that, based on the expected cassava output predicted by the regression model, there was under performance of cassava productivity in 1992 (-3.10288 tons), 1995 (-47.66424 tons), 1999 (-142.31533 tons), 2002(-235.11736 tons), 2005 (-459.79705 tons), 2006 (495.90230 tons), 2009 (-644.42606 tons), 2010 (-100.22905 tons), 2011 (-34.37684 tons), 2012 (-223.24455 tons), 2014 (-370.36504 tons) and 2015 (-334.35287 tons). This suggested that the fluctuation of the climate variables may be the major contributing factor for underperformance of cassava productivity in the study area.

4.5 Test of hypotheses

Hypothesis 1

H_o: There is no significant relationship between climate change and agricultural productivity of (yam and cassava) in the study area.

H_i: There is a significant relationship between climate change and agricultural productivity (yam and cassava) in the study area.

TABLE 4.5
Prediction of cassava output performance

Case Number	Std. Residual	Cassava output	Predicted Value	Residual
1992	-.007	534.00	537.1029	-3.10288
1993	.101	732.00	687.6211	44.37890
1994	.159	342.00	272.5935	69.40649
1995	-.109	245.00	292.6642	-47.66424
1996	.164	578.00	506.2603	71.73969
1997	.672	375.00	80.8977	294.10231
1998	-.311	427.00	563.1305	-136.13052
1999	-.325	389.00	531.3153	-142.31533
2000	1.714	1152.00	402.4985	749.50152
2001	.182	1024.00	944.3011	79.69887
2002	-.538	253.00	488.1174	-235.11736
2003	.091	611.00	571.1914	39.80861
2004	.292	1011.00	883.3317	127.66827
2005	-1.051	456.00	915.7970	-459.79705
2006	-1.134	125.00	620.9023	-495.90230
2007	.870	1023.00	642.6287	380.37127
2008	.314	543.00	405.4575	137.54245
2009	-1.473	222.00	866.4261	-644.42606
2010	-.229	432.00	532.2291	-100.22905
2011	-.079	567.00	601.3768	-34.37684
2012	-.921	247.00	649.6424	-402.64244
2013	-.510	269.00	492.2445	-223.24455
2014	-.847	325.00	695.3650	-370.36504
2015	-.764	458.00	792.3529	-334.35287
2016	.535	1229.00	995.0656	233.93440
2017	3.121	2346.00	980.8983	1365.10173
2018	.083	1243.00	1206.5880	36.41200

a. Dependent Variable: Cassava output
Source: Author's report, 2019

4.5.1 Multiple regression analyses on the relationship between climate and agricultural productivity for yam production in the study area

Table 4.6 shows the regression model summary for yam production and climate variables. The model summary indicated that the predictors constant is R=65.8%, dependent variable R Square=43.4% and the model performance is 33.1% with standard error of 215.33109 (Table, 4.6). The adjusted *R*-square compensates for model complexity to provide a fairer comparison of model performance. Nearly half the variation in the variables is explained by the model. Table 4.7 represent ANOVA analysis for yam yield and climate variables. This indicated that (F=4.210, P<0.05). This suggests that, there is significant difference between the variables. The regression analysis indicated that (R=-0.226, p<0.05). This suggested that there is a significant relationship between rainfall and yam yield in the study area. Based on the result returned by the regression analysis, the alternate hypothesis is accepted, that there is significant relationship between climate change and yam yield in the study area.

The standardized coefficients are used to determine the relative importance of the significant predictors. Temperature and relative humidity actually contributed more to yam yield because it has a larger absolute standardized coefficient than rainfall. The absolute standardized coefficients were rainfall 0.135 and temperature 0.730 followed by relative humidity 0.605 (Table 4.8). This implies that there is a significant relationship between yam yield and these climate variables. The coefficients show that for most predictors, the values of the partial and part correlations increase sharply from the zero-order correlation in the temperature (0.445). This means, that much of the variance in yam yield is explained by temperature.

TABLE 4.6

Model summary of climate and yam yield

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.658[a]	.434	.331	215.33109

Source: Author's report, 2019

TABLE 4.7

ANOVA of climate and yam yield

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	780920.915	4	195230.229	4.210	.011[b]
	Residual	1020084.492	22	46367.477		
	Total	1801005.407	26			

Source: Author's report, 2019

TABLE 4.8

Coefficients analysis of climate and yam yield

Model		Unstandardized Coefficients		Standardized Coefficients			Correlations			Collinearity Statistics	
		B	Std. Error	Beta	t	Sig.	Zero-order	Partial	Part	Tolerance	VIF
1	(Constant)	-51987.359	18180.342		-2.860	.009					
	Year	22.851	7.947	.689	2.876	.009	.553	.523	.461	.448	2.231
	Meanrainfall	-.277	.201	-.226	-1.376	.0183	-.125	-.282	-.221	.954	1.048
	Meantemperature	55.667	63.913	.166	.871	.393	.445	.183	.140	.713	1.403
	Meanrelativehumidity	73.375	54.281	.282	1.352	.190	-.175	.277	.217	.590	1.695

Source: Author's report, 2019

The tolerance is the percentage of the variance in a given predictor that cannot be explained by the other predictors. Thus, the small tolerances show that 44.8%-59% of the variance in a given predictor can be explained by the other predictors. When the tolerances are close to 0, there is high multi-collinearity and the standard error of the regression coefficients will be inflated.The smallest variance inflation factor (VIF) is 1.048 with tolerance of 95.4% (Table 4.8).

Table 4.9 indicated the rotated Component matrix for yam yield and climate. The rotated component matrix scores loaded on rainfall (0.135), temperature (0.730) and relative humidity (0.605). The regression coefficient is positive for temperature (0.166) and relative humidity (0.282). This implies that yam yield is expected to have high yield in every unit increase in temperature and relative humidity condition. The rotated component matrix load most strongly on rainfall (0.135) with negative regression coefficient of (-0.226). This indicated that in every unit decrease in rainfall yam yield is expected to decrease.

4.5.2 Multiple regression analyses on the relationship between climate and agricultural productivity for cassava production in the study area

Table 4.10 shows the regression model summary for cassava production and climate variables. The model summary indicated that the predictors constant is R=53.2%, dependent variable R Square=28.3% and the model performance is 15.2% with standard error of 437.38297 (Table, 4.10). The adjusted *R*-square compensates for model complexity to provide a fairer comparison of model performance. Nearly half the variation in the variables is explained by the model. Table 4.11 represent ANOVA analysis for cassava yield and climate variables. This indicated that (F=2.169, P>0.05). This suggests that, there is significant difference between the

TABLE 4.9

Component matrix of climate and yam yield

	Component				
	1	2	3	4	5
Year	.915	-.133	-.069	.133	.349
MeanRainfall	.135	-.863	.470	.098	-.080
MeanTemperature	.730	.204	.312	-.570	-.056
MeanRelativeHuumidity	-.686	.344	.605	.038	.210
Yamoutput	.696	.466	.268	.441	-.178

Source: Author's report, 2019

TABLE 4.10

Model summary analysis of climate and cassava yield

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.532[a]	.283	.152	437.38297

Source: Author's report, 2019

TABLE 4.11

ANOVA analysis of climate and cassava yield

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	1659483.782	4	414870.946	2.169	.106[b]
	Residual	4208684.958	22	191303.862		
	Total	5868168.741	26			

Source: Author's report, 2019

variables. Nevertheless, the regression analysis indicated that ($R=-1.994$, $p<0.05$). This suggested that there is a significant relationship between rainfall and cassava yield in the study area. Based on the result returned by the regression analysis, the alternate hypothesis is accepted, that there is significant relationship between climate change and cassava yield in the study area.

The standardized coefficients are used to determine the relative importance of the significant predictors. Rainfall and relative humidity actually contributed more to cassava productivity because it has a larger absolute standardized coefficient. The absolute standardized coefficients were rainfall 0.369 and relative humidity 0.298 followed by temperature 0.011 (Table 4.12). This implies that there is a significant relationship between cassava yield and these climate variables. The coefficients show that for most predictors, the values of the partial and part correlations increase sharply from the zero-order correlation in the temperature axis (0.206). This means, that much of the variance in cassava yield is explained by temperature.

The tolerance is the percentage of the variance in a given predictor that cannot be explained by the other predictors. Thus, the small tolerances show that 44.8%-59% of the variance in a given predictor can be explained by the other predictors. When the tolerances are close to 0, there is high multi-collinearity and the standard error of the regression coefficients will be inflated. The smallest variance inflation factor (VIF) is 1.048 with tolerance of 95.4% (Table 4.12).

Table 4.13 shows the rotated Component matrix for cassava yield and climate. The rotated component matrix scores loaded on rainfall (0.418), temperature (0.730) and relative humidity (0.569). The regression coefficient is positive for relative humidity (0.298). This implies that cassava yield is expected to have high yield with relative humidity. Cassava productivity is expected to increase in every unit increase

TABLE 4.12

Coefficients analysis of climate and cassava yield

Model	Unstandardized coefficients		Standardized coefficients	t	Sig.	Correlations			Collinearity statistics	
	B	Std. error	Beta		Sig.	Zero-order	Partial	Part	Tolerance	VIF
(Constant)	-78693.824	36928.119		-2.131	.045					
Year	34.890	16.141	.583	2.162	.042	.318	.419	.390	.448	2.231
Mean rainfall	-.815	.409	-.369	-1.994	.059	-.293	-.391	-.360	.954	1.048
Mean temperature	-6.422	129.821	-0.11	-0.49	.961	.206	-.011	-.009	.713	1.403
Mean relative humidity	139.611	110.256	.298	1.266	.219	-.027	.261	.229	.590	1.695

Source: Author's report, 2019

TABLE 4.13

Component matrix analysis of climate and cassava yield

	Component				
	1	2	3	4	5
Year	.915	-.121	-.028	.131	.361
Mean Rainfall	.084	-.833	.418	.336	-.108
Mean Temperature	.703	.118	.462	-.516	-.114
Mean Relative Huumidity	-.723	.315	.569	.034	.233
Cassava output	.475	.685	.162	.505	-.154

Source: Author's report, 2019

in relative humidity condition. The rotated component matrix loaded on rainfall and temperature (0.418 and 0.703) with negative regression coefficient of(-0.369 and -0.011). This indicated that in every unit decrease in rainfall and temperature cassava yield is expected to decrease.

4.5.3 Farmer's awareness to climate change in Etung LGA

Table 4.14 shows respondent's knowledge of climate change. As indicated, 87 percent or respondents, representing 328 respondents affirmed that they are aware of climate change in the study vicinity, while 8 percent of the sampled population denied knowledge and awareness of climate change existence and also 5 percent had no idea at all. Further analysis in Table 4.14 reveals that 71 percent agreed to the fact that dry seasons are longer, while 13.2 percent representing 50 respondents disagreed to the fact. Further, 15.8 percent of the sampled population had no idea about the duration of dry season. It inferred that majority of the sampled population agreed to the fact that dry seasons are longer. The table further revealed that 68 percent of the sampled population with a corresponding 260 respondents attested to low rainfall, while 80 respondents, which represents 21 percent declined knowledge about low rainfall. Also, 11 percent expressed no idea. Therefore, it is evident that a vast number of sampled population attested to low rainfall. Analysis from the table also show that 65 percent were aware that the temperature is warmer, while 28 percent were not aware. Meanwhile, 4 percent of the total population had no idea about the existence. It could be inferred therefore, that majority of the sampled population was aware of temperature to be warmer.

Table 4.14 also indicates temperature awareness as 65 percent attest to warm temperatures, 28 percent attest to low temperatures and 4 percent have no idea.

TABLE 4.14

Respondents knowledge o f Climate change

1.	Dry season awareness	Frequency	Percentage
	Yes	270	71
	No	50	13
	No idea	60	16
2.	Low Rainfall awareness		
	Yes	260	68
	No	80	21
	No idea	40	11
3.	Warm temperature awareness		
	Yes	247	65
	No	106	28
	No idea	27	4
4.	Wind strength awareness		
	Yes	270	71
	No	88	23
	No idea	22	6
5.	Flood severity awareness		
	Yes	46	12
	No	315	83
	No idea	19	5
6.	Watershed dryness		
	Yes	322	85
	No	30	8
	No idea	28	7
7.	Rain onset, early cessation and stormy weather awareness		
	Yes	302	80
	No	66	17
	No idea	12	3

Source: Author's report, 2019

Information in Table 4.14 further indicates the level of wind in recent times. The table revealed that 71 percent of the sampled population acknowledged to the fact that there is strong wind in recent times, while 23 percent declined to having the idea. Meanwhile, 6 percent argued on non-existence of strong wind in recent times. Therefore, it is evident that vast population sampled where aware of strong wind in recent times.

The analysis from Table 4.14 indicates the severity of floods in the study area. Information in the table show that 12 percent affirmed that there is severe flood in the study vicinity while 83 percent of the sampled population declined to having witnessed severe flood. 5 percent had no idea about the existence of the above deposition. It is evident therefore, that majority of the population sampled witnessed less flood in the study locality. The analyses also show the occurrence of dryness of streams and rivers in the study area. The table revealed that 85 percent with a corresponding 322 respondents attested to dryness of rivers and streams around the study locale, while 8 percent argued to the fact. Meanwhile, 7 percent declined having idea of the dryness of streams and rivers in the study area. It could be seen that a major part of the population sample attested to the fact that rivers and streams are drying up.

Data as indicated in Table 4.14 additionally reveals that 80 percent affirmed the cause of delayed rain onset, early cessation and stormy weather, while 17 percent of the sampled population were not in support. Meanwhile, 3 percent had no idea at all. Here, it could be observed that vast population sampled were of the opinion that there were evidence of delayed rain onset, early cessation and stormy weather in the study area.

Analysis from Table 4.15 reveals the perception of the farmers on the major causes of climate change. The analysis revealed that 40.1 percent of the sampled population posits that natural causes were the major cause of climate change, while 52 percent of the sampled respondents held that human causes were the major cause of climate change. Meanwhile, 7 percent posit spiritual believes to be the major cause of climate change. It could be inferred that human cause is the major cause of climate change in the study area. Further result from Table 4.15 indicates that 39 percent of the sampled respondents posit poor crop yield to be the evidence of climate change. While 12 percent revealed that increased disease infestation to be their evidence of climate change. Further, even soil has suffered from climate change causing loss of fertility. Hence, prevalence of reduced soil fertility as held by 13 percent of sampled population. Result further show that, there are issues of emergence in reduced vegetation and pastures as viewed by 11 percent of sampled respondents, other 6 percent held that increased flooding in their area is as a result of climate change. Lastly, 19.7 percent posit insufficient food supply as a result of climate change. It is therefore evident that a vast percentage of population sampled posit crop yield as a major evidence of climate change in their study locale.

Information from the same Table 4.15 reveals the mode of climate awareness in the study locale. 29 percent of the respondents posit natural experience to be their mode of awareness of climate change, while 42 percent got their awareness from media (newspaper, radio, television). Also, 9 percent had their awareness from attending workshops and conferences; 6 percent of the sampled respondents got their awareness from extension agents, while 3 percent had theirs through formal and informal education. Meanwhile, 7 of the sampled respondents got their awareness through discussions and lastly, 34 percent got theirs from physical evidence on crop yield. It could thus be deduced that a vast percentage got their awareness through their media.

On the question of whether climate change affects crop yield in the area, 72 percent of respondents reveled that one way or the other, climate change has affected the productivity of their crops (Figure 11). Probing further on how climate change affects crop yield, 51 percent of the respondents noted reduction in their yam and cassava yields (Figure 12).

4.5.4 Adaptation strategies of farmers to climate change in Etung LGA

The adaptation strategies of farmers to climate change in Etung LGA was also assessed. Table 4.16 revealed that 68 percent of the sampled population posit that the use of fertilizer will definitely enhance plant growth yield despite climate change impact, while 32 percent were of the view that despite application of fertilizers on plants, it would not still enhance plant growth. It evident that application of fertilizer will enhance plant growth. Table 4.16 indicates further that government, community base organization or farmers association create awareness on climate change.

A total of 52 percent of the sampled population attested to government and other agencies concerned in creating awareness on climate change. Therefore, it is evident to note that concerned organizations have created some level of awareness to the populace on climate change. Information revealed in Table 4.16 further indicate that 53 percent of the sampled population attest to the fact that using traditional institution to prohibit bush burning will ameliorate vagaries of climate change, while 47 argued to the fact. It could be seen that using traditional institution to prohibit bush burning will definitely ameliorate vagaries of climate change.

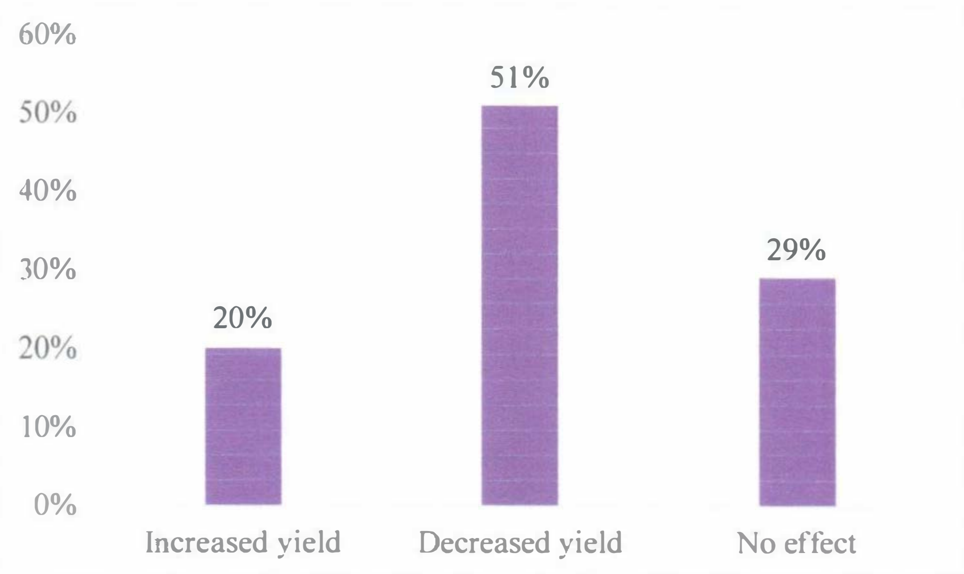

FIG. 12: Respondents perception on how climate change affects crop yield

Source: Author's report, 2019

TABLE 4.16

Respondents' mode of adaptation to climate change

	Item	Frequency	Percentage
1.	Will the use of fertilizer enhance plant growth/yield despite climate change impact		
	Yes	354	68
	No	170	32
2	do the government, community based organization or farmers association organize seminars		
	Yes	177	52
	No	163	48
3	using traditional institution to prohibit bush burning will ameliorate vagaries of climate change		
	Yes	146	53
	No	130	47

Source: Author's report, 2019

Figure 13 shows the adaptation methods adopted by farmers in the event of crop failure due to climate change. Most of the farmers (39 percent) change the location of their farms (shifting cultivation) while 35 percent practice mixed cropping, by planting two or more crops at the same time. A total of 19 percent use agro-chemicals to repel pest infestations. These adaptation methods have been mostly moderately effective. As shown in Figure 14, 23 percent of the respondents believe the methods they adopt are very effective, 32 percent were of the opinion that the methods they adopt are not effective while a higher percentage (45 percent) of respondents think their adaptation strategies are moderately effective.

4.5.5 Testing of hypothesis 2

H_0: There is no significant relationship between the effect of climate change on crop yield and the level of adaptive measures adopted by farmers in Etung LGA

H_1: There is significant relationship between the effect of climate change on crop yield and the level of adaptive measures adopted by farmers in Etung LGA

The Pearson product–moment correlation coefficient was run to determine the relationship between the effect of climate change on crop yield and the level of adaptive measures adopted by farmers in Etung LGA. The variable description for the analysis is shown in Table 4.17. The data showed no violation of normality, linearity or homoscedasticity. The output of the analysis as presented in Table 4.18 shows there was strong correlation ($r = 0.818$ or 66.9 percent) and a statistically significant relationship ($p = 0.007 < 0.05$) between the two variables.

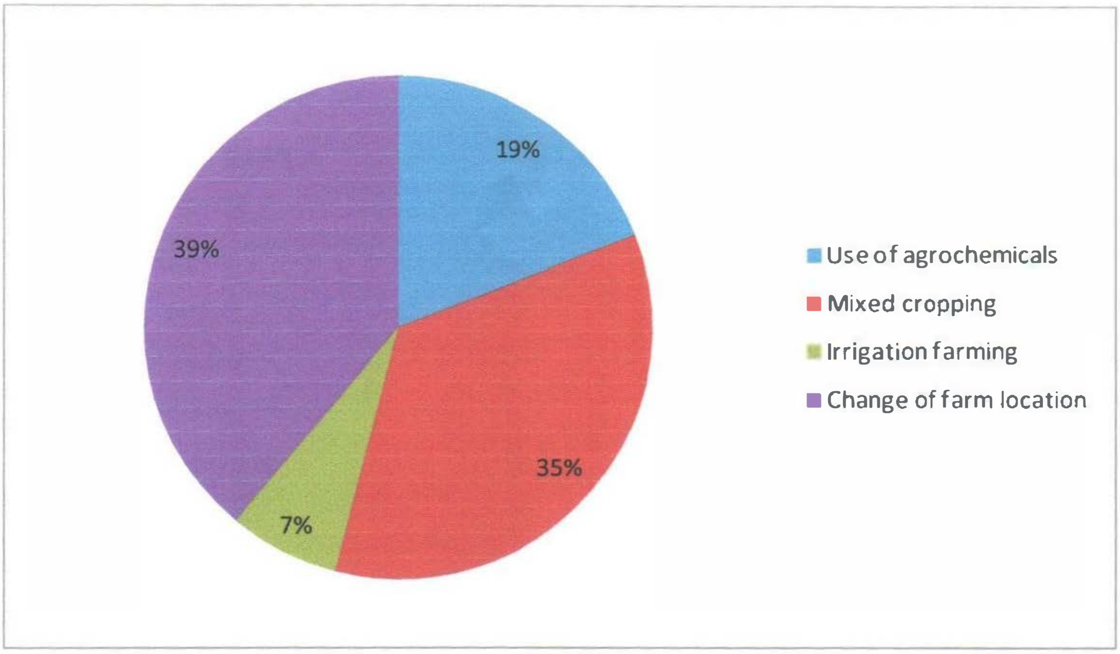

FIG. 13: Adaptation methods adopted in the event of crop failure due to climate change

Source: Author's report, 2019

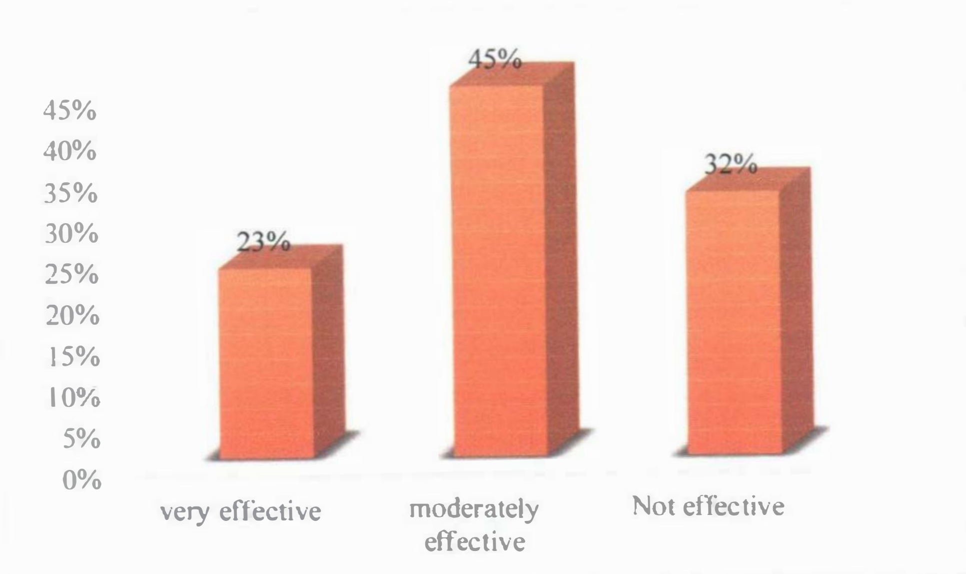

FIG. 14: Degree of effectiveness of the various adaptation practices employed

Source: Author's report, 2019

TABLE 4.17

Variable description for testing hypothesis 2

Effect of climate change on your crop yield (cassava and yam)?		
Increased yield	76	20
Decreased yield	194	51
No effect	110	29
Total	380	100
Level of effectiveness the various adaptation practices employed		
very effective	87	23
moderately effective	171	45
Not effective	122	32
Total	380	100

Source: Author's fieldwork (2019)

TABLE 4.18

Correlation result for hypothesis 2

		Effect of climate change on your crop yield	effectiveness of adaptation practices employed
Effect of climate change on your crop yield	Pearson Correlation	1	.818**
	Sig. (2-tailed)		.007
	N	9	9
effectiveness of adaptation practices employed	Pearson Correlation	.818**	1
	Sig. (2-tailed)	.007	
	N	9	9

**. Correlation is significant at the 0.01 level (2-tailed).

Source: Author's field work, 2019

Based on the result returned by the correlation analysis, the alternate hypothesis is accepted that stated there is significant relationship between the effect of climate change on crop yield and level of adaptive measures adopted by farmers in Etung LGA.

4.6 Discussion of findings

Long term climate change effect will result in poor productivity as it alters the effectiveness of climatic factors as said in literature (Fraser 2007 & Simelton *et al* 2009). Cassava and yams are the most commonly harvested tuber crops in the country (National Bureau of Statistics, 2012), despite this, the attention to cassava and yam production, considering climate change impacts is still not sufficient (Verter & Becvarova, 2014).

This climate change-cassava and yam relatedness study which focuses on Etung LGA reveals that there is significant relationship between climate change (particularly temperature and rainfall) and yam production in the study area. This corroborates with the studies of Yahaya, Tsado and Odinukaeze (2014) and Akpenpuan and Busari (2013) that there is strong correlation between rainfall, temperature and yam yield.

However, this study shows there was no significant relationship between climate change (rainfall and temperature) and cassava production in Etung LGA. This implies that unlike yam, cassava production and output in Etung LGA is not significantly influenced by climate change. This finding is supported by the assertion by Zhang *et al.* (2008) that "although cassava requires optimal conditions to achieve high growth rates, it performs well in drought-prone areas and on poor soils and is thus considered one of the most productive tropical crops on marginal lands".

Therefore, cassava is often considered an insurance and hence major food security crop for resource poor smallholder farmers in marginal lands (Kamukondiwa, 1996), such as in Etung LGA.

The knowledge and awareness to climate change in the study area is relatively high. This is also the case in the study of Babatolu and Akinnubi (2016)in their study of smallholder farmers' perception of climate change and variability impact and their adaptation strategies in the upper and lower Niger River Basin Development Authority Areas, Nigeria. Based on their awareness to climate change, farmers in Etung, like their counterparts in Chiredzi District of Zimbabwe (Mupakati & Tanyanyiwa, 2017). Egbe, Yaro, Okon and Bisong (2014) also earlier highlighted the awareness of rural peoples to climate variability/change in Cross River State, Nigeria. This finding is buttressed by the deduction from the hypothesis that there is significant relationship between the effect of climate change on crop yield and effectiveness of adaptive measures adopted by farmers in Etung LGA.

The study indicated that the mean variance of temperature was 0.105^0C, rainfall 39348.96mm and relative humidity 0.9889% respectively. The changes in the variance suggested that there was a serious situation in the climate between 1992 to 2018.

The study also shows the expected yam output predicted by the regression model, there was underperformance of yam output in 1992(-95.53395 tons), 1993 (-147.60112 tons), 1994 (-112.43067 tons), 1996 (-12.34777 tons), 1998 (-134.21109 tons), 2002 (67.90364 tons), 2005 (-164.63366 tons), 2006 (-149.50030 tons), 2012 (-209.38953 tons), 2013 (-220.63395 tons), 2014 (-176.47976tons), 2015 (-506.21262 tons) and 2018 (-105.04843 tons). This suggested that the fluctuation of the climate variables may be the major contributing factor for underperformance of yam productivity in the study area.

Similarly, based on the expected cassava output predicted by the regression model, there was underperformance of cassava productivity in 1992(-3.10288 tons), 1995 (-47.66424 tons), 1999 (-142.31533 tons), 2002(-235.11736 tons), 2005 (-459.79705 tons), 2006 (495.90230 tons), 2009 (-644.42606 tons), 2010 (-100.22905 tons), 2011 (-34.37684 tons), 2012 (-223.24455 tons), 2014 (-370.36504 tons) and 2015 (-334.35287 tons). This suggested that the fluctuation of the climate variables may be the major contributing factor for underperformance of cassava productivity in the study area.

Other findings from the analyses revealed that there is a variation in the trend of the climatic characteristics (rainfall, temperature and relative humidity) and agricultural productivity (yam and cassava outputs) in the area from 1997 to 2018. The regression analyses on the relationship between climate and agricultural yield for yam production in the study area indicated that the predictors constant is R=65.8%, dependent variable R Square=43.4% and the model performance is 33.1% with standard error of 215.33109 (Table, 4.6). The adjusted *R*-square compensates for model complexity to provide a fairer comparison of model performance. Nearly half the variation in the variables is explained by the model. Table 4.7 represent ANOVA analysis for yam production and climate variables. This indicated that (F=4.210, P<0.05). This suggests that, there is significant difference between the variables. The regression analysis indicated that (R=-0.226, p<0.05). This suggested that there is a significant relationship between rainfall and yam productivity in the study area.

The standardized coefficients are used to determine the relative importance of the significant predictors. Temperature and relative humidity actually contributed more to yam yield because it has a larger absolute standardized coefficient than rainfall 0.135. Temperature absolute standardized coefficient was 0.730 and relative humidity 0.605 (Table 4.8). This implies that there is a significant relationship between rice yield and these climate variables. The coefficients show that for most predictors, the values of the partial and part correlations increase sharply from the zero-order correlation in the temperature (0.445). This means, that much of the variance in yam yield is explained by temperature.

Table 4.9 rotated Component matrix[a] for yam production and climate. The rotated component matrix scores load most strongly on rainfall (0.135), temperature (0.730) and relative humidity (0.605). The regression coefficient is positive for temperature (0.166) and relative humidity (0.282). This implies that yam productivity is expected to have high yield with temperature and relative humidity. This suggested that yam productivity is expected to increase with temperature and relative humidity condition. The rotated component matrix load most strongly on rainfall (0.135) with negative regression coefficient of (-0.226). This indicated that in every unit decrease in rainfall yam productivity is expected to decrease.

The regression analyses on the relationship between climate and agricultural yield for cassava in the study area indicated that the predictors constant is R=53.2%, dependent variable R Square=28.3% and the model performance is 15.2% with standard error of 437.38297 (Table, 4.10). The adjusted *R*-square compensates for model complexity to provide a fairer comparison of model performance. Nearly half the variation in the variables is explained by the model. Table 4.11 represent ANOVA analysis for cassava yield and climate variables. This indicated that ($F=2.169$, $P>0.05$). This suggests that, there is significant difference between the variables. Nevertheless, the regression analysis indicated that ($R=-1.994$, $p<0.05$). This suggested that there is a significant relationship between rainfall and cassava productivity in the study area.

The standardized coefficients are used to determine the relative importance of the significant predictors. Rainfall and relative humidity actually contributed more to cassava productivity because it has a larger absolute standardized coefficient temperature 0.011. Rainfall absolute standardized coefficient was 0.369 and relative humidity 0.298 (Table 4.12). This implies that there is a significant relationship between cassava productivity and these climate variables. The coefficients show that for most predictors, the values of the partial and part correlations increase sharply from the zero-order correlation in the temperature axis (0.206). This means, that much of the variance in cassava productivity is explained by temperature.

Table 4.13 represents rotated Component matrix[a] for cassava production and climate. The rotated component matrix scores load most strongly on rainfall (0.418), temperature (0.730) and relative humidity (0.569). The regression coefficient is positive for relative humidity (0.298). This implies that cassava productivity is expected to have high yield with relative humidity. This also suggested that cassava productivity is expected to increase with relative humidity

The Pearson product–moment correlation coefficient was run to determine the relationship between the effect of climate change on crop yield and the level of adaptive measures adopted by farmers in Etung LGA. The variable description for the analysis is shown in Table 4.18. The major findings from the analyses as presented in Table 4.19 shows there was a strong correlation ($r = 0.818$ or 66.9 percent) and a statistically significant relationship ($p = 0.007 < 0.05$) between the two variables.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Summary

The study was tailored toward the response of climate change awareness and adaptation strategies of farmers in rural communities of Etung Local Government Area. The study firstly profiled the socio-economic characteristics of farmers in Etung LGA. This served as bases to examine their awareness to climate change and the adaptation strategies they adopt for resilience to climate change in the area.

The study adopted the ex-post facto research design, used in data gathering of climate elements information, correlational design which emphasizes on the level of relationship existing between a dependent and independent variable(s), and a cross sectional survey design which was adopted for questionnaire administration. A total of 380 questionnaires were administered to farmers. Considering a temporal scope from 1997 to 2018, secondary data such as climate data and crop output data were sourced from the NIMET office at Etung LGA and the Farmers association office at Etung LGA respectively. The analytical tools used are Regression Model and Pearson Product Moment Correlation Model. The results from the Regression analyses on the relationship between climate and agricultural productivity for cassava in the study area indicated that there is a significant relationship between rainfall and cassava yield in the study area. The results from the Regression analysis on the relationship between climate and agricultural productivity for yam in the study area indicated that there is a significant relationship between rainfall and yam yield in the study area. The relationship of the multiple regression is positive. The Pearson correlation result on the relationship between the effect of climate change awareness on crop yield and the level of adaptive measures adopted by farmers' in the study area indicated that there was a strong correlation (r=0.818 or 66.9 percent) and a statistical significant relationship (p=0.007, <0.005). The relationship of the Pearson correlation is positive. The mean variance for yam and cassava yield were 69269.44 tons and 225698.8 tons, temperature 0.612507^{0}C, rainfall 46189.51 and relative humidity 1.025641% respectively. The changes in the climate variance for yam and cassava implies a serious condition of the climate.

Based on the result returned by the correlation analysis, the alternate hypothesis is accepted that there is significant relationship between the effect of climate change on crop yield and level of adaptive measures adopted by farmers in Etung LGA.

5.2 Conclusion

Climate change is becoming a daily increasing challenge and requires continuous studies and updates on how to adapt to the increasing challenges. Results from the analysis of the study proves that climate factors support agricultural production in harmony, hence a challenge on one factor will negatively affect the effectiveness of other factors in the agricultural production process. Also, since climate change challenges is a recruitment problem in developing countries due to supreme dependence on natural climatic factors, more expectations would be anticipated in the future to be poor yields of agricultural products.

Farmers in Etung LGA are vulnerable to the effects of climate change given their dependence on rainfed agriculture. The farmers are aware of the changing weather patterns, major causes of change, as well as its impacts on their agricultural productivity, particularly in the yields of their cassava and yam. This begs the need for innovative adaptive solutions to the vagaries of climate change on their agricultural processes. This would ensure the achievement of the Sustainable

Development Goal 2 (end hunger in all its forms by 2030 and to achieve food security) in Etung LGA, Cross River State and Nigeria at large.

5.3 Recommendations

1. There is need for more and consistent training and sensitization of farmers in Etung LGA by the government and concerned civil society organizations on innovative adaptive strategies to combating climate change effects on their productivity. Apart from trainings, climate change resistant crops (such as drought resistant cassava or yam seedlings) should be made available to local farmers in the area.
2. The government, concerned civil society organizations and community-based organizations should as well create channels that would enable farmers report challenges they perceive are related to climate change impacts. These channels can be in form of a forum where resource persons from institutional establishments would share their expertise on best adaptive practices as applicable in the world over.
3. Farmers willing to grow cassava and yam should as well be assisted with improved seeds; this can be on a loan basis with attractive repayment plan such as payment after sale of harvested produce.
4. Farmers, the farmers association, the local government administration and other concerned civil and government agencies should invest in climate change adaptation research and strategies. This would gear even more evidence-based findings that would support the resilience of farmers to climate change effects, particular in local communities where farmers are more vulnerable.

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Appendix 1: Questionnaire

Department of Geography and
Environmental Science,
Faculty of Social Science,
University of Calabar.

Dear Respondent

This research on "Climate Change Awareness and Adaptation Strategies of Farmers in Rural Communities of Etung Local Government Area" aims at investigating the relationship between climate change awareness and adaptation strategies of inhabitant farmers. You are please expected to supply the needed information in this questionnaire as your responses will be kept confidential and strictly for the purpose of the research.

Thank you

SECTION A

SPATIAL DATA

1. Clan: ....
2. Ward: ....
3. Coordinate

Eastings	Northings

SECTION B

SOCIO-DEMOGRAPHIC

4. Gender (a) male[ ] (b) female [ ]
5. Age (a) 20-25yrs [ ] (b) 26-30yrs[ ] (c) 31-35yrs [ ] (d) 36-40 yrs[ ] (e) 41-45yrs [ ] (d) 45 and above [ ]
6. Marital status (a)Married [ ] (b) Singe [ ] (c) Divorced [ ] (d)Widowed [ ]
7. Level of education (a) Non-formal education[ ] (b) primary [ ] (c) secondary [ ] (d)college/polytechnic [ ] (e) university [ ]
8. Household size (a)< 5[ ] (b)6-10 [ ] (c) above 10 [ ]
9. Religion (a) Christian[ ] (b) Islam [ ] (c) tradition [ ]
10. Major occupation (a) farming [ ] (b) Gathering [ ] (c)fishing [ ] (d) trading [ ] (d)Artistry [ ] (e) Administrative [ ]

11. Income per annum (N) (a) 20,000-30,000[ ] (b) 31,000-40,000 [ ] (c) 41,000- 50,000 [ ] (d) 51,000-60,000 [ ] (e) above 60,000 [ ]

SECTION C

CLIMATE CHANGE AWARENESS

12. Are you aware of climate change? (a) yes [ ] (b) No [ ] (c) no idea [ ]
13. Do you agree that dry seasons are longer? (a) yes [ ] (b) No [ ] (c) no idea [ ]
14. Do you know that there is low rainfall? (a) yes [ ] (b) No [ ] (c) no idea [ ]
15. Do you know that temperature is warmer? (a) yes [ ] (b) No [ ] (c) no idea[ ]
16. Do you know that we have strong winds in recent times? (a) yes [ ] (b) No[ ] (c) no idea [ ]
17. Do you know that we have severe floods? (a) yes [ ] (b) No[ ] (c) no idea [ ]
18. Do you know that rivers and streams are drying up? (a) yes [ ] (b) No[ ] (c) no idea [ ]
19. Do you know that we have delayed rain onset, early cessation and stormy weather? (a) yes [ ] (b) No[ ] (c) no idea [ ]
20. What do you think are the causes of climate change? (a) Natural cause [ ] (b) Human cause [ ] (c) Spiritual believes [ ]
21. What is your evidence that there is climate change? (a) poor crop yield [] (b)increased disease infestation [ ] (c) reduced soil fertility [ ] (d) reduced vegetation and pastures [ ] (e) increased flooding [ ] (f) insufficient food supply [ ]
22. How did you become aware of climate change? (a) natural experience[ ] (b) media (newspaper, radio, television) [ ] (c) workshops and conference[ ] (d) extension agents [ ] (e) through formal and informal education [ ] (g) through discussion [ ](h) Physical evidence on crop yield [ ]
23. Does climate change in your area affect your crop yield (cassava and yam)? (a) Yes [ ] (b) No [ ]
24. If Yes, what is the degree of effect does climate change have on your crop yield (cassava and yam)? (a) Increased yield [ ] (b) Decreased yield [ ] (c) No effect [ ]

SECTIONS D

MEASURES TO BOOST AGRICULTURAL PRODUCE DESPITE CLIMATE CHANGE

25. Will the use of fertilizer enhance plant growth/yield despite climate change impact?(a) Yes [ ] (b) No[ ]
26. Do the government, Community Base Organization or farmers association organize seminars to create awareness about climate change?
(a) Yes [ ] (b) No[ ]
27. State the major climate change adaptation method you are using
....
28. Using traditional institution to prohibit bush burning will ameliorate vagaries of climate change (a) yes, (b) No[ ]
29. Which method do you adopt in the event of crop failure due to climate change? (a) Crop diversification [ ] (b) Use of Agro-chemicals [ ] (c) Mixed cropping [ ] (d) Irrigation farming [ ](e) Change of farm location [ ]
(f) others specify...........................
30. What is the degree of effectiveness of the various adaptation practices you employ? (a) very effective [ ] (b) moderately effective [ ] (c) Not effective [ ]