

*Full Length Research Paper*

# An appraisal of climate change and agriculture in Nigeria

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**Climate change is a phenomenon that has the potential of affecting all natural and human systems and may be a threat to human development. This is particularly the case in developing countries. This paper is a theoretical article that uses secondary sources of data including weather events that occurred recently to appraise climate change and agriculture in Nigeria. The results have shown that human activities are largely responsible for climate change experienced in different parts of the globe today. These activities have led to increased concentration of greenhouse gases into the atmosphere and they are associated with the industrialised countries and some emerging nations. Agriculture in Nigeria is entirely dependent on climate and changes in climate are bound to affect it. This paper found out that climate change has already had a negative impact on agriculture in Nigeria especially in the last few years. It is therefore recommended that conscious efforts should be made towards mitigating the impacts of climate change on agriculture in Nigeria.**

**Keywords:** Climate change, Agriculture, Nigeria.

## INTRODUCTION

Changes in global climates are not new in the earth's history. For example the glaciation period or ice sheet age indicates large fluctuations in the last 200,000 years (Bilham-Boult et al., 1999). Such events occurred naturally, but changes today appear to be largely the result of human activities. Climate change is evidently linked to human actions and in particular from the burning of fossil fuels and changes in global patterns of land use (Salami, 2010).

The United Nations Environmental Programme (UNEP) defines climate change as extreme reactions of the weather phenomenon which creates negative impacts on agriculture, water resources, human health, depletion of ozone layer, vegetations, soil and doubling of carbon dioxide in the ecosphere (Ezra, 2010). According to the

Nigerian climates reports 490, climate change is any long term change in the statistics to averages, extreme or other measures, and may occur in a specific region or the earth as a whole (Ali, 2011). Climate change has the potential of affecting all natural and human systems and maybe a threat to human development and survival socially, politically and economically (Ali, 2011).

Agriculture is a major form of human activity on the surface of the earth. It involves cultivating the soil, producing crops and raising livestock and in varying degrees the preparation and marketing of the resultant products. In the developing countries agriculture is a major branch of the economy not only providing employment to a very large percentage of the population but also providing a source of food, raw materials and item

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Figure 1. Map of study area Nigeria.

of trade and commerce. It is thus the main basis of the livelihood of the vast majority of the population as they engage in agriculture for their daily food supply, source of income and employment.

Agriculture is a primary activity that depends on natural conditions that is it is largely controlled solely by physical conditions such as temperature, precipitation and water supply, soil (edaphic factors), wind, altitude, angle of slope and aspect (Waugh, 1995). This is the situation in developing countries where agriculture is highly dependent on the climate elements such as temperature, precipitation and water supply.

### Study area

Nigeria is located entirely in the tropical region between latitude  $4^{\circ}$  –  $14^{\circ}$  north of the Equator and longitude  $3^{\circ}$  –  $15^{\circ}$  East of GMT and positioned on the west coast of Africa between the Bight of Benin to the fringes of Sahara desert between Benin Republic and Cameroon. The country has a land area of 923,768 km<sup>2</sup> with a coastline of 853 km. Based on the 2006 National Population Census the country has 140,431,790 people which make

it the most populous in Africa. The 2012 estimates are 170,123,740 people which make it the 7<sup>th</sup> most populous country in the world (Wikipedia, 2013a). In terms of physical setting the climate is varied sub-equatorial climate in the south and tropical continental in the north. The vegetation consists of forests in the south and savannah grassland in the north. The drainage consists of two major rivers and other smaller ones and lakes. These can be seen in Figure 1.

It is important here to state that the two major rivers and other smaller ones found in the Northern part are important for agriculture as they supply water for irrigation for the production of a variety of food crops, cash crops and market garden crops.

### METHODOLOGY

The paper is a theoretical (review) research that makes use of largely secondary sources of data to answer the research questions. These sources include textbooks, book of proceedings, published journal articles, internet sourced materials, daily newspapers etc. Statistical data were gathered from empirical studies and used to explain

**Table 1.** Proportion of global warming caused by the four greenhouse gases.

Gas	Percentage
Carbon dioxide CO <sub>2</sub>	64
Methane CH <sub>4</sub>	19
Chloro fluoro carbons (CFCs)	11
Nitrous Oxide (N <sub>2</sub> O)	06
Sulphur hexafluoride	0.4
Total	100

Source: Cunningham and Cunningham (2006).

climate change and agriculture in Nigeria. The data were collected over time and edited to suit the writing of the paper and the data were presented to answer the research questions. The research questions are:

- i) What is responsible for present day climate change?
- ii) What is the link between global climate change and agricultural products
- iii) How has climate changed in Nigeria?
- iv) What is the nature of agriculture in Nigeria?
- v) What are the impacts of climate change on agriculture in Nigeria?

### Climate change

Climate change is now widely recognised as the major environmental problem facing the globe (UNEP, 2013). It is due to this fact climate change is the most topical issue worldwide because of its impacts that are threatening the sustenance of man and his environment.

Human activities are largely responsible for climate change experienced in different parts of the globe today. These activities have led to increase in concentration of some gases called green house gases (GHGs) into the atmosphere. These GHGs are carbon dioxide (CO<sub>2</sub>), Methane (CH<sub>4</sub>), Nitrous oxide (N<sub>2</sub>O) and Chloroflouro carbons (CFCs) (Cunningham and Cunningham, 2006). These four GHGs result in the increase in temperature of the globe otherwise referred to as global warming. The proportion of global warming caused by the four greenhouse gases can be seen in Table 1.

The countries responsible for the increase in the concentration of GHGs are the industrialised nations and some emerging nations. The top 10 cumulative energy related CO<sub>2</sub> emitters between 1850 – 2008 can be seen in Table 2.

The above figures are for GHG emissions from generation of energy that is fossil fuel burning. The first column shows the main countries involved in the emission and it could be observed that majority (80%) are the industrialised countries. The second column shows the percentage of world total with the United States

emitting 28.5% of the world total. The third column shows the metric tonnes CO<sub>2</sub> per person with the United States and United Kingdom having the highest per person.

Presently there are concerns on climate change chief of which is the increase in CO<sub>2</sub> levels due to emissions from fossil fuel combustion, followed by aerosols and cement manufacture. Other factors include land use, ozone depletion, animal agriculture and deforestation. Also of concern is the role they play both separately and in conjunction with other factors in affecting climate, microclimate, and measures of climate variables (Wikipedia, 2013b).

Since the beginning of the Industrial Revolution in the 1750s, atmospheric concentration of carbon dioxide has increased by nearly 30%, methane concentrations has doubled and nitrous oxide concentration has risen by about 15%. These increases have enhanced the heat trapping capacity of the earth's atmosphere. Increased concentrations of greenhouse gases are likely to accelerate the rate of climate change (Ayuba, 2005).

It is these atmospheric emissions and subsequent concentrations of GHGs over the years that have now reached optimum level leading to disruptions in the atmospheric patterns that have caused climate change (Ladan, 2012).

African countries in general contribute the least to the emissions that caused climate change. Nigeria like other developing countries contributes insignificantly to the greenhouse emissions. The areas of contribution are in gas flaring, animal agriculture and deforestation which constitute small percentage in comparison to other countries (Ladan, 2012).

### The link between global climate change and agricultural products

Today despite advances in science and technology agriculture is still depended on climate. It is based on this that global climate change affects agricultural products in the following ways.

More extreme temperature and precipitation prevents crops from growing well. Extreme especially floods and drought harm crops and reduces yields. For example in 2008, the Mississippi River flooded just before the harvest period for many crops, causing an estimated loss of 8 billion USD for farmers (USEPA, 2014).

Heat waves which have started to increase with climate change have directly threatened livestock production. A number of States in the United States have each reported losses of more than 5,000 animals from just one heat wave. The heat waves affect animals both directly and indirectly. Over time heat wave increases vulnerability to diseases, reduces fertility and reduces milk production (USEPA, 2014).

The changes in temperatures and seasons affect the

**Table 2.** Top 10 cumulative energy related CO<sub>2</sub> emitters between 1850 – 2008.

S/No	Country	% of world total	Metric tonnes CO <sub>2</sub> per person
1	United States	28.5	1,132.7
2	China	9.36	85.4
3	Russian Federation	7.95	677.2
4	Germany	6.78	998.9
5	United Kingdom	5.73	1,127.8
6	Japan	3.88	367
7	France	2.73	514.9
8	India	2.52	26.7
9	Canada	2.17	789.2
10	Ukraine	2.13	556.4

Source: Wikipedia (2013b).

timing of reproduction and migration of fish and other aquatic animals. Many stages within an aquatic animal's life cycle are controlled by temperature and the changing of the seasons. For example in North West Europe warmer water temperatures affects the life cycle of salmon fish and increases the likelihood of diseases. This combined with other climatic impacts are projected to lead to decline in salmon fish production in the region (USEPA, 2014).

Increase in atmospheric carbon dioxide (CO<sub>2</sub>) is gradually making the world's oceans to become more acidic and this increasing acidity harms shell fish which are created from calcium and are vulnerable to increasing acidity. Ocean acidification can also threaten the structure of sensitive ecosystems which some fish and shell fish depend upon.

In the developing countries, one of the biggest effects of climate change on agricultural products is very unpredictable rainfall which affects the growth pattern of rain-fed crops such as maize and rice. In Southern Katsina State in Northern Nigeria for example, maize and rice are planted on farmlands at the beginning of the 2014 rainy season to take advantage of early harvest but there was a long delay in the rains for one month; this makes the crops to start drying which affects yield in the harvesting period. The farmers are experiencing an unusual situation where there is shortage of rainfall in the month of July and August (Mahmud, 2014). This situation primarily caused by climate change will affect maize and rice productivity both in terms of quality and quantity.

Due to climate change, temperatures are higher and it is in higher temperatures that most diseases thrive. new diseases are appearing at vegetables at alarming rates, a rate so fast that scientists find it difficult to keep up with tracking, naming and classifying them. The bird flu is a great example of this problem (Epperson, 2014).

The increase in temperature due to global warming has resulted that some food crops like wheat which was previously cultivated in Northern Nigeria at the Hadejia-Jamaare River Basin Development Project could not be

produced today as the crop cannot get the lower temperature it requires for its growth. This situation of non cultivation of wheat has resulted in shortage of wheat in the region and has prompted importation of the crop from foreign countries to meet up domestic demands within Nigeria.

### Climate change in Nigeria

Climate change is a global problem and many countries are experiencing different aspects of it.

In Nigeria, both temporal and spatial variations were observed in air temperature distribution. The temporal air temperature trend has remained generally on the increase since 1901 and within 105 years, temperatures increased by 1.2°C in the coastal cities of the Niger Delta and 2°C in the Northern extreme of Nigeria (Ojugbo, 2010). A mean air temperature of increase of 1.7°C was observed in Nigeria for the last 105 years. The lowest mean annual temperature was recorded on the Mambilla, Obudu and Jos Plateau because they experience semi-temperate climatic condition.

A further support of the evidence of climate change in Nigeria is the increase in rainfall in the coastal areas since the 1970s and a constant decline in rainfall amount and duration in the continental interiors of the semi-arid region of Nigeria. The increase in rainfall in the coastal cities is partially responsible for the increasing floods devastating the coastal cities like Calabar, Port Harcourt, Warri and Lagos as observed by Ojugbo (2010).

The increasing temperatures and decreasing rainfall in the semi-arid regions of Sokoto, Katsina, Kano, Nguru and Maiduguri have resulted in increasing evaporation, drought and desertification in Nigeria which have resulted in either reduction in water levels or total dry up of some rivers in Northern Nigeria; while Lake Chad is reported to be shrinking in size at an alarming rate since the 1970s (Ayuba, 2005). Dami et al (2011) in their study on Adaptation Strategies to Climate Change in Nigeria's

Section of the Chad Basin observed that the reduction in the size of the lake is associated with climate change and human demand for water. The climatic factors are the declining frequency and volume of rainfall received within and outside the basin. The human factors are mainly related to land use and are driven by an increasing demand for water even as its supply is decreasing (Dami et al., 2011).

Another study by Sawa (2010), using daily rainfall records of 30 years (1996-2005) for 15 selected meteorological stations in Northern Nigeria concluded that places in the Sudano-Sahelian region of Northern Nigeria are already experiencing the impact of global climate change in form of increasing number of dry spells during the rainy season from May to September of the years under study. This increasing dry spells result in that little vegetation growth which leads to drought and desertification as the vegetation gets degraded or completely removed due to human activities particularly fuel wood extraction and grazing by animals.

The occurrence of extreme weather events is one of the manifestations of climate change in Nigeria. Floods due to heavy rains have been experienced in parts of the country particularly in the southern parts and the Middle Belt in the years 2011 and 2012. In Ibadan, for example on August 28<sup>th</sup> 2011 heavy down pour in more than five decades wreaked havoc across the city. The rains that fell on that day hit an all time height of 187.50 mm accompanied by wind gust reaching 65 km/hr. The previous highest recorded was 178.30 mm in September 1987 (IITA, 2011).

The worst flooding in decades was witnessed in the months of July to September 2012 which affected several states close to the major rivers, Niger and Benue that burst their banks due to hours of incessant rains. The floods led to the death of 140 people, hundreds and thousands were displaced, schools and businesses were closed and thousands of hectares of farmlands were submerged. Thousands of people lost properties and lived in displacement camps for three to four months in Benue, Niger, Kogi, Edo and Rivers States. The President of Nigeria while visiting some of the affected states called the floods a national disaster (Daily Herald, 2012).

Rising sea level and ocean surge as a result of global warming are evidences of climate change in Nigeria. Awosika and Folorunsho (2005) reveal that Victoria Island is one of the fastest eroding beaches as it loses about 30 meters to the ocean annually. Ugborodo /Escavors loses around 24 metres yearly and by the end of the 21<sup>st</sup> Century Lekki and Victoria Island will lose 602 and 584 square kilometres. The Niger Delta will be worse with about 15,000 square kilometres under the sea. Lagos in recent times has suffered from ocean surges and the degradation of beaches such as Alpha, Kurama and Lekki with properties destroyed and lives lost. For example, in early August 2012 the people of Lekki were

displaced from their homes when the Atlantic Ocean water surged into their residences. The Lekki Beach was totally wiped off as it remained under water for some days.

The weather condition in the Niger Delta region has presently changed primarily as a result of the activities of crude oil extraction companies that operate there. Gas flaring is the singular and most common source of global warming and contributes to the emission of carbon monoxide, nitrogen (II) oxide and methane which cause environmental pollution and ecological disturbances (Ubani and Onyejekwe, 2013). Gas flaring contaminates the atmosphere and produces emissions that cause thermal pollution as the immediate impact of gas flaring is experienced in high and rising temperature in the communities close to the flare sites and beyond, acidification of rain water and deposit of black powder cover (Alaba et al., 2013)

## AGRICULTURE IN NIGERIA

Agriculture used to be the principal foreign exchange earner of Nigeria from independence in 1960 up to the mid 1970s; at that time Nigeria was the world's largest of groundnuts, cocoa and palm oil and a significant producer of coconuts, citrus fruits, maize, pearl millet, cassava, yam and sugar cane. About 60% of Nigerians work in the agricultural sector and Nigeria has vast areas of underutilised arable land (Wikipedia, 2013c).

In Nigeria today agriculture is the main source of food and employer of labour employing about 60 – 70 percent of the population. It is a significant sector of the economy and source of raw materials used in processing industries as well as source of foreign exchange earnings for the country (Ayinde et al., 2011).

Agriculture in Nigeria is mostly rain fed. In the north where rainfall is seasonal farmers clear their land and await the commencement of the rains mostly in May/June. Food crops produced are mainly grains and cereals such as millet, guinea-corn, maize, rice, wheat, beans and cash crops include cotton, groundnut, sugar cane. The occurrences of droughts since the 1970s have necessitated the building of dams to supply water for irrigation agriculture. Examples include Tiga and Kadawa dams in Kano and Jigawa States, Zobe and Jibia in Katsina State, Goronyo and Bakalori dams in Sokoto State.

In the Middle Belt food crops produced are mainly root crops like yams, cassava, cocoyam, potatoes, and beniseed. There are also highland temperate mixed crops produced on the high Plateaux of Jos and Adamawa and examples are Irish potatoes, tea, temperate fruits like apple etc.

In the southern part the main crops are roots and tree crops such as yams, cocoa yams, plantations, cocoa, rubber, palm produce, kola nuts etc. There is double

maxima rainfall in the south which favours the growth of these crops. Some of these crops are grown for commercial purposes in plantations. Shifting cultivation remains the major farming system among the peasant/local farmers who produce a large percentage of the total food supplies in the country (Akor, 2012).

Forestry is another major activity in Nigeria. In 2005 forestry production shows that 86.7% of the wood is used as fuel while the remaining 18.3% of the wood is used for producing sawn wood, veneer, railways sleepers, pulp and other products (Macmillan, 2007). These are products mainly from the southern forest region and some from the Middle belt and the north where there are forest reserves, communal forest areas within the savannah vegetation zones. Deforestation is however severe in the northern and southern parts and moderate within the north central and middle belt areas of Nigeria. Desertification is severe along the extreme north and moderate in the surrounding areas.

A cattle rearing is predominantly practiced in the northern part by the Fulani herdsmen who are nomadic in nature. They move in search of pasture grass and water for their cattle from the north to the middle belt up to the southern parts of Nigeria. There are also mixed farmers who rear cattle and sedentary rearers found in different parts especially in the northern parts. The main livestock reared are sheep, goats, pigs, cattle and poultry and the products include lamb and mutton, goat meat, pork, beef, milk and eggs (Macmillan, 2006).

Fishing is carried out on inland rivers, fish farms lakes and dams and along coastal waters. Fish production for the year 2005 shows that fishing on fish farms account for 8.6%; inland rivers and lakes, 40.78%; coastal waters, 44.7%; shrimps, 2.8%; and fish, 3.2% (Macmillan, 2007). Fish production for the year 2006 was 620,000 tonnes. Fishing is a major source of income and occupation to many people along inland rivers, riverine areas of the Niger Delta and the coastal areas of Nigeria.

## **CLIMATE CHANGE AND AGRICULTURE IN NIGERIA**

The effects of climate change have already been felt in many parts of the country with the modification of intensity and seasonal nature of the rains, elevation of average annual temperatures, and intense frequency of wide-spread, high impact weather phenomena including drought and flooding. These effects of climate change directly have an impact on agriculture in Nigeria. Agricultural activities in Nigeria such as rain fed agriculture, livestock rearing, fisheries and forest products extraction are sensitive to climate change (Salami, 2010).

Climate change has impact on agriculture in Nigeria in the following ways.

### **Increase in temperature**

Increase in temperature especially in the semi arid region

has resulted in the less farm work as farmers and other farm workers get tired easily due to dehydration and constant sweating. This was supported by Bello *et al* (2012) who indicate that sudden increase in air temperature in Nigeria was observed as from the early 1970s until 2005 which is linked to the effect of climate change and its associated global warming which was previously reported by several studies. The mean air temperature from 1901-1970 was 26.3<sup>0</sup>C and increases to 27.8<sup>0</sup>C from 1971-2005 (Bello et al., 2012). Also farmers continue to complain that agricultural produce has been very poor these days as they are facing declining crop yields due to weather fluctuations and other environmental threats. The result is that some farmers in Nigeria are abandoning farming for non-farming activities.

### **Drought**

Due to drought in the north east, the Lake Chad is receding at a very fast rate so much so that the quantity of water is one third of its original volume. This has affected farming activities around the lake particularly dry season farming. According to Dami et al. (2011), the reduction in the size of the lake is associated with two main factors: climate change and human demand for water. The climate factors include declining frequency and volume of rainfall received within and outside the basin from Rivers that drain into the Lake Chad such as Hadejia-Jamaare and Chari. The human factors are mainly related to land use and the increasing demand for water even as the supply is decreasing from the lake due to the climatic factors. The problem of drought had remarkably impacted the socio-economic life of the people in the region as the major activities in the basin are fisheries, rain-fed and irrigated farming which solely depend on the prevailing climatic conditions (Dami et al., 2011). A study by Joshua and Ekwe (2013) state that field interaction and discussion with the farmers on the farm reveal that many farmers are willing to do dry season farming but the available water is not enough for any meaningful production.

### **Serious and severe floods**

In 2010, there was serious flooding due to heavy rains in different parts of the country which destroyed vast fertile farmlands at that time and subsequently resulted in higher food prices, increasing the fear of food insecurity and aggravating rural poverty. The problem of incessant floods and erosion continue to expose peasant farmers to the hazards of climate change. In 2011, there were severe floods in different parts of the country which directly affected agriculture. For example a heavy down pour that lasted six hours on 26<sup>th</sup> August, 2011 in Ibadan, Oyo state swept away poultry farms and fish ponds filled with chicken and fishes worth millions of Naira (Sunday



Tribune, 2011). Again in 2012, the worst floods in over five decades submerged and destroyed farmlands of rice, yams cassava, maize, melon as well as plantain and banana in the State around River Niger, Benue and Cross River as the rivers were filled to capacity by heavy rains and thus over flow from their banks. This has also occurred in the far northern states of Katsina, Jigawa and Kano where farmlands of millet, guinea corn, maize etc were destroyed by the floods (Ibekwe, 2012).

Global climate change has brought heavy rainfall where rains that are to fall in different days in one month fall within one or two days leading to massive flooding as witnessed presently in 2014 in parts of India, Pakistan, USA, United Kingdom and Japan. The average temperature in regions across the globe goes up, as more rain has fallen. This happens because warm air holds more moisture and when warm air holding moisture meets cooler air, the moisture condenses into tiny droplets that float in the air. If the droplets gets bigger and become heavy enough, they fall as rain (UCS, 2010). In Nigeria, this is the case where heavy seasonal rains fall particularly in the month of July to September were experienced in 2010, 2011, 2012 and 2013 which causes massive flooding that results in the bursting of rivers, collapse of earth dams, release of water from large dams which displace people especially farmers in rural areas, submerging of farmlands and destroying crops, poultry and fish farms, contaminating water sources and sanitation facilities (IFRC, 2013).

### **Weather fluctuations**

Fluctuation of the weather arising from climate change causes insurgence of infectious diseases such as malaria, cholera and meningitis particularly among rural dwellers thereby affecting their output in farming activities. This affects the health of farmers and market transactions, reducing their quality of life and agricultural output. Indeed many prevalent infections including malaria, dengue fever and cholera are climate sensitive as they are transmitted by mosquitoes which cannot survive if temperatures are too low and thus thrive when the weather conditions are warmer with global warming. According to Akingbade (2010), investigations revealed that in the year 2009 that over 200 people were killed by meningitis in Nigeria and Niger Republic in one week. There were 25,000 suspected cases and 1,500 deaths in the first quarter of 2009. Experts have found a correlation between weather and meningitis which affects people in periods of erratic and unpredictable weather (Akingbade, 2010). In many areas in northern Nigeria fluctuating weather does not only cause diseases which affect the health of the farmers, but also confuse farmers about the start of the planting season.

### **Gas flaring and crude oil pollution**

The flaring of gas in the Niger Delta area has over the

years raised the heat level in many host communities (e.g Ode in Edo State) which creates environmental hazards that destroy the environment and makes it difficult for agricultural activities such as fishing and farming to thrive due to increase in heat arising from thermal pollution. Empirical studies carried out on the impact of gas flaring on agriculture showed a direct relationship between gas flaring and productivity that tends to decrease for farmlands close to the flare sites. One of such studies was by Ubani and Onyejeke (2013), whose results obtained show that gas flaring is responsible for the contamination of water bodies which affects the survival of fishes and other aquatic animals. Acid rain has eliminated insect life and some fish species over the years due to the gas flaring and dangerous gaseous emissions. The acid nature of the soils has attendant effect on the soil usually used in agricultural purpose. Farmers and fishermen have for decades being confronted with difficulties arising from gas flaring.

Crude oil pollution includes oil spillages on farmlands, oil flow sites, gas flaring sites, burrow pits, pipelines and other oil and gas activities which affect crop production in the Niger Delta. Ojimba and Iyagba (2012) in their study on the effects of crude oil pollution on horticultural crops in Rivers State reveal that the output of fruits, banana, pepper, okra and leafy vegetables in non-polluted farms were considerably higher than the output in crude oil polluted farms. The average output per horticultural crop farm produced in crude oil polluted farms was 384.58 and 550.94 kg in non-polluted farms, which indicate that crude oil pollution had a negative effect on the quantity of output (Ojimba and Iyagba, 2012).

### **Extreme weather events**

Besides floods and drought, there is another extreme weather event as hailstones that accompanied heavy rains caused widespread destruction of houses of rural farmers, farmlands and agricultural products in some local government areas of Jigawa and Katsina States in September 2012. According to the residents of the areas the hailstorms and the destructions they cause were not seen by the people in their entire life time (Ibrahim, 2012). In June 2013 a late night heavy downpour showered large ice pellets on maturing plants destroying most of the crops which include okra, maize, vegetables and sugar cane on some irrigated farms in Mairuwa near Funtua in Katsina State. Most of the farmers have to bear the loss as the okra and the maize were not ready for harvest and cannot be sold (Abubakar, 2013). Also in the same State, Katsina and in the same month of June 2013 hailstorm consisting of ice pellets destroyed okra, maize and other vegetables in farmland whose cost is worth N10 million in villages of Faskari Local Government area. About 2,000 farmers were affected as most of their crops planted were completely damaged by the hailstorm which occurred when the crops were not ready for

harvesting. Some of the farmers interviewed said that unless the Government helps the affected farmers, most of them will not be able to farm in the next planting season because they have lost all they have in the disaster (Ibrahim, 2013). In Nigeria's tropical weather, hailstorm was not normal but presently has been occurring frequently and in different locations in the country due to climate change.

### Drought conditions

Drought condition created by climate change especially in the north eastern part leads to decrease in pasture grass and water availability in the region. This leads to decrease in livestock production resulting in an impaired availability of milk, meat, egg and animal products such as hides and skin. The decrease in pasture grass can cause migration of herdsmen further down South and can increase the rate of Farmers-Fulani clashes as was recently witnessed in May 2013 near Abuja, the federal capital territory. The persistent drought conditions and desertification in the North East have been identified as the primary cause of reduction of the inflow of water into the Lake Chad, causing shrinking of the lake and resulting in conflicts between farmers, fishermen and pastoralists living along the border of the lake. The shrinking of the lake led to a reduction of land for cultivation and grazing (Fagbohun, 2010). According to Akingbade (2010) agriculture in northern Nigeria in general has been affected by drought as the dryness has led to dry farmlands, water beds and movement of people and their livestock to the southern region thus causing tension and conflict between the original inhabitants and the newcomers.

### Increasing number of environmental refugees

Increase in the number of environmental refugees has drastically increased as people were forced to leave their homes in search of relief from harsh environmental conditions. These include floods, drought, oil spillage/crude oil pollution, hailstorm/windstorm, pest incidence etc (Gwaram *et al.*, 2004). For example many victims of 2012 devastating floods who were farmers were still living in displacement camps as at January 2013 which is bound to affect food security as many farmlands are idle and unprepared for the coming planting season. Drought conditions in the North east has led to the reduction in the size of the lake Chad apart from intensifying the conflict between pastoralists, farmers and fishermen had also led to the emergence of environmental refugees (Fagbohun, 2010). Oil spillage and crude oil pollution has created climate refugees as flare motivates change in climatic conditions making large part of the Niger Delta land uncultivable and water resources economically unviable which has pushed people to migrate in order to seek

alternative source of livelihood (Alaba *et al.*, 2013).

Furthermore on the occasion of World Environment Day 2014 with the theme : "Raise Your Voice not the Sea Level", the Minister of Environment warned that about 32 million Nigerians living along the coastlines of the Niger Delta might be displaced by rise in the sea level and thus become environmental refugees. An accelerated sea level rise of 0.5 meters, 35 per cent of the Niger Delta land mass would be lost, with an accelerated rise of 1.0 meters, 7.5 per cent of the Niger Delta gone under the sea (Blueprint, 2014).

### Conclusion

Climate change is now a reality and its effects are felt all over the globe. These effects are largely negative and have serious repercussion for human beings, their source of livelihood and the environment. It is due to this that climate change is the single biggest environmental issue facing the world today. Nigeria is one of the most vulnerable countries to climate change in Africa due to her varied climatic zones, coastal location and more people are living and working in climate change prone areas. Agriculture in Nigeria is largely dependent on the climatic conditions and changes in these conditions can have impact on agricultural activities. Based on the discussions in this article it could be observed that climate change has brought negative impacts on agriculture in Nigeria. However, conscious efforts must be made towards mitigating the impacts of climate change on agriculture in Nigeria.

### Conflict of Interests

The author has not declared any conflict of interests.

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