Climate Variability, Environment Change and Food Security Nexus in Nigeria[1]

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ABSTRACT

In the recent times, due to the increasing rate of global warming, the Savannah region of Nigeria has been experiencing continuous climatic change characterized by drastic reduction in rainfall, increase on the rate of dryness and heat, with depletion of the amount of water, flora and fauna resources. This situation has been on for years without much questions and answers with regard to how it affects food production and security in the country. Against this background, this paper investigates the chain of interactions between climatic change, draught condition and food production in Nigeria. It addresses the estimate of draught condition in the savannah region of Nigeria, the nature of food production activities in the area and the extent to which continuous climatic change has affected the state of food production. The paper also examines the indigenous and formal institutional frameworks in addressing the situation for assured food security in Nigeria.

I. Introduction

The environment provides all life support systems with air, water and land as well as the materials for fulfilling all developmental aspirations of man and animal. The suitability of the environment to provide these basic supports to life is dependent on the stability of the climate which is undergoing constant changes. The world had gone through series of climate epochs, which include the ice age, and consequently, the ice recessions among others. In the recent times, Intergovernmental Panel on Climate Change (IPCC), World Meteorological Organization (NMO) and United Nations Environment Programme (UNEP) established that the earth has become warmer over the last century. According to them, the average surface temperature of the earth has increased during the twentieth century by about 0.6±0.2°C. It is warmer presently around the world than at any time during the past 1000 years, with possibilities of warmest years of the previous century occurring within the past decades. This change in temperature usually lead to lower ozone levels near the earth's surface, and significant increase of Smog problems in the cities where the release of carbon dioxide is greater.

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Compared with other region of the world, Africa, especially, the sub-Saharan region is the second adversely affected by drought condition and other hydro-meteorological natural disasters after Asia, (Table 1.). As in most other countries of the world, the Nigerian environment presents a grim litany of woes (FGN, 1997). Every state of the federation suffers from one form of environmental problem or the other in varying degrees. The northern part (Savannah) of the country is being "blown away" by wind erosion while most southern part (forest) is being washed away into the ocean by erosions.

Table: 1 Effects of Drought on Population

Region	Total number affected, 1975-2001(millions)	No of people affected per occurrence (millions)
Africa	222.1	0.87
Asia	1095.83	9.36
Latin America	47.89	0.72
Oceania	8.65	0.39
Europe	6	0.27
North America	0.03	0.0025

Source: Underlying data from Reuveny (2005)

Recognizing that Nigeria is confronted by major environmental problems, one of the most important is drought. Drought is an insidious hazard of nature that originates from a deficiency of precipitation over a long extended period of time, usually a reason or more, which results in water shortage in the environment (Okorie, 2003). It occurs whenever the supply of moisture from precipitation or moisture stored in the soil is insufficient to fulfill the optimum water needs of plants, which can be identified into four types[2]. Drought should be considered relative to some long-term average condition of balance between precipitation and evapor-transpiration (evaporation + transpiration). It is also somewhat related to the timing and effectiveness of rains from the perspective of principal season of occurrence, delays in the start of rainy season and occurrence of rains in relation to principal crop growth stages. More importantly, rainfall intensity and number of rainfall events are important benchmarks for ascertaining drought in an

[2] Four types of drought can be identified:
1) Permanent Drought: This occurs in arid areas where at all seasons, precipitation is not enough to satisfy the water needs of plants. 2) Seasonal Drought: Occurs in areas with well defined wet and dry seasons especially in the tropics owing to seasonal changes in the atmospheric circulation patterns.3) Contingent Drought: This occurs as a result of irregular and variable rainfall. This is characteristic of sub humid and humid areas and it occurs when the rain fails to fall over a period of time. 4) Invisible Drought: occurs any time the daily supply of moisture from the soil or falling precipitation fails to equal the daily water needs of plants

environment. Drought[3] as defined above maybe perceived from discipline wise perspective, namely meteorological, agricultural or hydrological with particular reference to its manifestation and impact.

Wind erosion could be quite severe in most Sahel states of Sokoto, Zamfara, Kebbi, Katsina, Kano, Jigawa, Borno, Yobe, Kano, Adamawa and Bauchi as a result of drought conditions in the area. Climate variability resulting to drought incidence is not new in the savannah region of Nigeria considering the fact that some of the region, especially the Sahel is susceptible to climatic anomalies. The most northern Nigeria which was mainly Sudan Savannah is increasingly becoming an arid environment at a very fast receding rate per year occasioned by fast depletion on the amount of surface water, flora and fauna resource on the land. Land cover changes are indeed important index of climate change in Nigeria and other countries. Nigeria is presently losing about 351,000 square kilometers of its landmass to the desert, which is advancing southward at the rate of 0.6 kilometers annually. The consistent reduction in rainfall leads to a reduction in the natural regeneration rate of land resources, which presents a chain of causal reaction that, makes people to exploit more previously undisturbed lands leading to depletion of the forest cover and increase on the sand dunes/Aeolian deposits. The strong and worrisome increase of 425% in the extent of sand dunes/Aeolian deposits between 1976 and 1995 is a strong pointer to land resource loss due to climate change (Fasona and Omojola 2005) and possibilities of desert encroachment around the northern axis of Nigeria. . As a result of increasing dryness and accumulation of sand, farmlands become inundated by drifting sands, which bury crops, roads, huts and other public buildings, and in extreme case entire villages buried under sand dunes.

Previous studies in the Savannah, particularly in the sahel region of Nigeria (Obioha, 2005; Nyong, and Fiki, 2005; Fiki and Lee 2004) have highlighted some aspects of population drift, violent conflict, conflict generation, conflict management, and self –

[3] **Meteorological Drought** is defined usually on the basis of the degree of dryness (in comparison to some "normal" or average amount) and the duration of the dry period. Definitions of meteorological drought must be considered as region specific since the atmospheric conditions that result in deficiencies of precipitation are highly variable from region to region. **Agricultural drought** links various characteristics of meteorological (or Hydro logical) drought to agricultural impacts, focusing on precipitation shortages, differences between actual and potential evopotranspiration, soil water deficits, reduced ground water of reservoir levels and so forth. **Hydrological drought** is associated with the effects of period of precipitation (including snowfall) shortfalls on surface or subsurface water supply (i.e. stream flow, reservoir and lake levels, ground water).

organizing capabilities in drought – prone in the area, but this present study seeks to integrate food production and security as the fulcrum of analysis. In other words, an attempt would be made to understand the role of drought in the question of food availability. In relation to other issues, perhaps more spectacular and of grave consequence of persistent droughts is food insecurity which had occurred in northern part of Nigeria in the recent past. For instance during the drought of 1972-1973 for instance, about 300,000 animals died and farm yields dropped by up to 60% in Nigeria. This implies that drought may portend adverse effect on food production and security[4]. However, the extent to which food production and security arise from drought phenomenon in Nigeria is not very certain. What we know is that drought has caused serious food insecurity situation in some African countries. In Eritrea, because of lack of seasonal rains and aftermath of war with Ethiopia, I million of the country's 3.7 million people face drought and starvation. Farmers in Gambia are despairing as shortage of rain is causing new seedlings to wilt and die off. The international Institute of Tropical Agriculture (IITA) in Nigeria has estimated that by 2010 around 300 million people in sub-Saharan Africa, nearly a third of the population, will be malnourished (Meron Tesfa Michael, 2006). The recent famine in Niger Republic is still fresh in mind. Confronted with crop-devouring locusts and drought as a result of inconsistent rainfall, Niger has experienced a loss in cereal production 11 of the past 22 years. Catholic Relief Services (2005) estimates that as many l 3,815 villages have lost 50 percent or more of their food production. Country-wide, Niger is short of at least 223,487 metric tons of food. As a result, people are eating leaves and grass, selling personal items, removing their children from school, and migrating to neighboring cities and countries to find work or food.

Nigeria may not be an exception in the above problem if the rate of desertification continues without adequate checks, especially as there are obvious indications of food insecurity in the country as a result of other economic factors. The issue of food insecurity is of high importance to Nigeria because average calorie and protein intake is

[4] "Food insecurity is the inability of a household or nation to meet target consumption levels in the face of fluctuating production, prices and incomes". Food insecurity may be chronic or transitory. In chronic food insecurity, there is continuous inadequate diet and nutrition caused by the household's inability to acquire food. It therefore afflicts households that persistently lack the ability to either buy food or produce their own. On the other hand, transitory food insecurity results from a temporary decline in household access to food due mainly to instability in food prices, production, household income or a combination of these factors (Reutlinger *et al*. (1986)

only at the threshold of adequacy. Estimates show that at least 41% of the population is food-insecure; with 16 percent being severely undernourished (Olayemi 1996). The daily per capital calorie supply as a proportion of requirement was 90 percent between 1988-90; 85 percent between 1992-96 (FOS 1999). Following the above, the need to be fore armed about the devastating effect of drought on food production activities and security motivates this discourse.

Objectives

The man objective of this paper is to demonstrate the chain of interactions between climate changes, drought condition and food production in Nigeria. Specific objectives include.

1) Describe the climate condition and vegetation in Nigeria (particularly the savannah)
2) Examine the drought condition in the savannah over the years through rainfall
3) Examine the nature of food production activities in the area
4) Ascertain the impact of climate change (drought) on food production and security
5) Examine the institutional frameworks in addressing food security in Nigeria.

The Study Area

The savannah region, which comprises Guinea, Sudan and Sahel, lies about 7°N and 11.5°N. The Guinea-savannah zone falls within 7°- 9°N, around Lokoja, Markudi, Ilorin, Abuja, Lafia, Yola and Jos, while the Sudan or midland zone is found 9°N – 11.5°N which comprises Minna, Zaria, kaduna, Bauchi and Gombe. The third zone, Sahel savannah, immediately north of 11.5°N includes Kano, Yelwa, Gussa, sokoto, Katsina, Dutse, Damaturu and Maiduguri.

Rainfall in the Guinea Sudan and Sahel Zone (GSSZ)[5] is however largely seasonal and vary from year to year. Two distinct seasons are observed, dry and wet. Dry season covers up to a period about 7-8 months, from October to April/May and wet season about 4-5 months from May to September. The region is rich in agricultural production but the large inter annual variability of rainfall subjects it to frequent dry spells, which sometimes result in severe and widespread drought that imposes serious socio-economic constraints. Agriculture through irrigation is widely practiced in order to

[5] GSSZ will be used interchangeably with Savannah in the whole of this discourse

improve on soil moisture content. Major crops include grains such as rice, wheat, soybeans, beans, maize, millet, sorghum found mainly from the Guinea savannah. Cotton, groundnut and livestock production are mainly concentrated in the Sudan and Sahel savannah region.

Scope of the Study

This article covers period 1991-2004; however, there may be no restriction on discussion to this specific period where there are data that cover longer or shorter time frame. Essentially, the aim of the study is to demonstrate the interface between climate variability (represented by declining rainfall) and food production. With respect to the space, the study covers the whole country Nigeria, but with more emphasis and attention focused on the savannah region of the country due to its more relevance to the issue of discussion than the forest region, where there may be no apparent cases of drought condition.

Methodology

This paper relies mainly on secondary data that were generated by relevant government and non-governmental agencies as the main sources of data for the analysis and discussions. From these sources, both quantitative and qualitative information were collected depending on the immediate importance. Data related to climate, population, food production, food security and conflict were sought. For food production, to be more specific, grains that are predominantly grown in the Savannah region were the selected crops, which their production was used as the indicator for food production. These secondary sources include National Bureau of Statistics (NBS) Statistical fact sheets on Economic and Social Development, Annual Abstract of Statistic, Central Bank of Nigeria Annual Report and Statement of Account, Journals, Newspapers and other periodicals. The information gathered from the above secondary sources were analyzed and presented in the following sections.

The paper continues with theoretical explication of environment – resource scarcity in section II, while a description of climate, vegetation and drought condition in Nigeria is presented in section III. Section IV deals with presentation on the nature and types of food production activities in the savannah region of Nigeria. In sections V and VI, the impact of climate variability on livelihood, food production and security; and the institutional frameworks available in addressing food security are presented respectively.

II. Theoretical framework

In this section the theoretical framework of analyzing inter-linkage between environmental changes, possible conflict situation and food security is presented. Without the full understanding of the intervening factors, it may be difficult to grasp the true nature of the relationship between these variables in the Savannah climate region of Nigeria. This discourse utilizes some theoretical orientations from earlier scholars in examining environment – resource nexus. Prominent among these works are those of Hommer-Dixon of the Toronto School of thought.

The illustration suggested by Hormer-Dioxon implies that the total effect of human activity on the environment in a particular ecological zone is mainly a function of two variables: first, the product of total *population in the region* and *physical activity per capita*[6], and second, the vulnerability of the ecosystem in that region to those particular activities. The theory also emphasized that environmental effects may cause "social effects" that in turn could lead to conflict. For instance desert encroachment on landmass may produce large-scale migration, which could create ethnic conflicts as migratory groups clash with indigenous (settled) populations. Within this paradigm, we must be aware of the interviewing role of population growth, demographic structure, and patterns of population distribution. (Simon, 1981; McNicoll, 1984; Ehrlich and Ehrlich, 1990). Similarly, researchers must understand the effect of the ideational-factors[7] in conflict generation. The threshold beyond or within which given societies could respond effectively to the inbuilt stress induced by climate/environmental change differs. Particularly, if we wish to understand a society's' propensity towards conflict, given certain social effects due to the environmental stress, we need to understand the relationship, between the ideational factors and conflict. However, environmental stress and consequent conflict relation does not occur if environmental and resource scarcity threshold is not attained. The thresh-hold of environmental scarcity could be attained as a

[6] Activity per capita, in turn, is a function of available physical resource, which include non-renewable resources such as animals, and renewable resources such as water, forests, and agricultural land and ideational factors, including institutions, social relations, preferences and beliefs.

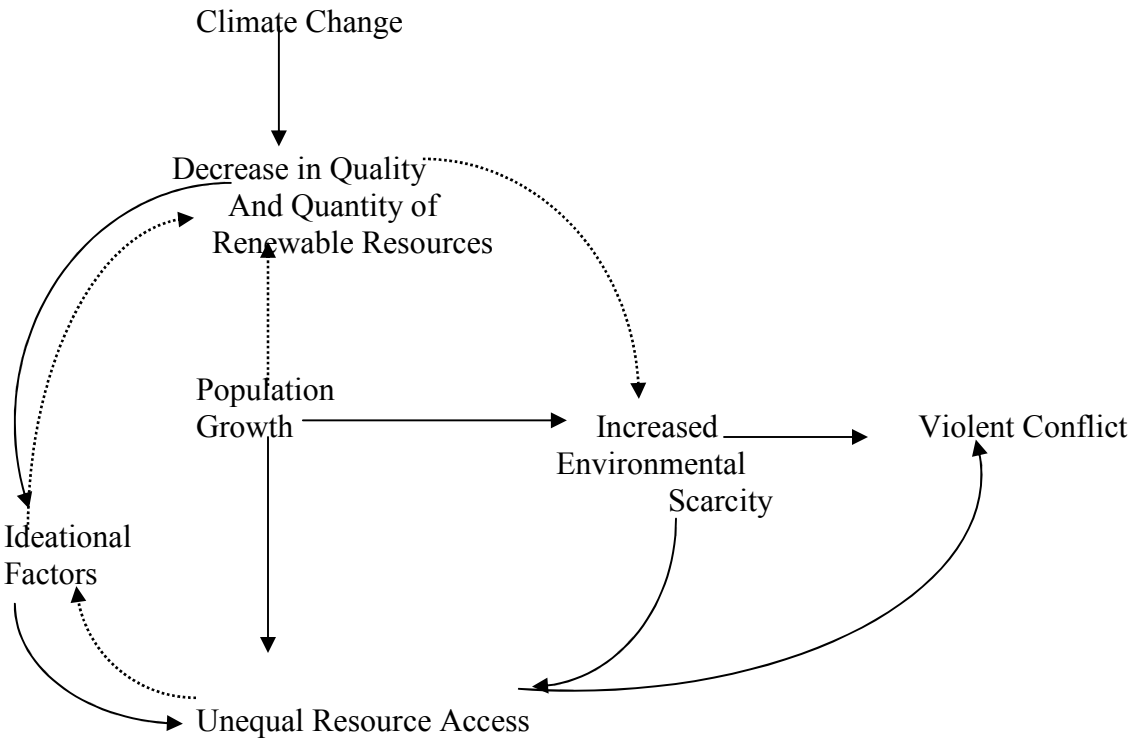
[7] Ideational factors are broad and complex social and psychological context. It includes patterns of land distribution; family and community structure; the economic and legal incentives to consume and produce goods, including the system of property rights; perceptions of the probability of long-rum societal stability; historically noted patterns of trade and interaction with societies; the distribution of coercive power within and among nations; the form and effectiveness of institutions of governance; and metaphysical beliefs about the relationship between humans and nature.

result of interaction of sources of scarcity in a particular environment as proposed by Homer-Dixon (1994). According to him, the three sources of environmental scarcity often interact, in two distinct patterns "resource capture" and "ecological marginalization" (see fig. 1).

Resource capture depicts a situation where a fall in the quantity and quality of renewable resources can combine with population growth to encourage powerful or advantaged groups within a society to shift resource distribution in their favour. This usually produces acute environmental scarcity for poorer and weaker groups whose claims to resources are opposed by more powerful groups. On the other hand, unequal resource access can combine with population growth to cause migration to regions that are ecologically fragile, such as steep upland slopes, areas at risk of desertification, and tropical rain forests.

High population densities in these areas, combined with a lack of knowledge and capital to protect local resources, causes severe environmental damage and chronic poverty. The second process is usually called "ecological marginalisation" (Homer-Dixon, 1994).

Fig: 1 Resource Capture and Ecological Marginalization in the process of Violent Conflict Re-modeled from the original work of Homer-Dixon, (1994)



Note:
Resource Capture: Resource Depletion as a result of Climate Change and Population Growth Cause Unequal Resource Access, which in turn predisposes to violent conflict

Ecological Marginalisation: Unequal Resource Access and Population Growth Cause Resource Degradation and Depletion, which leads to increased environmental Scarcity and in turn violent conflict.

Key: The broken arrow indicates ecological marginalisation
The continuous arrow indicates Resource Capture

III. Climate variability Scenario and vegetation of Nigeria Savannah

Nigeria climate is characterized by extreme humid weather condition in the forest southern region and extreme dry conditions in the savannah region of the north. For the purpose of clarity and detail (Table 2), Nigeria is divided into ultra humid, very humid, humid, sub-humid, plateau, mountain, dry humid and semi arid ecological zones. The highest annual rainfall length (mm p.a) ranges from 2000 + mm in the ultra humid region down to 200-400mm in the semi arid zone of the north. Similarly, the mean monthly

maximum range for temperature is 40°C in the semi arid down to 31°C in the plateau zone. The minimum mean range of temperature is lowest in the mountain zone at 5°C compared to 23°C in the ultra humid climate zone.

Table: 2 Agro-ecological zones of Nigeria

	Rainfall	Temperature	
Zone	Rainfall (mm pa)	Max	Min
Ultra humid	2000 +	32	23
Very humid	1200 – 2000	33	21
Humid	1100 – 1400	37	18
Sub-Humid	1000 – 1300	37	14
Plateau	1400 – 1500	31	14
Montean	1400 – 2000	36	5
Dry sub humid	600 – 1000	39	12
Semi arid	400 – 600	40	13

Source FGN 1997 from Akeh *et al*

Guinea Savanna Zone

The delineation of the Guinea Savanna Zone is based on the mean annual rainfall as well as the severity of the dry season. The southern limit of Guinea Savanna zone is based on a mean annual rainfall of at least 120 cm and lowest mean monthly relative humidity at 9 a.m of not less than 70%. The northern limit of Guinea Savanna zone is at approximately 100 cm mean annual rainfall, with the lowest mean monthly relatively humidity at about 29%. Guinea Savanna is found throughout the middle belt of Nigeria. The typical vegetation is open woodland with tall grasses (1 to 3 m high) in open areas and trees (up to 15 m high) usually with short boles and broad leaves. Fierce fires burn this vegetation almost annually in the dry season therefore fire-resistant species predominates. Many of the species in the southern areas of the Guinea Savanna zone are closely related to high forest species.

Sudan Savanna Zone

A drift of sand covers most of the zone. It is seen in the northern areas of the country encompassing three geological regions, which influence the vegetation in each of these areas. The vegetation of the Sudan Zone has been interfered with by man and for a long period of time. Overall, the number of thorny shrub plants (mostly Acacia) in this zone is noticeably greater than in the Guinea Zone. Grass is shorter and more feathery than in the Guinea zone. Relatively mature woodland on high-level sites has a fairly uniform structure and appearance, but the floristic composition varies as described in the "dominantly shrubs and dense grasses with minor tree component" legend class. The

legend class "dominantly shrubs and dense grasses with minor tree component" was the primary class used to delineate this zone. The classes "extensive small holder rainfed-agriculture with denuded areas" and "sand dunes" were also common on the sandy soils in this zone.

Sahel Savanna Zone

The delineation of Sahel Savanna zone is based on the 50 cm isohyets and less. The Zone is seen along the northeastern border of the country, and is influenced by the presence of late Chad and the Komadugu-Yobe river systems. Typically the vegetation consists of grasses, open thorn shrub savanna with scattered trees, 4 to 9 m in height most of them fine leafed and thorny, and extensive sparse grasses. Typical species are the trees Accacia raddianna, A. Senegal, A. Laeta and Commiphora africana, the shrubs Salvadora persica, Leptadenia pyrotechnica and four species of Grewia, and the grasses Artistida stipoides, Schoenefeldia gracilis and Chloris priean.The legend class "dominantly grasses with discontinuous shrubs and scattered trees" was the primary class used to delineate this zone. The class "extensive small holder rainfed-agriculture with denuded areas" was also common in this zone.

IV. Anatomy of Drought condition in the GSSZ of Nigeria

As observed in the previous section, climate condition in the GSSZ of Nigeria is usually at the extreme point. In some cases, annual range of rainfall goes down as low as 200mm, coupled with harsh temperature conditions. The index of aridity is estimated to be within the range of 0.2-0.6. A time series data of rainfall for the years 1994 – 1998 (Table 3) shows that some states are more affected than others, especially those that lie within the borders of Nigeria with Chad and Niger Republic (Sokoto, Borno, and Katsina States). The table reflects a non-directional trend in the data over the years, with previous or next years not necessarily lower or higher than the reference year. The dry land/GSSZ of Nigeria forms an undulating plain at a general elevation from about 450m-700m. Unpredictability and unreliability characterizes the pattern of rainfall in this zone. As in other arid and semi-arid areas of the world, it is not just the total amount of rainfall that is important, but the distribution and timing. In this respect, the pattern of rainfall is highly variable in spatial and temporal dimensions with an inter-annual variability of between 15 and 20 percent. Average rainfall varies from the northeastern with least rainfall to the southern sub-area with heaviest rainfall recorded.

Table: 3 Annual Mean Rainfalls by State 1994-1998

	Annual Mean Rainfall Per Year				
State	1994	1995	1996	1997	1998
Bauchi	1174.3	1023.2	1316	900.2	1122.6
Benue	973.2	1152.1	1158.9	1308.7	871.8
Borno	222.1	698.4	630.5	406.9	534.8
Adamawa	821.6	985.2	935.1	960.4	1043.9
Kaduna	1098.5	890.6	744	1240.8	889.9
Kano	755.5	515.3	570.5	1289.3	1397.8
Katsina	501.5	431.1	413.2	473.2	
Niger	806.9	1273.3	690	940.2	1237.3
Sokoto	762.1	337	714.8	645.5	845.9
Kwara	461.5	1409.2	745.5	1334.4	1349.5
Plateau	1165.9	833.6	436.2	1329.3	1261.3

Source: Federal Office of Statistics, Nigeria 2001

Besides high inter-annual variability, the rainfall regimes of dry land/GSSZ of Nigeria are characterized by high concentration in few months, intermittence and violent storms. Thus the region is by nature prone to recurrent, intense, and persistent periods of drought. The intensity of drought may be short – lived or long in duration depending on the interaction among the natural push factor variable at work. Table 4 shows that in 1960-1999, there were visible occurrences of drought for a cumulative period of approximately 8-18 years in most of the desertification frontline states of Nigeria.

Table: 4 Frequency of Drought Occurrence in Desertification Frontline states in Nigeria 1960-1999

States	1960	1969	1970-79	1980-89	1990-90	Total
Bauchi	-	Na	4	6	2	12
Gombe	-	Na	-	-	-	-
Borno	1	Na	3	7	5	16
Yobe	-	Na	2	7	3	12
Kano	1	Na	2	5	1	9
Jigawa	-	Na	-	-	-	-
Katsina	1	Na	3	5	8	18
Kebbi	-	Na	-	--	-	-
Sokoto	1	Na	5	8	3	17
Zamfara	-	Na	3	3	3	9

Source: Akeh et al 2004

The extent of drought condition in this zone has caused both temporary and permanent damage to the ecosystem. During such extended dry periods, the stress on the land is increased from both human and livestock, which had left the environment into a precarious equilibrium. The trend in the drought induced by climate change is further aggravated by anthropogenic factors such as over grazing and over exploitation of

marginal lands. Other factors include deforestation and poor irrigation practices that are influenced by changes in population and socio-economic conditions. (Federal Ministry of Environment, Report). Be that as it may, Nyong had contented in several writings that the blame on overgrazing practices of the local population for desertification is not true. Rather, the real problem is climate change, which has caused steadily decline in rainfall in the Sahel region of Africa since 1960s. (Tanya Salseth Feau, 2005, Washington File staff Writer; Courtesy of Woodrow Wilson International Center for Scholars, Washington).

The extent and severity of drought in Nigeria has not been fully established neither the rate of progression properly documented. However, drought induced desertification is regarded as the most pressing environmental problem in the dry land parts of Nigeria, with both flora and fauna loss at fast rates. The visible sign of this phenomenon is the gradual shift in vegetation from grasses, bushes and occasional trees, to grass and bushes, and in the final stages, expansive areas of barren sand dunes. Land degradation indicators shows that drought related degradations such as wind erosion, deforestation (natural loss) and forest fire have had more and far reaching negative impact on the environment compared with other agents of land degradation. However, the underlying observation is that more areas and hectares of land are affected and made unproductive as a result of drought related environmental problems. For instance the difference between the area affected in 1990-1999 and 2000-2003 indicates a steady loss from wind, deforestation and forest fire (Table 5). In relation to the land loss, an estimate of 50% and 75% of the desertification frontline states in Nigeria are affected by the phenomenon (Federal Ministry of Environment, 2004).

Table: 5 Areas Affected by Wind, Deforestation and Savannah Forest Fire 1990-2003

Indicator	Area Affected	
	1990-1999	2000-2003
Wind Erosion	6,500,000ha	9,000,000ha
Deforestation	350,000ha/ann	400,000 ha/ann
Savannah forest fire	100,000 ha/ann	120,000 ha/an

Source: FGN 2004

The severity and fast rate of aridity in the Sudan, and Sahel zones is not unconnected with the climate change, which has affected the pattern of rainfall in the areas since

60years. The trend and pattern of rainfall for 22 stations located within the GSSZ of Nigeria for a 6 decade period shows that there have been significant reduction in rainfall received over the years (Fasona and Omojola 2005). It is clear from the figures in the table (Table 6) that for most stations located in the upper Sudan and Sahel zone of Nigeria, the deviation of rainfall from the grand mean is negative. Worst affected are Nguru, Maiduguri and Katsina areas that are located in the interior of the Sahel zone.

Table 6 Mean Decadal Rainfall (1940-2000) for Selected Stations in GSSZ of Nigeria

Station	1940s	1950s	1960s	1970s	1980s	1990s	Total decade mean	mean aver for all decade	Deviation from the mean
Bauchi	1121.02	1080.75	1039.29	1000.34	898.91	1112.54	6252.85	1042.14	70.8753
Birnin-Kebbi				715.557			715.55	715.557	-255.71
Gusau		1062.04	945.7	877.21	646.03	1069.29	4600.26	920.053	-51.213
Kaduna	1076.97	1469.57	1269.62	1020.09	1116.15	1202.02	7154.42	1192.4	221.137
Kano	781.39	909.51	837.44	706.16	613.98	1119.11	4967.59	827.932	-143.33
Maiduguri	592.5	723.49	658.07	582.97	419.17	601.3	3577.5	596.25	-375.02
Sokoto	657.01	779.54	693.64	597.8	538.23	673.6	3939.82	656.637	-314.63
Yola	924.92	992.43	844.9	915.8	832.02	937.75	5447.82	907.97	-63.297
Nguru	554.16	586.12	518.82	449.11	335.24	431.456	2874.91	479.152	-492.11
Potiskum	713.18	864.6	772.14	623.65	591.41	706.322	4271.3	711.884	-259.38
Katsina	682.25	786.31		584	482.73	360.144	2895.43	579.087	-392.18

Source: Underlying Data from Fasona and Omojola, (2005)

High water deficit associated with the GSSZ has led to more exploitation of the ground water reserve. Currently, the extraction of groundwater through boreholes and hand-dug wells is tapping one or more of the aquifers underlie the area. Continuous over-pumping of ground water will definitely lead to continuous depletion on the water table as observed by Carmalt and Tibbisalts (1969) who recorded a decline of 6.5m, in the mean ground water level around Maiduguri axis between 1963 and 1972. Expert options suggest that the situation is currently probably worse in most parts of the dry land areas than in the past. This however suggests for a full study of the exact recharge rate and the magnitude of the recharge in this zone.

V. Agriculture and food production activities

The GSSZ of Nigeria occupies more than 60% of land surface in Nigeria. The people in these areas are predominantly farmers, like in other parts of Nigeria where farming/agriculture engages over 65% of the population. However, food production activities in this zone can be discussed under types of agricultural activities, and major food produce estimates. Climate determines the location of the crops and animals and the

farm routine in GSSZ of Nigeria. While grains and livestock are grown mainly in the drier north, mix crops and livestock in are practiced in the middle belt zone.

Types of Agricultural activities and Production

Arable cropping is one of the main occupations of majority of the inhabitants in GSSZ of Nigeria, where two types of farmlands are maintained (Iloeje 1975), namely compound land and outfield. The former, generally a quarter to half an acre, is located within the compound and is intensively cultivated. It is heavily manure with household refuse and animal droppings and planted annually with garden crops like vegetable, fruits and pepper. The outfield is usually more extensive and situates some distance from the compound. It is cropped under the bush fallow system, and planted with basic food, staple, and cash crops like maize, millet sorghum, wheat, cotton, ground nuts among others. Within the outfield farms, there are also areas where tree crops like citrus are grown.

Livestock farming is also practiced widely in the GSSZ, especially in the Sudan-Savannah area where cattle, sheep, goat, poultry, horses, and donkeys are the main livestock reared. It is difficult to say how many of each of these exists because accurate records do not exist. Nevertheless, recent estimates of domestic livestock in the Nigeria indicate some increases for some species that are more drought resistant. Most of the cattle/animals that are domesticated are either kept as beast of burden or for food. A very prominent feature in the livestock farming in the GSSZ of Nigeria is the traditional pastoral nomadism with some transhumance. In this practice mainly an occupation of the Fulani ethnic group, there are no permanent homes for the animals. The nomads pitch their tent when they want to sleep, and take them away when they want to move with their cattle. Though the herdsmen's way of life is simple and primitive, but they are intelligent enough to move their cattle as the environment demands. They move northwards in the wet season, but southward in the dry season; when the grasses in the Sudan and Sahel zones have all died away. Similarly, they drive their cattle up the plateau in the wet season when the valleys are tsetse fly infested, but in the dry season when the valleys are free from the pests and the plateau are dry and patchy, they drive their cattle down. Particularly in the Sahel region they keep their livestock near rivers where water is available for their cattle, which accounts for large concentration of cattle

around Sokoto and Hadeija river valleys in the Sahel climatic zone of far non-Nigeria (Iloeje, 1975). Besides arable and livestock farming, fishing activities has go on around major river valleys. Even though most of the rivers loose a great volume of their content during the dry seasons, some of them still retain quite considerable volume of water that is good for fishing. Major rivers in this characteristic include, Sokoto, Yobe, Gongola, Kaduna, Niger, Hedeija etc. where various types of fishes are caught in different sizes.

VI. Climate variability, food production and security interface

Recognizing that Nigeria is confronted by the problem of drought and desertification, it is estimated that about half of Nigeria 71.2 million hectares of available agricultural land is currently being utilized. Studies have indicated that the country would suffer large ecological and economic losses if the environmental problems continue unchecked. Initial estimate indicate that the cost of unsustainable development for Nigeria may be as high as US $ 5.1 billion per year. (Federal Government of Nigeria, 1997). Most of the losses are likely to be in the agricultural production, which depends much on the climate condition. Any drastic change in the climate regime in Nigeria will affect the food production capacity of Nigeria because the traditional small holder farmers who use simple techniques of production and the bush fallow system of cultivation account for over $^{2}/3$ of Nigeria's total agricultural production. The impact of climate change on the capacity of the local people to produce is further compounded by the incessant conflicts as a result of population pressure and scramble for resources.

As a result of the increasing aridity and desert encroachment from the far north fringes of Nigeria around the Sahel region, there have been unplanned and chaotic population displacement and drift towards the southern axis of the GSSZ. The pressure of the migrating human and livestock population from the Sahel areas are absorbed by pressure point buffer states in the middle – belt region of the GSSZ. These buffer states have about 10-15% of their land area threatened by desertification due to drought phenomenon. This action leads to an intensified use of fragile and marginal ecosystem resulting into progressive degradation even in the years of normal rainfall. (Federal Ministry of Environment, Report). Additionally, pressure is put on the pasture resources by livestock from other Sahel countries, especially Chad, Niger and Cameroon. Livestock from these countries are attracted to the Nigeria's GSSZ towards the northeast axis

because of abundant supply fodder around the patches of the wetland area of Lake Chad and beyond, which sparks off conflicts.

In North East Nigeria there are many conflicts, which are environmental induced. These are conflicts over grazing land, over cattle, over water points and over cultivable land. While there are conflicts over grazing land and over cattle amongst pastoral people, there are also conflicts over cultivable land amongst peasant farmers within the same ethnic group and also between ethnic groups. Such conflicts amongst pastoralists are common and widespread in Nigeria. This is similar to what happens in, the Karamajong of Uganda and the Pokot of Kenya who have been fighting over grazing land and over cattle for more than three decades (Bujra, 2000). Other examples of conflicts amongst pastoralists are many in other parts of Africa: among the Somalis, Oromos, Karamojong, Pokot, Masai, etc. Similarly, conflicts for fertile and cultivable land have been taking place amongst many ethnic groups in the area like elsewhere in Africa[8].

Most of these rural conflicts over land and cattle have been going on over a long period, with very little attention given to them. Even today most such conflicts go unnoticed and unreported – unless large-scale killing and injuries takes place and the state intervenes militarily. These conflicts go back a long way, in some cases to the pre-colonial period. However, major changes have been introduced in the countries' economies such as changes over land laws, which often contradict customary laws (Obioha, 2000; Obioha, 2002; Obioha, 2004), confiscation of large tracts of land for ranching and large-scale farming, and increase in population. Most important is the rise of rural inequalities – between rich and poor/landless farmers, between rich ranchers and poor cattle owners. These changes have led to a considerable competition for the scarce resources of land (cultivable and grazing, including water). Furthermore, environmental deterioration in land productivity and scarcity of water has contributed to the intensity of the competition. Amongst pastoral societies in particular, the system of grazing, which involves movement of large cattle herds to water points and in search of pasture, has created a serious problem. Private ownership of land has restricted these necessary

[8] Examples of large-scale conflicts over cultivable land (involving ethnic groups) are not, suspect, as frequent as those among the pastoralists. Nevertheless, there are recent examples of well-reported conflicts in Kenya (Rift Valley), Nigeria (Ife and Modakeke Yoruba communities), the DRC (between the Hema and Lendu, in Ituri District) and in Ghana.

movements of pastoralist and the impact has been serious and catastrophic on pastoralist societies (Bujra, 2000).

Different cases and examples of violent conflict over land resources in north eastern Nigeria in the recent time include those that have been occurring in different states of that region of Nigeria. The particular worrying situation is the ongoing conflict between the Jukuns and the Tivs, and related tensions between other groups, in the central states of Benue, Taraba and Nasarawa. This conflict culminated in the killing of more than 200 civilians by the military in Benue in October 2001. More critical empirical examination of the emerging violent conflicts over land resources in northeast Nigeria indicates that about eleven types of conflict types could be identified and distinguished (Table 7). The various emerging conflict types in the northeast Nigeria fit into the earlier analysis of Homer-Dixon (1991), where he distinguished simple scarcity, Group identify and Relative deprivation conflicts. Simple scarcity conflicts are explained and predicted by general structural theories.

Table 7: Typologies of Climatically induced Violent Conflict Over land Resources in North East Nigeria

Types	Level	Actors	Occupation	Stake	Dimension	Objective sort
TP1	Inter Ethnic	Indigene/settler	Cultivators/herdsmen	Vegetation and land	Domestic/ international	Relief from scarcity/ reinforcement of group identity
TP2	Inter Ethnic	Indigene/settler	Cultivator/cultivators	Arable land	Domestic	Relief from scarcity/ reinforcement of group identity
TP3	Inter Ethnic	Indigene/settler	Herdsmen/herdsmen	Grazing land	Domestic/international	Relief from scarcity/ reinforcement of group identity
TP4	Inter Ethnic	settler/settler	Cultivator/cultivators	Arable land	Domestic	Relief from scarcity/ reinforcement of group identity
TP5	Intra Ethnic	indigene/indigene	Cultivator/cultivators	Arable land	Domestic	Distributive Justice
TP6	Intra Ethnic	Indigene/indigene	Herdsmen/herdsmen	Grazing land	Domestic	Relief from scarcity
TP7	Intra Ethnic	Settler/settler	Herdsmen/herdsmen	Grazing land	Domestic	Relief from scarcity
TP8	Intra Ethnic	Settler/settler	Cultivator/cultivators	Arable land	Domestic	Distributive Justice
TP9	Inter Personal	Settler/settler	Cultivator/cultivators	Arable land	Domestic	Distributive Justice
TP10	Inter Personal	Settler/indigene	Cultivator/cultivators	Arable land	Domestic	Distributive Justice
TP11	Inter Personal	Indigene/indigene	Cultivator/cultivators	Arable land	Domestic	Distributive Justice

Obioha, 2005,

As vulnerable as the GSSZ of Nigeria is, if has a high carrying capacity, being a home to over a quarter of Nigerian population. It supports about 90% of the cattle production, $^{2}/_{3}$ of the goats and sheep, and almost all the donkeys, camels and horses found in the country. Implicitly, the zone plays a dominant role in the agricultural modernization and irrigation of the country, promotion of export crops such as cotton, groundnuts and gum Arabic and production of food crops, mostly the import substitution crops.

Previous studies have shown that the interaction between climate change and agricultural production could be negative or positive. In the case of the GSSZ of Nigeria, the extent to which drought affects food production in the area and Nigeria in general can be deduced from the observation of United States Development Agency Foreign Agricultural services forecast 2006 (Table 8). According to the forecast based on four cereal crops of GSSZ, wheat compared to other crops rice, sorghum and corn is experiencing static growth between 2005/06 and 2006/07 because it is the most climate dependent crop. Wheat production is not expected to expand significantly beyond this level due to local climate conditions, which are not suitable for wheat production in the GSSZ of Nigeria.

Table: 8 Estimate of Selected Cereal Production in Nigeria 2004-2006

Crop	2004	2005	2006
Wheat	60	60	60
Rice	2300	2700	2800
Corn	6500	7000	7350
Sorghum	10000	10500	10600

Source: USDA Foreign Agricultural Services 2005

Generally, agricultural production has not performed very well in Nigeria owing to some other factors that may not be very necessary to capture in this paper. Table 9 below shows how agriculture is disfavoured, which also points out to the fact that this may not be unconnected with the climate variability and changes that affect the potentials of agriculture.

Table: 9 Agricultural Production Labour and Land Capital Indicators

Indicators	Unit	1979-81	1991	2000	2001	2002	2003
Population and Agric. Labour							
Rural Population	Percent	73	65	56	55	54	53
Agric labour force/T. Lab.	Percent	54	43	33	32	32	31
Land use							
Arable land + perm. Crops	1000 HA	30 360	32099	30850	31200	33000	-
Arable land	1000 HA	27827	29564	28200	28500	20200	-

Irrigated land	1000 HA	200	220	233	233	233	

Source: Underlying Data from FAOSTAT, World Bank-World Development Indicators, 2005

From average annual growth rate perspective, most population and agricultural labour force indicators and agricultural food production have been on steady decline between 1980 and 2003 Table 10).

Table: 10 Labour Force and Agricultural Food Production

Indicators	1980-1990	1990-2003
Rural population	1.7	1.0
Agric labour force	0.2	03
Agric production	5.6	5.6
Per capita agric prod	2.6	0.7
Food production	5.5	3.6
Per person food production	2.5	0.7
Food production	5.5	3.6
Per person food. Prod.	2.5	0.7

Source: Underlying Data from FAOSTAT, World Bank-World Development Indicators, 2005

Climate (rainfall) and Food Production Nexus in GSSZ

Food items production in the GSSZ of Nigeria may be dependent on the climate variability regime, especially on the amount of rainfall. From 1960-2004, there has been more drought than rainfall in the GSSZ of Nigeria. To be specific, in Katsina for example, the number of years with drought is 29 while those with rain are just 16. This means that Katsina is still very prone to drought. The drought implication from this is that Katsina has experienced more drought years. This by now would have seriously affected their agricultural products. There could be serious shortage of water supply in the city and state. The rivers will dry and this will decrease the quantity of water available for use. Any form of agricultural project will be seriously hampered, as it is not likely to be successful because of the low availability of water. Industries that make use of a lot of water mill by now have to find alternative means of water supply as the state may not be able to provide them with water and they cannot depend on rain. Their best bet is to opt for borehole drilling. Due to lack of specific data to demonstrate the relationship between drought condition and agricultural production, the supposition of fish production as a proxy will suffice for this discourse. Below is the result of an analysis of the interface between rainfall and fish production (Drought Situation over Katsina State, 1960-2004)

Food production and food security Scenario GSSZ of Nigeria

Similar to what has been discussed in the above sub-section of this paper; the food production outputs and the level of agricultural production intensification are shown in the different tables below.

The interface between adverse climate condition characterized by extreme dryness or drought is not an issue to be questioned in Africa in general and Nigeria in particular. For instance during the drought of 1972-1973 for instance, about 300,000 animals died and farm yields dropped by up to 60% in Nigeria. This implies that drought may portend adverse effect on food production and security[9]. However, the extent to which food production and security arise from drought phenomenon in Nigeria is not very certain. What we know is that drought has caused serious food insecurity situation in some African countries. In Eritrea, because of lack of seasonal rains and aftermath of war with Ethiopia, I million of the country's 3.7 million people face drought and starvation. Farmers in Gambia are despairing as shortage of rain is causing new seedlings to wilt and die off. The international Institute of Tropical Agriculture (IITA) in Nigeria has estimated that by 2010 around 300 million people in sub-Saharan Africa, nearly a third of the population, will be malnourished (Meron Tesfa Michael, 2006).Most indicators examined point out to the fact that food production in Nigeria, especially in the GSSZ of Nigeria has not witnessed a steadily appreciable growth in the last two decades.

For the purpose of ascertaining whether climate change in the GSSZ of Nigeria has any implication on food production in Nigeria in the recent time, some cereals that are dominant produce of the area, including fish are used as reference points of analysis. For fish production, while Table 11 shows quantity of fish production in the selected states per annul in Table 12 the annual percentage growth indicates a drop in 1992, 1995, 1998, and 2000, relative to previous year, with the worst situation being in 1995 at -41%.

[9] "Food insecurity is the inability of a household or nation to meet target consumption levels in the face of fluctuating production, prices and incomes". Food insecurity may be chronic or transitory. In chronic food insecurity, there is continuous inadequate diet and nutrition caused by the household's inability to acquire food. It therefore afflicts households that persistently lack the ability to either buy food or produce their own. On the other hand, transitory food insecurity results from a temporary decline in household access to food due mainly to instability in food prices, production, household income or a combination of these factors (Reutlinger *et al*. (1986)

Table: 11 Estimate of Fish Production in GSSZ by State 1991-2000

	Fish Production Per Year									
State	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Bauchi/Gombe	488	405	173	172	144	154	159	53	67	66
Borno/Yobe	71832	46398	47266	34657	74852	96413	97712	94344	82399	79307
Taraba/Adamawa	14331	13558	13568	13089	11897	11494	11105	16023	18344	22003
Kaduna	6341	1530	756	1101	1096	1373	1276	6700	6314	5153
Kano/Jigawa	1056	838	735	996	1050	565	837	822	1022	843
Katsina	801	1109	547	520	706	591	695	768	685	727
Niger	1671	1076	1019	1024	1554	1193	995	1391	876	1219
Sokoto/Kebbi/Zamfara	16442	25428	26161	54144	31844	53815	68015	55745	89511	81007

Source: Federal Office of Statistics, Nigeria

Table 12 Estimated % Growth of Fish Production Per Annum per state

State	Annual Ave	1992	1993	1994	1995	1996	1997	1998	1999	2000	Ave
Bauchi/Gombe	188.1	-17.01	-57.28	-0.58	-16.28	6.94	3.25	-66.67	26.42	-1.49	-13.63
Borno/Yobe	72518	-35.41	1.87	-26.68	115.98	28.80	1.35	-3.45	-12.66	-3.75	7.34
Taraba/ Adamawa	14541.2	-5.39	0.07	-3.53	-9.11	-3.39	-3.38	44.29	14.49	19.95	6.00
kaduna	3164	-75.87	-50.59	45.63	-0.45	25.27	-7.06	425.08	-5.76	-18.39	37.54
Kono/Jigawa	876.4	-20.64	-12.29	35.51	5.42	-46.19	48.14	-1.79	24.33	-17.51	1.66
Katsina	714.9	38.45	-50.68	-4.94	35.77	-16.29	17.60	10.50	-10.81	6.13	2.86
Niger	1201.8	-35.61	-5.30	0.49	51.76	-23.23	-16.60	39.80	-37.02	39.16	1.49
Sokoto/Kebbi /Zamfara	50211.2	54.65	2.88	106.96	-41.19	69.00	26.39	-18.04	60.57	-9.50	27.97
	143415.6	-20.02	-0.13	17.15	16.50	34.48	9.18	-2.74	13.29	-4.46	7.03

Source: Data Analysis

Among all the states, Bauchi /Gombe experienced the least fish production growth in the negative direction. Table 13 shows estimate of areas harvested with major crops from 1991-2000. An insight into the situation using growth change analysis in Table 14 indicates that the estimated areas harvested had a drop in 1992 and 1999 relative to the previous year for most of the crops. Millet, Guinea Corn and Cotton had more years of decrease in the expanse of areas harvested, because of their relative more sahel environment compared to beans.

Table: 13 Estimated Area harvested with major crops in GSSZ 1991-2000 in 000Hecters

Crops	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Millet	2594	1941	5113	5138	4268	4409	4400	4376	4395	4390
Guinea Corn	3052	2973	6236	6392	5895	5896	5803	5910	5870	5861
Groundnut	846	755	1949	1979	2539	2611	2486	2542	2546	2525
Beans	1858	1876	3501	3589	4814	4888	5583	6099	5522	5735
Cotton	117	73	485	521	224	228	200	189	206	198

Source: Federal Office of Statistics, Nigeria

Table 14 Estimated % Growth of Areas Harvested Per Annum

Crops	Annual Ave	1992	1993	1994	1995	1996	1997	1998	1999	2000	Ave
Millet	4102.4	-25.17	163.42	0.49	-16.93	3.30	-0.20	-0.55	0.43	-0.11	13.85
Guinea Corn	5388.8	-2.59	109.75	2.50	-7.78	0.02	-1.58	1.84	-0.68	-0.15	11.26
Groundnut	2077.8	-10.76	158.15	1.54	28.30	2.84	-4.79	2.25	0.16	-0.82	19.65
Beans	4346.5	0.97	86.62	2.51	34.13	1.54	14.22	9.24	-9.46	3.86	15.96
Cotton	244.1	-37.61	564.38	7.42	-57.01	1.79	-12.28	-5.50	8.99	-3.88	51.81
	16159.6	-10.03	126.88	1.94	0.69	1.65	2.44	3.49	-3.02	0.92	13.88

Source: Data Analysis

The report in Table 15 and further analyzed in Table 16 shows that yield per hectare decreased in 1993, 1996, 1997 and 1999. Similarly, total output for major crops experienced decline in 1992 and 1999 relative to the previous years as indicated in Tables 17 and 18.

Table: 15 Estimated Yield per hectare of major crops in GSSZ 1991-2000 in 000Tonnes

Crops	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Millet	1003	1253	549	574	882	889	915	1444	1329	1372
Guinea Corn	1024	1048	574	602	1106	1155	1080	1426	1204	1175
Groundnut	937	918	398	451	917	1014	962	997	992	984
Beans	420	516	317	419	458	480	460	471	453	457
Cotton	1376	1932	346	353	1304	882	990	1841	1694	1843

Source: Federal Office of Statistics, Nigeria

Table 16 Estimated % Growth of Yield per Hectare for Major Crops Per Annum

Crops	Annual Ave	1992	1993	1994	1995	1996	1997	1998	1999	2000	Ave
Millet	1021	24.93	-56.19	4.55	53.66	0.79	2.92	57.81	-7.96	3.24	9.31
Guinea Corn	1039.4	2.34	-45.23	4.88	83.72	4.43	-6.49	32.04	-15.57	-2.41	6.41
Groundnut	857	-2.03	-56.64	13.32	103.33	10.58	-5.13	3.64	-0.50	-0.81	7.31
Beans	445.1	22.86	-38.57	32.18	9.31	4.80	-4.17	2.39	-3.82	0.88	2.87
Cotton	1256.1	40.41	-82.09	2.02	269.41	-32.36	12.24	85.96	-7.98	8.80	32.93
	4618.6	19.05	-61.46	9.84	94.54	-5.29	-0.29	40.21	-8.21	2.80	10.13

Source: Data Analysis

Table: 17 Estimated output of major crops production in GSSZ 1991-2000 in 000met Tonnes

Crops	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Millet	2602	2432	2809	2949	3760	5921	5917	6317	5842	6025
Guinea Corn	3124	3116	3577	3845	6517	7608	7959	8430	7066	6885
Groundnut	793	693	776	893	2329	2647	2392	2535	2525	2484
Beans	780	968	1109	1503	2203	2143	2488	2875	2502	2622
Cotton	161	141	168	184	292	301	308	348	349	365

Source: Federal Office of Statistics, Nigeria

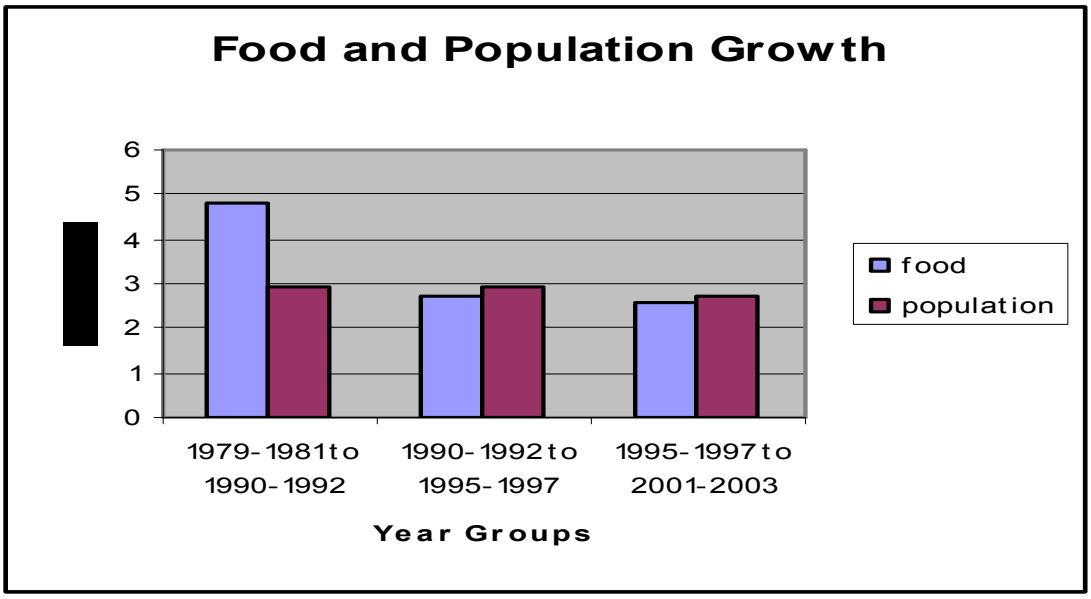
Table 18 Estimated Annual Percentage Growth of Total Output of Major crops

Crops	Annual Ave	1992	1993	1994	1995	1996	1997	1998	1999	2000	Ave
Millet	4457.4	-6.53	15.50	4.98	27.50	57.47	-0.07	6.76	-7.52	3.13	11.25
Guinea Corn	5812.7	-0.26	14.79	7.49	69.49	16.74	4.61	5.92	-16.18	-2.56	11.12
Groundnut	1806.7	-12.61	11.98	15.08	160.81	13.65	-9.63	5.98	-0.39	-1.62	20.36
Beans	1919.3	24.10	14.57	35.53	46.57	-2.72	16.10	15.55	-12.97	4.80	15.72
Cotton	261.7	-12.42	19.15	9.52	58.70	3.08	2.33	12.99	0.29	4.58	10.91
	14257.8	-1.47	14.82	11.08	61.09	23.30	2.38	7.56	-10.83	0.53	12.05

Source: Data Analysis

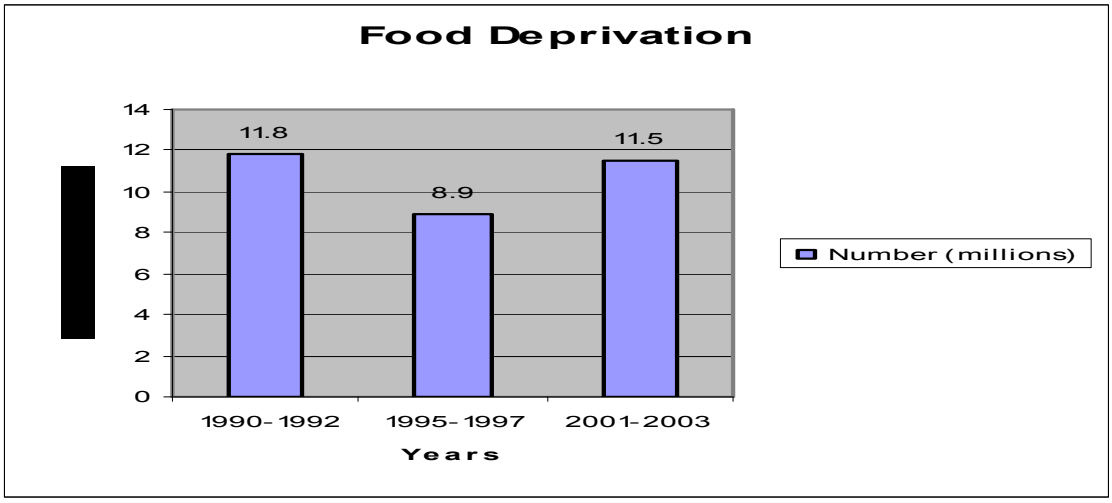
The general scenario of food production and security in Nigeria depicts a state of food insecurity. Food and population growth comparison shows that the annual population growth rate has exceeded the growth rate in food production (fig: 2), similarly, the food deprivation prevalence is on the increase, from 8.9 million in 1997 to 11.5million in 2003 (fig 3). As a result of this, child nutritional status index shows 9.3% as wasting and stunting, respectively (FOA, 2006)

Fig. 2 Difference in Food and Population Growth 1979-2003



Source: Food and Agricultural Organization (2006) FAOSTAT: Food Security Statistics- Nigeria

Fig. 3 Food Deprivation Estimate



Source: Food and Agricultural Organization (2006) FAOSTAT: Food Security Statistics- Nigeria

Similar to the above statistics, further statistical analysis had shown that there has been an established gap between food production and food demand for the cereal crops in Nigeria from 1995-1997 (Table 19)

Table: 19 Food Demand and Production Differences 1995-1997

Commodity	Projected Demand 5% growth			Estimated output			Gaps		
	1995	1996	1997	1995	1996	1997	1995	1996	1997
Rice	2918	3064	3217	3203	3122	3230	285	58	13
Maize	4288	4502	4727	6931	6217	6285	2643	1709	1558
Sorghum	7327	7693	8078	6997	7514	7954	-330	-179	-124
Millet	6514	6474	6798	5563	5803	5997	-951	-671	-801
Wheat	2982	3131	3288	44	47	49	-2938	-3084	-3239
Groundnut	911	956	1004	1579	2078	2101	668	1122	1097

Source: Nigeria; Directory of Soil Institutions and Experts in Africa, 2002

Note: The projection for Demand here was based on 5% growth irrespective of the actual or estimated population growth in the country.

VII. Institutional Framework in Combating Drought and Desertification for assured food Security

Drought and desertification are the most important twin environmental problems affecting the 15 northernmost states of the country. The Government, and at some instances in collaboration with donor countries, international organizations and institutions, has done a lot to combat desertification, and mitigate the effects of drought since the beginning of the 1970s. Efforts have been made through more efficient utilization and alternative sources of fuel wood, promulgation of State Edicts, afforestation and reforestation programmes. Despite all these efforts, desertification has continued its down-south movement, which currently renders the areas north of latitude

15 either desertified or prone to desertification. These processes coupled with the effects of drought have continued to cripple the socio-economic lives of the people living in the affected areas. The negative impacts on the people call for urgent actions to check the desert encroachment currently estimated at about 1 km annually, and institutionalize drought-ameliorating measures, which should be periodically reviewed.

In view of the serious ecological and socio-economic implications of desertification and drought, programmes, some activities have been conceptualised in line with the aim to ameliorate the effects and increase food production by the Government and non-governmental organisations. These activities can be identified into different schemes as they are implemented in Nigeria presently.

Government Initiatives and Programmes

In the first place, there are programmes and policies that are designed by the Federal government through her line ministries and agencies. These include issues that mitigate the causes of drought and those that concern food supply and production. With regard to the former the identified programmes are

Reforestation: Shelterbelt Establishment

This programme is specifically concerned with the re-greening of the environment. The programmes are either directly financed through the regular funding of line projects by government or implemented jointly by the FGN and State governments in collaboration with bilateral or multilateral aid organizations. In all, the following have been achieved:

(i) establishment of over 201 nursery units,
(ii) establishment of over 3515 community nurseries,
(iii) establishment of over 891 institutional and 936 private nurseries,
(iv) production and distribution of over 75 million tree seedlings,
(v) establishment of over 2,298 km of shelter belts and 600 ha of woodlot,
(vi) over 320,000 farm families benefitted from the programme.

Research and Linkage Programme

The objective of this programme is to generate credible data and train manpower for planning purposes in environmental management of natural resources and, in particular, to develop practical measures for combating desertification and mitigating the effects of drought in the semi arid and arid areas of the country. Specifically, the Linkage Centre undertakes research and training in vegetation and land use management, arid land

human ecology and management of rangeland. It is designed to involve the local people in the designing, implementation and management of natural resources conservation programmes inimical to combating desertification and ameliorating the effects of drought
In its effort to create the enabling environment for food self-sufficiency, the Government, through the Ministry of Agriculture and Natural Resources has embarked on a number of programmes geared towards promotion of sustainable agriculture and rural development. These include

Surface and Groundwater Monitoring Under the National Fadama Development Programme
The main objective of the programme is to monitor and study the effect of groundwater exploitation in flood plains in the semi-arid areas of the country for irrigation in order to design effective and sustainable exploitation regimes for the various aquifers encountered. The study will also seek to ascertain the pollution potentials of the saturated groundwater zone due to the irrigation activities in the project area. The study will ultimately assist in the design of the groundwater exploitation plan for the project area.

Water Supply and Formulation of Irrigation Policy for Nigeria
Nigeria has sufficient water potential to meet the 2025 food requirements, but will have to more than double their efforts to develop water sources to do so. However, finding the financial resources to build enough water development projects to accomplish this will be extremely difficult. Irrigation and drainage infrastructure, especially with regard to drought have a critical role in the prevention of famines and widespread starvation and in the rising standard of living of millions of farmers in parts of the GSSZ of the nation. Specifically, in order to increase food production and raise hope for food security in the nearest future in Nigeria, a number of initiatives have been undertaken to promote rational lowland development, especially in narrow “fadama”, strips, which are scattered everywhere in Nigeria. Improved and locally adapted irrigation techniques are being promoted by several research institutes, led by the West African Rice Development Association (WARDA), which manages an Inland Valley Consortium composed of several national and international research institutes. Technical documents have been published both for the humid tropics and the Sahelo-Sudanian zone. Some irrigation schemes were implemented with the object of reducing the dependence on imported rice,

and wheat but very few were really successful. Kano River Irrigation Project is however a good example of successful irrigation scheme that has boosted food production.

Technology/Crop Yield Research and National Seed Service (NSS) Programme

The objective of this programme is to produce high quality seeds for Nigerian farmers within a commercial environment of sound certification and quality control and to sell high quality seeds and seedlings of selected arable tree crops, namely oil palm, rubber, cotton, groundnut, soybeans, gum arabic etc. The following have been achieved

- Over 2,460 kg of foundation seeds has been produced by the project to the Research Institutes and out growers respectively.
- The Seed Certification and Quality Control Programme of NSS tested a total of 2,425 seed samples in 1996.
- Rehabilitation of seed testing laboratories and seed processing plants at NSS Jos, Ibadan, Zaria and Umudike has been completed.
- Under the Community Seed Development Programme, demonstration plots were set up to create awareness of modern varieties of maize, cowpea, sorghum, rice and soybean and to offer easy access good seeds produced by the contract grower.

There is an enormous potential in Nigeria through development of irrigation for higher yields, which could possibly be achieved by advances in biotechnology through development of higher producing, pest and drought resistant crops. However, seeing the present state of affairs, there is little likelihood of a substantial breakthrough. Only comparatively small advances in the order of five to ten percent may be expected.

The Strategic Reserve Scheme

The objective of the Strategic Grains Reserve Scheme at its second inception is to undertake the storage of excess grains in the market during the harvest and to release some when prices are high in the market thus stabilising the price and making grains available all year round. Of the thirty-three (33) medium and large scale silos commissioned for construction, seven (7) have been completed. At present, there is gross under-utilization of these silos due to lack of available grains for storage. Only 3 of the silos contain grains. Measures have been taken to restore the storage efficiency of the silos in the 1997 season and beyond. Steps are also being taken to ensure high production of grains and minimize illegal export arid smuggling across the border. Direct purchase for farmers is expected to bring about increase in the quantity of grains reaching the silos.

Community Adaptation

Diversification and Indigenous Knowledge Skills

Besides, the efforts of the government, non-governmental organizations and community groups have contributed in ameliorating the impact of drought on food production. The local people have adopted indigenous intelligence in dealing with the problem as earlier cited from Iloeje (1975) on the pastoral transhumance pattern among the Fulani herdsmen in Nigeria. Ayeni (2004) describes some adaptive capacity measures that could be taken. Among the poor, coping strategies change as vulnerability varies, since some groups are more lacking in financial, social and political means of securing alternative lower-risk livelihoods than others. Pastoral communities in Nigeria have developed several coping (short term response to stress) and adaptive (long, multi-year stress) strategies. Several major strategies, such as livestock mobility, livestock marketing and livelihood diversification, show features of both coping and adaptive strategies. It is these that are most likely to be sustainable in the long term.

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