

2013

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ABSTRACT.

This paper focused on climate change and agricultural activities in Nigeria. The aim of the study was to examine the implication of climate change on agricultural activities in Nigeria and the objectives included to: identify the various variables of climate change which tend to affect agriculture and proffer measures to mitigate them. Part of the data used for this paper were derived from recent studies by various authors such as the onset and cessation of rains in Kaduna, Kano and Sokoto and reasons for the shift in crops production in the semi – arid region of Nigeria. The mean decadal temperature for six (6) meteorological stations (Lokoja, Yola, Sokoto, Ibadan, Owerri and Kano) as well as the occurrences and length of dry spells at Lokoja and its environs for 30 years (1981 - 2010) were calculated by the author using the temperature and daily rainfall data obtained from the Nigeria Meteorological Agency, Oshodi, Lagos. The Post disaster assessment on flood in Nigeria for 2010 was obtained from the National Emergency Management Agency, Abuja. Data were presented in tables, analyzed using descriptive method and discussed. The various implication of climate change on agriculture according to the study include: changes in rainfall characteristics, erosion / floods, incidence of pests and diseases, dry spells, drought and desertification; shortage of cultivable land, increased water requirement by crops and shift in agro – ecological zone. The conclusion focused on measures of mitigating the effects of climate change on agriculture such as the use of irrigation, cover cropping, planting of hybrid crops and cloud seeding among others.

Key words: Climate Change, rainfall characteristics, dry spell, cultivable land and agro – ecological zones.

INTRODUCTION.

Climate change is one of the prevailing environmental problems in the world and has gained universal discourse in recent time because its effects are multi – faceted. It is a single problem which has given birth to numerous known issues such as sea level rise, ocean warming, increasing temperature, rainfall variability, increasing evaporation and increasing tropical storms among others. These effects have also metamorphosed into some impacts such as the decline in agricultural activities, drought, migration, health problems, crises among farmers and herds - men, flooding, erosion, hunger and poverty among others and other numerous problems yet to manifest.

Climate change refers to any change in climate over time that alters the composition of the global atmosphere (Audu *et al*, 2010). The Inter Governmental panel on climate change (IPCC, 2007 cited in Audu, *et al* (2010) refers to it as any change in climate or weather due to natural variability or as a result of human activity. Climate change is one of the most critical socio- technological issues mankind faces in the present century (IPCC, 2007 cited in Levi and Prashnant, 2010). In other words, climate change may be defined as the alteration of the climatic system over a long period. Bello (2010) further argued that an extreme weather event that exhibits temporary departures from the mean climatic state is not synonymous to climate change, but rather the long – term persistence of either positive or negative anomalies of a given or combination of climatic events above or below the normal that characterizes climate change. Also, the United Nation Frame Work Convention on climate refers only to the

natural variability as the causes (according to African Partnership Forum, 2007 reported by Audu *et al*, 2010).

Causes of climate change are two (2). These are natural causes which could be movement of continents due to plate tectonics, solar output of radiation, volcanism and ocean variability; and anthropogenic causes such as fossil fuel burning, deforestation, cattle rearing and so on (Ekundayo, 2010). Bello (2010), argued that climatic change could be due to astronomical, extraterrestrial, terrestrial and human activities. It should be noted that the activities of man are the major cause of climate change due to population explosion, advancement in technology and uncontrolled exploitation / utilization of natural resources among others.

Bello (2010) identified rise in temperature and drought as evidences of climate change. Other evidences of climate change include: increase in annual rainfall during wet season, shorter rainy season and longer dry season, increasing cases of dry spells and drought, unpredictability of rainfall, change in the distribution of rainfall in wet season, excessive dryness during dry season and increasing temperature in wet and dry seasons likewise the harmattan period.

Most recent researches on climate change and agriculture focus on few areas mostly dry spells (Sawa, 2010), drought (Binbol, 2010) and desertification. It is based on this that this paper seeks to focus on the general implication of climate change on agriculture.

THE STUDY AREA.

According to Bello (2007), Nigeria is a former British colony which came into existence as a result of the amalgamation of Northern and Southern protectorates, empires and smaller territories. Today, Nigeria is made up of 36 states and the Federal Capital Territory (FCT). Nigeria extends from latitude 4°N to 14°N and from longitude 3°E to 15°E (Macmillan Nigeria Secondary Atlas, 2006). It is bounded to the North by Niger Republic, Benin Republic in the West, Cameroun in the East and the Atlantic Ocean to the South (Macmillan Nigeria Secondary Atlas, 2006). Nigeria experiences both rainy and dry seasons (National Bureau of Statistics, 2009). In terms of size, Nigeria has a total area of 923,769km² (National Bureau of Statistics, 2009). There are three (3) most influential ethnic groups namely, Hausa, Yoruba and Igbo. The major export commodity is crude oil (petroleum) which also serves as its economic backbone. Its relief is generally divided into lowlands and highlands (Bello, 2007). Nigeria is drained by many rivers the major ones being Rivers Niger and Benue. The vegetation is also grouped into two (2) main categories- forest and savanna (Bello, 2007). Nigeria's population is estimated at one hundred and sixty seven million (167,000,000), (National Population Commission, 2011). Of this population, over 60% engages in agriculture (Bello, 2007). The crops grown in Nigeria are classified into three (3) namely; tree, tuber and grains. Figure1 shows the study area and the agro – ecological regions.

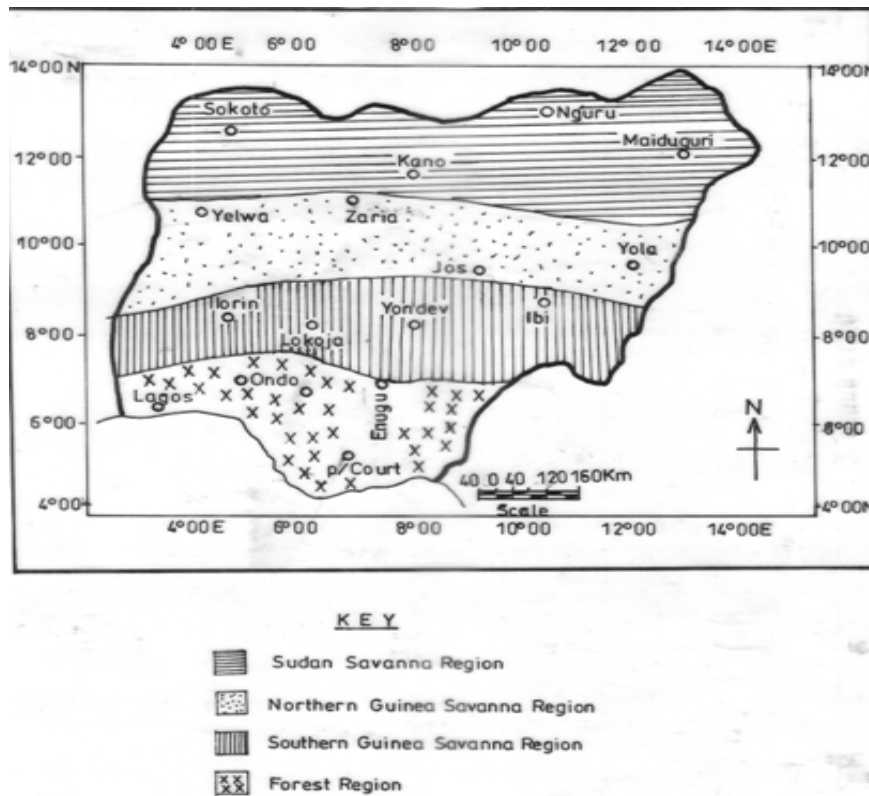


Fig.1. Map of Nigeria showing the agro- ecological regions.

Source: Adapted from Bello (1998)

METHODOLOGY.

The data used for this study are secondary and are obtained from recent studies by various authors such as the onset and cessation of rains in Kaduna, Kano and Sokoto (Umar, 2010) and reasons for the shift in crops production in the semi – arid region of Nigeria (Odujogo, 2010). The post disaster assessment on flood for Nigeria in 2010 was obtained from NEMA, Abuja. The decadal temperature was computed by the author using the maximum and minimum temperature ($^{\circ}\text{C}$) data for six (6) meteorological stations (Lokoja, Yola, Sokoto, Ibadan, Owerri and Kano), 1971 – 2010 (40years) obtained from the Nigerian Meteorological Agency, Oshodi, Lagos. To obtain the mean decadal temperature, the following formula was used:

annual mean temperature ($^{\circ}\text{C}$)

n (10years)

The dry spells for Lokoja, 1981 – 2010 (30years) was computed by the author from the daily rainfall data obtained from the Nigerian Meteorological Agency. Five consecutive (5) days (pentad) and above of absence or trace of rain (less than 2mm) were taken as a period of dry spell (after Adebayo, 1997). The dry spells were calculated using 8th April and 7th October as mean onset and cessation of rain for the station (after Umar, 2010). The frequency of dry spells was obtained by adding all the dry spells with equal number of days, while the total

days of dry spells were derived by adding all the dry spell days from 1981 – 2010. The results are presented in tables, analyzed using descriptive method and discussed.

RESULTS AND DISCUSSION.

Changes in rainfall characteristics (variability in the onset and cessation of the rains).

The onset and cessation of rains according to Walter (1967 cited in Umar, 2010) is obtained using the following formula:

Days in Monthx (51 – accumulated rainfall of the previous month)
total rainfall for the month

Where the month under reference is that during which the accumulated total rainfall is in excess of 51mm. However, if the month following has less than 51mm of rainfall, the previous month is disregarded and the next month with more than 51mm of rainfall is taken as the month of the onset of rainy season. For the cessation of the growing season, the formula is applied in the reverse order from December.

In recent times, Nigeria experiences fluctuations in the onset and cessations of rains. From table 1, there are variations in the onset and cessation dates of rains at the three (3) stations which have severe effects on planting and harvesting of crops. Planting is usually delayed when there is late onset of rains, while the early cessation destroys the late crops thereby causing poor crop yields, poor quality of crops, hunger, poverty, migration and so on. Whenever there is early onset of rain, early crops are usually destroyed by dry spells which may follow later. The late onset, dry spells and early cessation of the rains reduce the total number of rain days / growing seasons thereby discouraging double cropping while the single cropping even survives with uncertainty.

The variability in the onset and cessation of rains as observed at the three (3) stations (table 1) has confirmed the study of Ojonigu and Seidu (2009) which stated that because of the internal annual variability of rainfall, the Sudanian zone is subject to frequent dry spells resulting in severe and widespread droughts capable of large scale destruction of plants, animals and human life. Also, Adebayo (1997) reported that when there is prolong breaks in between rain spells, plants may wilt and die or have reduced yield. Dry spells lead to re – planting of crops during growing season due to wilting.

Table 1: Variability in Onset and Cessation of Rainy Season for Kaduna, Kano and Sokoto, 1961 – 2007 (46 years).

Station Year	Kaduna		Kano		Sokoto	
	Onset	Cessation	Onset	Cessation	Onset	Cessation
1961	20th Apr	4 th	12 th Jun	13 th	5 th Jun	19 th
1962	Sep		Sep		Sep	
1963	26 th Apr	8 th	20 th May	2 nd	2 nd Jun	11 th
1964	Oct		Sep		Sep	
1965	4 th Apr	4 th	30th May	19 th	1 st	Jun
1966	Oct		Sep		18thOct	
1967	14 th Apr	2 nd	3 rd May	20 th	30 th May	12 th
1968	Sep		Sep		Sep	
1969	1 st May	5 th	6 th Jun	12 th	1 st Jun	7 th
1970	Sep		Sep		Sep	
1971	5 th May	2 nd	10 th May	9 th	4 th Jun	23 rd
1972	Sep		Sep		Oct	
1973	12 th Apr	2 nd	27 th May	16 th	13 th Jun	11 th
1974	Sep		Sep		Sep	
1975	6 th Apr	4 th	15 th Apr	1 st	6 th May	31 st
1976	Sep		Aug		Oct	
1977	14 th Apr	12 th	3 rd Jun	22 nd	24 th May	11 th
1978	Oct		Oct		Sep	
1979	18 th May	31 st	19 th Jun	6 th	1 st Jun	14 th
1980	Oct		Sep		Sep	
1981	3 rd May	25 th	17 th May	8 th	7 th Jun	23 rd
1982	Oct		Sep		Sep	
1983	2 nd May	1 st	19 th Apr	1 st	7 th Jun	8 th
1984	Sep		Aug		Sep	
1985	22 nd Apr	2 nd	2 nd Jul	3 rd	21 st Jun	22 nd
1986	Sep		Aug		Sep	
1987	1 st May	1 st	7 th Jun	5 th	5 th Jul	9 th
1988	Sep		Aug		Sep	
1989	1 st Apr	4 th	26 th May	9 th	16 th May	16 th
1990	Sep		Aug		Sep	
1991	3 rd Apr	8 th	1 st Jun	26 th	23 rd May	17 th
1992	Oct		Oct		Oct	
1993	14 th May	3 rd	7 th Jun	13 th	3 rd Jun	19 th
1994	Sep		Sep		Sep	
1995	15 th Apr	13 th	7 th May	22 nd	11 th Jun	23 rd
1996	Oct		Sep		Sep	
1997	22 nd Apr	25 th	5 th Jun	8 th	10 th Jun	11 th
1998	Oct		Sep		Sep	
1999	6 th May	1 st	17 th May	7 th	23 rd May	2 nd
2000	Sep		Sep		Sep	
2001	11 th May	5 th	28 th May	14 th	19 th May	10 th
2002	Sep		Sep		Sep	
2003	12 th Apr	23 rd	15 th May	21 st	1 st Jul	7 th
2004	Oct		Sep		Sep	
2005	8 th May	7 th	15 th Jun	23 rd	1 st Jun	5 th
2006	Sep		Sep		Sep	

2007	7 th May	4 th	15 th Jun	20 th	7 th Jun	18 th
	Sep		Sep		Sep	
	22 nd Apr	19 th	10 th Jun	19 th	7 th Jun	9 th
	0ct		Sep		Sep	
	13 th Apr	24 th	2 nd Jun	18 th	22 nd Jun	18 th
	0ct		Sep		Sep	
	5 th May	2 nd	2 nd Jun	20 th	9 th Jun	24 th
	Sep		Sep		Sep	
	12 th Mar	5 th	2 nd Jun	1 st	13 th Jun	22 nd
	Sep		Sep		Sep	
	4 th May	12 th	1 st Jun	2 nd	4 th Jun	13 th
	0ct		Sep		Sep	
	9 th May	4 th	6 th Jun	17 th	30 th Jun	9 th
	Sep		Sep		Sep	
	2 nd May	26 th	23 rd Apr	2 nd	4 th May	16 th
	Sep		Aug		Sep	
	1 st May	18 th	4 th May	7 th	6 th Jun	21 st
	Sep		Sep		Sep	
	8 th May	2 nd	1 st Jun	16 th	26 th May	15 th
	Sep		Sep		Sep	
	27 th Apr	9 th	8 th Jun	3 rd	30 th Jun	23 rd
	0ct		Sep		Sep	
	26 th Apr	2 nd	3 rd Jun	8 th	1 st Jun	14 th
	Sep		Sep		Sep	
	9 th May	20 th	3 rd Jun	1 st	1 st Jun	26 th
	0ct		Sep		Aug	
	3 rd Apr	21 st	6 th May	1 st	10 th May	5 th
	0ct		Sep		Sep	
	25 th Apr	11 th	16 th May	2 nd	16 th Jun	26 th
	0ct		Sep		Sep	
	3 rd May	17 th	2 nd Jun	4 th	4 th Jun	25 th
	0ct		Sep		Sep	
	7 th May	22 nd	16 th May	3 rd	12 th Jun	29 th
	0ct		Sep		Sep	
	19 th Apr	4 th	2 nd May	7 th	14 th May	16 th
	Sep		Sep		Sep	
	24 th Apr	15 th	12 th May	28 th	17 th Apr	30 th
	0ct		Sep		Sep	
	20 th Apr	8 th	19 th May	5 th	11 th May	19 th
	0ct		Sep		Aug	
	3 rd Apr	2 nd	9 th Apr	7 th	11 th May	12 th
	Aug		Aug		Aug	
	1 st May	27 th	13 th May	2 nd	15 th May	11 th
	0ct		Sep		Sep	
	13 th May	18 th	11 th May	5 th	23 rd Jun	4 th
	0ct		Sep		Sep	
	30 th Apr	9 th	4 th Apr	1 st	30 th May	8 th
	Sep		Aug		Sep	

Source: Umar (2010).

EROSION AND FLOOD.

Heavy rainfall has lead to severe erosion which has affected farmlands. In most farmlands, rill, splash and gully erosion have devastated the lands as well as crops. Most farmlands have been turned into “badlands”. Sheet erosion in particular washes the top soil and nutrients thereby exposing the sub soil which is very poor in nutrients hence leading to drastic reduction in crop yield. This confirms the study of Ayuba and Dami (2011) which stated that erosion removes the top soil, the zone of plant nutrients and thus causes reduction of soil

fertility, hence reduction in agricultural production. Onyekuru and Uzuegbé (2010) discovered that erosion reduces yield of crops in Osumenyi, Nnewi South Local Government of Anambra State, Nigeria.

Flooding has also led to the submergence / washing away of crops, farmlands, livestock and death of some people thereby causing crop failure, poor yield/ harvest, shortage of food as well as poverty. Table 2 shows the effect of flooding in Nigeria in 2010.

Table 2: Post Disaster Assessment on Flood for Nigeria in 2010.

S/N	State	No. of Farmlands/ Industries Destroyed	No. of Livestock Destroyed	No. of Lives Lost
1	Adamawa	-	20	-
2	Akwa Ibom	-	-	05
3	Bayelsa	20%	-	-
4	Borno	-	-	02
5	Cross Rivers	-	-	30
6	Ekiti	-	-	01
7	Enugu	-	-	02
8	Gombe	-	-	17
9	Imo	-	15	-
10	Jigawa	50%	-	-
11	Katsina	-	-	01
12	Kebbi	60%	-	-
13	Kogi	-	-	400
14	Lagos	70%	-	-
15	Nasarawa	-	-	400
16	Ogun	40%	-	-
17	Plateau	-	-	400
18	Rivers	-	-	15
19	Sokoto	80%	-	20
20	Taraba	-	-	10
21	Yobe	80%	10,000	-
22	Zamfara	-	-	175
	Grand Total	Average % of the total farmlands 53.3%	10, 035	1, 978

Source: National Emergency Management Agency (NEMA), Abuja (2010).

From table 2, over half of the farmlands in the affected states were destroyed by flooding meaning that less than half of the expected crops and livestock were probably harvested as there are other indices capable of reducing the quantity and quality of crops and livestock. Most well- drained farmlands have been turned into marshy areas thereby making it unsuitable for crops. Even water - loving crops like swamp rice experiences stunted growth as a result of heavy rains which are concentrated within a specific period of the year that reduce photosynthesis due to reduction in sunlight duration and intensity. This makes most crops to develop shallow roots. NEMA (2010) reported that flood destroyed a lot of economic trees, livestock, farmlands, and cash /food crops; while in Yobe State alone, about 3,142 metric tons of expected harvest was lost to flood. Also, Okoye and Ojo (2007) opined that floods in parts of Nigeria seriously threatened residential accommodation, important business centres and agricultural farmlands. In addition, out of the 1, 978 people killed by flood in 2010 (see table 2) most of them were probably farmers which again reduces agricultural manpower. As the climate is still changing, more flood is been expected.

THE INCIDENCE OF PESTS AND DISEASES.

The incidence of pests and diseases in Nigeria is very common and it is becoming worrisome because the environment is becoming warmer, dryer and more conducive for them. Migratory birds (birds which were not found in the past) are now very common likewise insects and pests. These attack and destroy crops thereby causing poor yield and crop failure. The recent bird flu outbreak in Nigeria was not unconnected with climate change. Pests such as locust are very common in North – Eastern part of Nigeria. These pests feed on crop leaves leading to very low crop production while others attack the roots, seeds and fruits. The quality of crops is also affected when attacked by pests and diseases. This confirms the studies of Ayoade (1988), Thompson and Amos (2010). Obi (2010) also opined that Climate change is expected to reduce pesticide sensitivity. He added that pest population may increase and threaten food production. Audu *et al* (2010) reported that climate change has altered the natural hydrological calendar to the extent that the life cycle of most insect pests which were controlled or disrupted with the onset of rainfall which is now inconsistency has resulted in the strengthening of the lifespan of those biological pests and further destruction of forest and agricultural crops. NEMA (2010) reported the outbreak of pests and diseases in part of Borno State. Pests and diseases reduce crop yield, quality and value. In addition, when heavy rain is concentrated within few days or weeks, well – drained lands become water – lodged and if animals especially cattle graze within the area, they develop foot disease which can easily kill them.

DRY SPELL, DROUGHT AND DESERTIFICATION

Dry spell, drought and desertification are never agricultural friendly as they lead to extensive destruction of crops. Dry spell is a meteorological condition which is characterized by long period of absence or trace of rain which lasts for about 5 days consecutively (pentad), but less than 30 days. Dry spell is now very common and occurs annually in Nigeria especially in Northern Nigeria causing a decline in agricultural activities and production (See table 3).

Table 3: The occurrence of dry spells in Lokoja (Kogi State) and its environs, 1981 – 2010 (30yrs).

Days	5	10	15	20	Total
Frequency	105	18	0.0	01	124

Source: Author's computation (2011).

From the table 3, dry spell of 5days is the commonest at the station; while a total of about 124 dry spells were recorded within 30years (1981 - 2010). This has confirmed the studies of Sawa (2010) and Bello (2010). The dry spell of 20 days occurred once in 1983. It should be noted that, Nigeria experienced a severe drought in 1982 and 1983. During dry spells, temperature increase is observed, while evaporation increases from not only water bodies, but also from moist soils thereby leading to drastic reduction in soil moisture, withering of plants and destruction of plant tissues. When dry spell is prolonged, it results in drought such as Meteorological, ecological, hydrological, agricultural, contingent and socio - economic

droughts leading to general dryness of the environment, little or no vegetative growth especially in Northern Nigeria thereby causing poor pasture, reduction in both the surface and underground water available for irrigation, consumption and other uses by both man and animals as wells, dams, rivers water reservoirs and lakes dry up; crop failure / poor yields, hunger, temporary unemployment, migration as well as poverty among farmers. Animals also die in large number during drought. Commenting on the effect of drought, Ayuba and Dami (2011) opined that, drought causes withering of vegetation and crops, dehydration or death of animals. Also, Sawa (2010) opined that when dry spells are prolonged, they result into drought and plants may wilt and die or yield may reduce. Southern part of Nigeria which experiences high total annual rainfall due to its proximity to the Atlantic Ocean still experiences drought, while the rainfall pattern / regime has been altered (see Bello, 2010). In the same way, desertification is extending South-ward at alarming rate from the extreme northern Nigeria claiming agricultural lands by making the environment drier and less productive. Soils become looser and less fertile when encroached by desertification. This threatens farming and affects food production. According to Thompson and Amos (2010), desertification is the insidious cause of the decline in Nigeria's agricultural productivity which has taken hold of 35% of previously cultivable land in the eleven (11) northern states. Ayuba and Dami (2011) also stated that Nigeria is losing an estimated land of 351, 000sq.km to desert representing 38% of its total landmass, which corresponds to the landmass of the desert – threatened frontline states of the country (Bauchi, Gombe, Borno, Yobe, Jigawa, Kano, Katsina, Zamfara, Sokoto and Kebbi States). It should be noted that these states represent the centre of grains (guinea corn, millet, maize, groundnut, beans and so on) production in the country and now seriously affected by desertification thereby bringing a decline in agricultural produce and causing food insecurity. In addition, in Northern Nigeria, after harvest; the shafts, leaves and stems of crops are used to feed animals and / or sold, but with the decline in crops bundles; it means that even animals are under fed and malnourished especially during dry season. During dry spell, drought and desertification, wind speed increases. This, apart from destroying buildings and trees; also causes mechanical damage to crops and destroys flowering crops (like beans and okra), guinea corn, maize, tree crops like kola nut, cocoa, coffee and so on thereby causing low agricultural output. In their study, Thompson and Amos (2010) opined that thunderstorms, heavy winds and floods devastate farmlands and can lead to crop failure. Also, Ayoade (1988), stressed that wind may cause physical damage to crops by encouraging a high rate of transpiration. Wind erosion can also damage good agricultural land, while high velocity winds, especially harmattan in relatively dry areas or during dry season in both sub-humid and northern region can increase the risk of forest fires that can damage farm crops. Bello (2010), in his study discovered high velocity winds as indices of drought in South – Western Nigeria.

INCREASING WATER REQUIREMENT BY CROPS.

One of the effects of climate change is increasing temperature. Temperature has been increasing steadily across Nigeria. Table 4 shows the mean decadal temperature for six (6) meteorological stations in Nigeria.

Table 4: Mean Decadal Temperature (o_c) for Sokoto, Kano, Yola, Ibadan, Lokoja and Owerri, 1971 – 2010 (30 years).

Station / Years	1971 – 1980	1981 – 1990	1991 – 2000	2001 – 2010	Diffirence in temp
Sokoto	28.4	28.8	28.9	29.9	+1.0
Kano	26.5	26.6	26.7	26.8	+0.3
Yola	28.1	28.4	28.6	28.4	+0.3
Lokoja	27.8	28.0	28.2	28.1	+0.3
Ibadan	26.6	27.2	27.2	27.2	+0.6
Owerri	27.1	27.6	27.6	28.0	+0.9

Source: Author's Computation (2011)

The meteorological stations in table 4 have been experiencing a steady mean decadal temperature increase. This increasing temperature affects plant physiology such as respiration, transportation of substances, transpiration, hormone and tropisms among others. Due to the increasing temperature, crops lose water rapidly through transpiration thereby causing increasing demand for water. High potential evapotranspiration (E_o) is usually observed during high temperature causing negative water balance which is unfavourable to crops. When plant water deficit is not met on time, it causes contingent drought. Intensive heat also increases evaporation from both water bodies and moist soils. Crops growing under low soil moisture yield little and poor quality seeds. As reported by Obi (2010), increase in temperature is expected to elongate the growing season in temperate regions, while further increase in temperature within the tropics is expected to decimate output by aggravating soil evaporation rate and invariably drought. Ayoade (1988) observed that excessive heat destroys the plant protoplasm and also decreases the reproductive capacities of animals. Increasing temperature weakens plants and their leaves wither easily hence poor photosynthesis. Increasing temperature especially in Northern Nigeria is turning surviving crops / plants into scrubs.

SHIFT IN AGRO- ECOLOGICAL ZONE.

With climate change, there is an alteration of agro- ecological zones. Crops which were traditionally grown in the extreme northern Nigeria are now tilting towards the guinea ecological zone for instance, guinea corn. In the southern part of Zamfara State, millet is gradually replacing guinea corn due to shortage of rainfall (Odujugo, 2010). Crops which were grown in the Sahelo – Sudan region are now finding their way to the guinea ecological zone, while those of guinea ecological zone are now migrating to the northern part of the forest zone. The various reasons for the shift were due to climate change (See Table 5).

Table 5: Reasons for the Shift in Crops Production in the Semi- Arid Region of Nigeria

S/N	Reasons	Percentage
1	Late Onset of rains	97
2	Early Cessation of rains	90
3	Shorter Growing Season	86
4	Frequent Agricultural Droughts	76
5	Erratic nature of the rains	75
6	Introduction of shorter duration crops	60

Source: Odujugo (2010).

In like manner, the growth of tree crops in the forest region is declining; while cattle's rearing which was strictly practiced in northern Nigeria some years past is increasingly

being reared in southern Nigeria and on the plateaux due to drastic reduction in vegetal cover in northern Nigeria and near absence of water during dry season. Audu *et al* (2010) observed that a continued negative shift in vegetation is initiating the desert encroachment. Signs of savannah vegetation are becoming evident in Oyo, Osun, Edo, Ekiti, Ondo and Enugu states among others. The extension of animal rearing zone to the plateaux and southern Nigeria is the major cause of the frequent crisis between the farmers and herds – men

SHORTAGE OF CULTIVABLE LAND.

Drought, flooding, erosion and desertification are reducing cultivable land in northern Nigeria, while in southern Nigeria, sea surges, erosion and flooding among others have drastically reduced the available cultivable land. The effect of this is the reduction in agricultural activities which has culminated in decreasing crop yield, increasing unemployment, shortage of food supply and increasing importation of food. Central Bank of Nigeria and National Bureau of Statistics reports (2007, cited in Thomas and Amos, 2010) indicated that, Agricultural GDP as reduced from 49.0% in 1970 to 31.9% in 2007, while food importation has increased from #57.7million in 1970 to #1,401,675.5 billion in 2007. Also, Obi (2010) stated that areas flooded by sea water become salinized, just as the regions that receive low rainfall or irrigation water due to high evapotranspiration. Salinized water affects soil physical properties and soil structure thereby inhibiting both the germination and growth of plants by hindering plant roots from withdrawing water from the surrounding soil, hence lowering the water available to the plant resulting in plant stress. Enete (2007) observed that over half of the present global population lives in coastal ecosystem, an increasing number of who are vulnerable to flooding, sea – level rise, destruction of wetlands and fresh water systems and collapse of near shore fishes. He added that sea level rise offers particularly dangerous prospects for coastal communities in Nigeria, especially the Niger Delta people. Adefolalu (1999, cited in Enete, 2007) reported 65 deaths, flooding and washing away of over 12 billion hectares of farmland and loss of 100 million tones of farm produce in three (3) months of 1999. It should be noted that when a farmland is washed by erosion and / flooding, the top soil is mostly affected thereby exposing the sub- soil which is not useful for farming because the nutrients needed for good crop growth and production are contained in the top soil.

CONCLUSION AND RECOMMENDATIONS.

This paper has revealed that climate change is a very serious enemy to agricultural activities in Nigeria. Even in the temperate zone where it has been discovered that climate change will elongate the crops growing season, it would only last for a while, but on the long- term, crops and animals likewise aquatic creatures would be badly injured. The impact of climate change is severe in Nigeria due to the over dependence on rain – fed agriculture which does not encourage commercialization of agriculture. Agricultural production is usually restricted in Nigeria by extreme weather conditions such as drought, desertification and flooding among others.

Based on this paper, the measures to combat the adverse effect of climate change on agriculture are classified into two (2); namely short- term measures such as irrigation, cloud seeding, use of insecticides, cover cropping, growing of hybrid crops, changing of the micro climate by introducing windbreaks, shading to reduce heat and so on; and long-term measures such as afforestation, controlled grazing, population control, creation of more forest reserves and construction of more multi- purpose dams just to mention, but few. Nigeria which is an agrarian country should be an exporter of agricultural commodities and not an importer of common foodstuffs.

Finally, the above recommendations would help to mitigate the effects of climate change on agriculture in Nigeria if well adopted and would not only ensure adequate food production, but also food security.

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