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RESEARCH ARTICLE

CLIMATE CHANGE: EFFECTS ON AGRICULTURAL GROWTH AND RURAL TRANSFORMATION IN NIGERIA

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ABSTRACT

Agriculture is one of the key sectors of a country's economy and the linchpin of rural development. Essentially, seventy-five (75%) of world's rural population which lives in rural areas depend on agriculture for their livelihood. Hence, Agricultural growth is a crucial factor for inclusive growth and helps in raising rural income and purchasing power. However, agriculture in the rural areas is highly at the mercy of climatic parameters principally rainfall, which makes it critically vulnerable to climate change. Anchoring on exploratory research method and considerable reliance on secondary sources of data, the paper probes in-depth the nexus between climate change and agricultural development cum rural transformation. The mainspring of this article is to analyse the effects of climate change on the role of agriculture in rural development in terms of food production, reduction of poverty and hunger, creation of jobs and exports. To sum up, the paper contends that agriculture should be accorded its prime position in the national economy. It calls for concerted and informed efforts by government to create the enabling environment for Climate Change mitigation, agricultural development and rural transformation, especially in terms of policy formulation, articulation and implementation that would eventually enhance the living conditions of the rural dwellers.

INTRODUCTION

Unreservedly, agriculture offers enormous promise for Africa. It plays a key role in overall economic growth, by providing labour, capital, food, foreign exchange, and market in consumer goods for the nascent industrial sector in a low income country (Frank and Stephen, 2001). According to the African Development Bank(ADB) (2000),64% of Nigerians are employed in the agricultural sector, 13% in industry and 23% in the services sector. Hence, agriculture is the life wire and the back bone of the Nigerian economy.Numerous studies show that GDP growth generated by agriculture is more than twice as effective in reducing poverty as growth in other sectors. For instance, it was reported in Hazell and Haddad (2000) that a 1% addition to the agricultural growth rate in India stimulated a 0.5% addition to the growth rate of industrial output, and 0.7% addition to the growth rate of national income.Correspondingly,Gallup, Radelet, and Warner (1997) find that a 1% increase in agricultural GDP leads to a 1.61% increase in the incomes of the poorest quintile, while the corresponding values for the manufacturing and services sectors are only 1.16% and 0.79%. Further more,Singh (1990); Frank and Stephen (2001) and Xavier, Lin, Colin, and Steve (2001) opined that without agricultural growth in rural areas, redressing poverty would be an impossible task. Notably enough, greater percentage of the total population lives within the rural environment and further much greater percentage of them are involved in rural economic activities,mostly agriculture. Hence, Nigeria is predominantly an agricultural economy, for several years her economy swivelled on agriculture; and no doubt over 50% of the entire labour force are engaged in agriculture (Akaahan and Ngutsav, 2004). However,in the recent past, agriculture, which accounted for about 80% of the government's revenue dwindled and became over shadowed by the oil sector. For instance, the contribution of the oil sector to total exports rose from 57.6% in 1970 to 97.2% in 1986. In terms of government revenue, the oil sector accounted for 26.5% in 1970 while in 1987, it rose to 75.2% (Ogboru, 2004).

Admittedly, the small scale farmers,which constitute the majority of the farming population have high vulnerabilty to climate change and poor adaptive strategies. In addition, the peasants, who have not effectively and efficiently tapped the numerous abundant rural resources, have chosen to remain in their culture and despite their rural character; those population have been increasingly affected by decisions and activities which occur in small but growing urban centres in the country.

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Besides, the collapse of prices in the international oil market in the early 1980s led to recession and economic deterioration as manifested by financial and external debt crisis,high rate of unemployment, negative economic growth, persistent current account and budget deficits, a huge backlog of uncompleted projects, large scale retrenchment, acute shortages of essential commodities and galloping inflation (Ogboru, 2004). Hence, there have been persistent clarion calls to revamp the agricultural sector which is considered a panacea to the recent economic downturn facing the nation. In view of the foregoing, this study intends to examine the impacts of climate change on agriculture and rural development by answering the following questions:

I. How important is agricultural growth in alleviating rural poverty?
II. To what extent can we rely on agriculture as the engine of rural development?
III. To what extent does climate change impact on Agricultural Development?
IV. What are the right approaches to agricultural transformation?
V. How can the government create an enabling environment for rural transformation?
VI. What strategies can be adopted to mitigate climate extremes among smallholder farmers?

To construct answers to the preceeding questions,this paper is organised as follows

I. Conceptual framework
II. Materials and Methods
III. Impact of Climate Change on Agricultural Development
IV. Effects of Agricultrural Growth on Rural Poverty Reduction
V. Agricultural Development Strategies under a Changing Climate
VI. Results and Discussions
VII. Conclusion

Conceptual clarifications

For the avoidance of doubt and misinterpretation, it has been deemed essential to elucidate the basic concepts in the paper. The objective is to provide empirical coherence for the reason that concept may have both cultural and ideological contextualization. Hence, this article provides conceptual framework for four major concepts namely Rural, Rural Development, Agricultural Growth and Climate Change

Rural

For the purpose of epistemological clarity, it is worth mentioning that the term 'rural' is undeniably ambiguous owing to the great eclecticism of places recognized as rural (Caroline and Simon, 2001). Similarly, Dakare (2004) pointed out that the word 'rural' is manifested in economic, sociological, Psychological, ethnic, racial and geographical forms. He further stressed that urban peoples are generally non-agricultural while ruralists are predominantly agricultural. Hence, the word 'rural' means agriculture and other occupations such as trades and crafts carried on in the rural areas. In addition, Yusuf and Ukoje, (2010) observed that rural areas are the non-urbanised places where the dominant livelihood activities are agriculture. In their conception, agriculture is not considered synonymous with rural areas but rather a reflection of the fact that agriculture is most peculiar to rural life in Nigeria. Subscribing to the foregoing, Steve and Proctor (2001) stated that there is no exact definition of the term 'rural', but that rural areas are 'clearly reconisable'.They constitute the space where human settlement and infrastructure occupy only small patches of the landscape, most of which is dominated by fields and pastures,woods and forests, water, mountains and deserts .Likewise, International Fund For Agricultural Development (IFAD)(2001) added that rural people usually live in farmsteads or settlements of 5-10,000 persons, but also makes the point that 'national distnctions between rural and urban are arbitrary and varied.Besides, Alinno *et al.,*(2012) opined that the term rural has been technically taken to signify any area of underdevelopment, poverty and thin population whereas Umebali and Akubuilo (2006) itemised the key features of a rural community to consist of:

1. Vicious Cycle of poverty
2. Poor Infrastructure
3. High Population Density
4. High Level of Illiteracy
5. Low Social Interaction and Local Politics
6. Rural-Urban Migration

Rural development

The meaning of rural development has been the subject of much deliberation and diminutive agreement. The definition of rural development varies from one point of view to the other. For instance, some scholars like Haddad (1990) and Hinzen (2000) conceived rural development from the aspect of Education and Training.Uchendu and Michael (2013) viewed it as any effort made at improving the lives of people and environment in rural areas. Consequently, the definition of rural development may be centred on income measure in which the concept is tailored towards addressing the issue of rural poverty. Besides, it may be defined in sociological conception wherein the rural poor embodies a reservoir of unexploited talent; a target group duty bound to enjoy the benefits of development through improved education, health and nutrition. This is one of the most central definitions of rural development as the provision of social infrastructures could provide the catalyst that would transform the rural areas (My Agriculture Information Bank, 2011). Subscribing to the preceding, Moseley (2003) and Chigbu (2012) opined that Rural Development generally refers to the process of improving the quality of life and economic well being of people living in relatively isolated and sparsely populated areas. On the other hand, Rural Development may also be seen as an ideology and a practice. It may mean planned change by public agencies based outside the rural areas such as the national Government and International organization; It may also be the bringing of the countryside into an active state, as well as the transformation of the inferior nature of the country

side into something more superior in terms of activities (Nchuchuwe and Adejuwon, 2012). However, Moseley (2003) remarked that rural development should be characterised by its emphasis on locally produced economic development strategies i.e the local populations should be encouraged to also bring about endogenous initiatives for development.This has given rise to approaches like bottom-up, Participatory Rural Appraisal (PRA), Rapid Rural Appraisal (RRA) etc According to Van der Ploeg *et al.* (2000) rural development is reconstructing the eroded economic base of both the rural economy and the farm enterprise…(and) represents the well understood self-interest of increasing sections of rural population.Hence rural development guarantees the reconstruction of the rural society and the evolution from its traditional remoteness to integration with the national economy.

It is to be noted at this juncture that Rural Development is not synonymous with Agricultural Growth or development.Rural development though leads to agricultural growth but transcends above it. Indeed, Successive governments miscontrued rural development for agricultural development,hence their efforts to pump money into agricultural development did not yield the meaningful change desired. Therefore, Oigidefa (2010) opined that for meaningful rural development to take place, efforts should be made to include provision of modern infrastructure, primary health care,food and shelter,employment opportunities,recreational facilities, affordable and compulsory primary and secondary education, loans and other incentives for the benefit of rural dwellers. On the other hand, Olayiwola and Adeleye (2005) construe rural development as a broad based re-organisation and mobilisation of the rural masses in order to enhance their capacity to cope effectively with the daily task of their lives and with changes consequent upon this.The foregoing analysis asserts that rural development is not an immediate and snap phenomenon but a gradual and progressive towards perfection having a set standard in mind.

Agricultural growth

Agricultural growth or development is a subset of economic development.According to Nchuchuwe and Adejuwon (2012), It implies a sustained increase in the level of production and productivity over a reasonable length of time and the subsequent improved wellbeing of farmers as reflected in their higher per capita income and standard of living.They reiterated that Rural development relates not only to a sustained increase in the level of production and productivity of all rural dwellers, but also leads to a sustained physical, social, and economic improvement of rural communities. In a similar vein, Dakare (2004) remarked that agricultural development is a continuous process of making concious and systematic attempts to utilize the agricultural resources of a nation in order to benefit agricultural workers and farmers in particular and the entire population in general. He restated that in the developing or less developed countries of the world,the process of agricultural development is held to be synanimous with the process of transformation, that is, the structural change of an economy from pristine agricultural subsistence to investment-dominated agriculture. It is in view of the preceding that Famoriyo (1979) construed agricultural development as a modernisation process.

Climate change

Climate change is undoubtedly one of the greatest outstanding challenges fronting the global community. Hence, various authors or authorities have given diverse definitions to this concept according to their perception and the way it affects them.Thus, the Intergovernmental Panel on Climate Change (2007) defines climate change as statistically significant variations that persist for an extended period,typically decades or longer.It includes shift in the frequency and magnitude of sporadic weather events as well as the slow continuous rise in global mean surface temperature. Accordingly Elvis-Imo (2010) defined climate change as any long term change in statistics of weather over periods of time, ranging from decades to millions of years.Additionally,Climate change is defined in the article 1 of the United Nations Framework Convention on Climate Change(UNFCCC) (1992) as 'a change of climate which is attributed directly and indirectly to human activity that alters the composition of the global atmosphere and which in addition to natural climate variability observed over considerable time periods'. Adesina (2009) posited that the climate change phenomenon had already manifested through increases in dust and rain storms,floods and above average daily minimum and maximum temperatures; intra and inter annual rainfall variability in northern Nigeria.Further more, Ifanyi-Obi *et al.* (2012) remarked that scientists have noted that the average temperature of the earth has increased by 0.74 degrees Celsius over the past hundred years. And if not combated, there is going to be additional upsurge in the earth's temperature to the level that it will be dificult to manage with. However, the Nigerian Meteorological Agency as the agency charged with the responsibility of providing climate information has affirmed that Nigeria's climate is already changing.The report noted the following changes in climatic condition of Nigeria over the past 59 years:

I. Between 1941 and 2000, annual rainfall decreased by 2.8 mm across most of the country, but increased by 2.4 mm in a few places especially in Port harcourt
II. There was evidence of long-term temperature increase in most parts of the country.The main exception was in the Jos area,where a slight cooling was recorded.
III. The most significant increases were recorded in the extreme northeast(Maiduguri), extreme northwest(Sokoto) and extreme southwest (Ibadan), where average temperatures rose by 1.4-1.90C.

There is no gainsaying the fact that the disruptions in climate patterns in Nigeria have already led to frequent drought, desertification and flooding which is now a common occurrence in most states in Nigeria.

MATERIALS AND METHODS

Study Area

Nigeria is a federation of thirty-six(36) States and a Federal Capital Territory. It has an area of 923,768 square km ennclosed within longitude 3^0 and 15^0 East of Greenwich meridian and Latitude 4^0 and 14^0 North of the Equator and a

population of approximately 140 million, growing at 2.4% per annum. Nigeria is the most populous country in Africa accounting for about 47% of west Africa's population. Although, it is endowed with enviable land resource, about 70%-80% of the land area lie within the rural areas where the major activity is agriculture, which is highly vulnerable to climate change. Nigeria has diverse ecosystems; extending from mangroves and rainforests in the south to the savannah in the north. Admittedly, these ecosystems are sternly confronted with global warming ensuing undue flooding hampering farming activities in coastline communities, while desertification is devastating the sahel. Though,desertification in the sudano-sahelian region had been absolutely attributed to overgrazing by herders, in the recent time, it has been discovered that the actual problem is climate change. Consequently, the livelihoods of the vast population of people are greatly hampered.There is no gainsaying the fact that the previously poor are becoming more impoverished creating a situation of Climate refugees (Abdullahi *et al.,* 2013) The South is defined by its tropical rain forest climate, where annual rainfall is between 60 and 80 inches per year. The North has almost desert-like climate where rainfall is less than 20 inches per year. The rest of the country between the North and the South is savannah, with annual rainfall between 20 and 60 inches per year (Nation Master, 2009).

Methods

The study employs time series data extending from 1980 to 2005 and Descriptive Statistics. It aligned with previous researches that attempted to assess the impact of climate change on agriculture through exploratory research. The types of data used for the study include:

1. Trend of Nigeria Agricultural output and crop production were sourced from Federal Bureau of Statistics (FBS) and Food and Agricultural Organization (FAO) Publications
2. Reports of Nigeria House Committee on Agriculture were sourced from Federal Bureau of Statistics (FBS)
3. Data on Federal Budget and Actual Expenditure on Agriculture and Share of Agricultural Sector in Federal Capital Budget were sourced from the Central Bank of Nigeria (CBN) bulletin.
4. Rainfall and Temperature records were obtained from Nigeria Meteorological Agency (NMA).

The time series was used to analyse the trend of rainfall and temperatures. The rainfall pattern was depicted using histogram, while trend lines were used to depict the slope of the rainfall and temperatures. The Share of Agricultural Sector in Federal Capital Budget and the Trend of Nigeria Agricultural output were depicted using the frequency distribution curve.

Effects of agricultural growth on rural poverty reduction

There is no gainsaying the fact that both theorectical deductions and the experiences of countries in the developing regions have shown clearly that poverty reduction is a function of agricultural growth.According to World Bank(2007), growth originating in agriculture could be up to four times as effective in reducing poverty as growth from other sectors of the economy.Hence, it is to be noted that the causal chain between agriculture and poverty is resilient.Correspondingly,Eric, Moses, and Oliver(2012) opined that higher incomes from agriculture and access to cheaper food have helped hundreds of millions of people move beyond the US$1 per day poverty line.For example,China,Vietnam,Brazil and Thailand have experienced substantial agricultural growth over the last three decades with corresponding decline in poverty.Particularly, approximations indicate that Vietnam and China took 40% of their population out of poverty in 10 years, as a result of aggressive agricultural investment and growth.In China, poverty dropped from 33% to 17% between 1990 and 2001 and in India from 42% to 35% (Eric, Moses, and Oliver, 2012).Additionally, Thirtle *et al*(2001) established from cross-country regression analysis that, on average every 1% increase in labour productivity in agriculture reduced the number of people living on less than a dollar a day between 0.6 and 1.2%. In actual fact, no other sector of the economy shows such a strong correlation between productivity gains and poverty reduction.Hence, it is to be noted that agricultural productivity has undoubtedly been the most central factor in determining the speed and extent of poverty reduction during the past 40 years.However, most of these indications are derivative of Green Revolution in Asia.

According to Central Bank Of Nigeria (CBN) (2008), in Nigeria, economic growth has largely been accounted for by resilient agricultural growth.Similarly, the Nigeria vision 2020 First Implementation Plan for the period 2010-2013 stated that the agricultural sector contributed 73% of GDP growth over the period 1999-2009. With real growth averaging about 7% per annum from 2004-2008, and value added to the tune of 42% of Gross Domestic Product (GDP) within the same period.Admittedly, the agricultural sector in Nigeria is conspicuously the most dominant and leading component of economic growth.

Impacts of climate change on agricultural productivity

Climate Change is perhaps the most serious environmental threat to the fight against hunger,malnutriton, disease and poverty in Africa mainly through its impact on agricultural productivity (Enete and Amuse, 2010).According to Ziervogel *et al.* (2006) Climate Change, which is attributable to the natural climate cycle and human activities has adversely affected agricultural productivity in Africa.Similarly, Nwafor (2007) and Jagtap (2007) remarked that Climate Change is global like wise its impact but most adverse effects will be felt mainly by developing countries especially those in Africa,due to the low level of coping capabilities.In reality, Climate Change can affect different agricultural dimensions, causing losses in productivity, profitability and employment (Maria *et al.,* 2013). This according to Sanchez (2000) and Siwar *et al.* (2013) has obviously endangered food security owing to the instability of crop production, and induced changes in markets, food prices and supply chain infrastructure.Hence, Paehler (2007) noted that alteration of global rainfall patterns would have adverse effect on the agricultural sector, causing devastating socio-economic consequences owing to the fact that 40% of the African Gross National Product is obtained in

Agriculture and 70% of all African labour is employed in this sector.

Agricultural development strategies under a changing climate

The current effects of climate change necessitate the individuation of mitigation policies to lessen green house gas emmissions and find suitable adaptation strategies that aim at curbing agricultural losses both in market goods and environmental services (such as protection of biodiversity, water management, landscape preservation etc.) (Maria *et al.,* 2013). The term Adaptation is a reference to modifications in practices, processes or structures in response to projected or actual changes in climate with the goal of sustaining the capability to deal with current and future changes (Dixon, 2003). It can also be seen as measures taken to reduce the vulnerability of natural and human systems against climate change effects. Consequently, International Fund for Agricultural Development (IFAD 2010) remarked that the international community has agreed on four building blocks of response to climate change. They are adaptation, mitigation, technology and financing. Adaptation includes all activities that help people and ecosystems adjust to and reduce their vulnerability to the impact of climate change. There is no universal way to adapt; specific measures need to be tailored to specific contexts. Traditionally, agriculture has adapted to climate variations. Today, unsustainable land practices are no longer viable. Good adaptation strategies must build on sustainable development. Mitigation aims to reduce greenhouse gases or enhance the ability of nature, in particular forests, to absorb them. Poor rural people can play an important role in climate change mitigation by using better agricultural practices and by promoting forestry activities that contribute to carbon absorption. But governments need to put policies and the right incentives in place to make this happen. Technology has a significant role to play in tackling the causes of climate change and helping people adapt to its impact.

We can develop new, cleaner technologies and breed plants and animals more able to tolerate climate variability. A major push in research and development, and information exchange and training, is needed to create farming systems that are more resilient to climate change, as well as new technologies to sequester carbon. Financing the response to climate change will cost billions of dollars and involve massive shifts in investment patterns across a huge range of sectors, from power generation to agriculture and forestry. New finance is essential because the reality is that climate change is making development more costly. However, neither adaptation nor mitigation alone can offset all climate change impacts. To respond to this threat it will be necessary to focus both on mitigation, to reduce the level of emission of gases contributing to global warming, and on adaptation, to support local communities in dealing with the impacts. (Eboh,2009; Ozor and Cynthia, 2010).

Hence, Table 1 shows adaption measures that could complement mitigation efforts.

RESULTS AND DISCUSSION

Trend of Agricultural Productivity

The research has disclosed that there are constantly higher rates in agricultural productivity between 1981 and 1995 in the study area (Fig. 1). This may be traceable to the structural adjustment programme (SAP) in Nigeria which began around 1986. This was perhaps attained by means of a more growth rate in capital expenditure in favour of agriculture than the rate in other sectors of the economy. Furthermore, Figure 1 suggests that a much lower rate was experienced in agricultural productivity in the 1996–2000 sub periods, which may be attributed to climatic factors climatic factors, changes in political views, and unrest observed in some parts of the country (Ayinde, 2010).

Table 1. Adaptation measures for rural areas

Source: (Christineand Heike 2011)

	Technical/agro-ecological	Agro-political	Socio-political	Institutional
NATIONAL/POLICY LEVEL	.National Research and Extension on Multisectoral implementation of adaptation and of decision- making under uncertianty. .Expansion of Meteorological research and extension. .Improving public access to weather and climate information. .Investment in early warning systems. .Expansion of Conservation areas	.Investment in rural marketing infrastructures-roads,markets,market information systems. .Expansion of agricultural Extension systems to include climate know-how .Investment in strategic food reserves and post harvest technologies.	.Expansion of public healthcare .Public investment in rural education,especially for women and girls. .Expansion of social security systems .	.Good governance and anti-corruption measuresin connection with administration international adaptation funds .Decentralisation to stregthen local adaptation and decision making capacities. .Implementation of National Adaptation Programme of Action(NAPAs)
LOCAL/ FARM LEVEL	Breeding of adapted varieties .Sustainable water management .Expansion of land under irrigation .Conservation of soil fertility and water storage capacity. .Anti-erosion measures .Sustainable land management .Agro-forestry systems and afforestation .Composting of organic matter .Rain water harvesting	Decentralized post-harvest protection .Expansion of agricultural finacial services .Introduction of rural insurance systems(e.g. weather-based harvest insurance)	.Support the creation of social capital at local level,e.g. by promoting social or ecological services. .Expanding social security systems such as safety Nets for the most vulnerable population groups .Investment in education, especially for women and on issues of agriculture and climate ecology.	.Community involvement in implementation of National Adaption Programmes of Action(NAPAs) .Decentralized disaster management schemes .Involvement in resource conservation at community level.

Table 1. Federal budget and actual expenditure on Agriculture (Billion)

Fiscal year	Budget	Actual Expenditure
2001	17,575	15,916
2002	16,509	9,521
2003	14,908	8,917
2004	12,725	10,768
2005	11,516	11,847
Average	1.78%	1.67%

Source: Mogues et al. (2008)

Table 1 shows the budget and the actual expenditure of Nigerian government on agriculture between 2001 and 2005. The table reveals that the highest actual expenditure was in 2001. This was followed by a decrease between 2002 and 2003and an increase again in 2004 to 2005. The average actual expenditure for the five years was 1.67%. It can be deduced from the preceding that government's spending on agriculture is still low for the country to achieve appreciable growth in agriculture.

Table 2. Crop production in Nigeria from 2003-2005 (million tonnes)

Crop	2003	2004	2005	% Growth
Maize	8,685.1	9,503.4	10,369.6	19.4
Millet	6,561.1	6,963.3	7,394.7	12.7
Sorghum	9,460.8	9,994.4	10,593.6	12.0
Rice (Paddy)	3,520.3	3,713.9	3,929.4	11.6
Plantain	1,096.0	1,161.5	1,246.7	13.8
Potato	1,442.1	1,528.3	1,640.4	13.7
Yam	25,073.3	26,700.2	28,521.8	13.8
Cassava	31,698.1	33,393.	36,057.8	13.8
Cocoyam	2,350.5	2,407.0	2,479.2	0.5
Cowpea	4,210.7	4,328.3	4,462.2	0.6

Source: National Bureau of Statistics

Table 2 shows selected crops produced between 2003 and 2005. It has revealed that plantain was the lowest crop produced in 2003, though with higher growth rate (13.8%). Cassava production on the other hand was the highest 31, 698.1 million tonnes with highest growth rate of 13.8% to year 2005, followed by yams, millet, maize, cow-pea and rice. This confirms the submission of Odjugo (2009) who noted that climate change has led the farmers to a shift in crops cultivated in northern Nigeria. The preferred crops grown are guinea corn followed by groundnut and maize, but due to increasing temperature and decreasing rainfall amount and duration occasioned by climate change, the farmers as a means of adaptation in 2007 shifted to the production of millet followed by maize and beans (Odjugo, 2009).

Similarly, Climate change has also caused reduction of arable lands cultivation in Nigeria. While the sea incursion is reducing the arable land of the coastal plains, the desert encroachment with its associated sand dunes is depriving farmers of their agricultural farmlands and grazing rangelands. Moreover, the frequent droughts and lesser rains have started shortening the growing season thereby causing crops failure and food shortage Accorging to Odjugo and Ikhuoria, (2003); Ayuba *et al.* (2007), it has been noted that drought, desert encroachment and coastal inundation have started affecting the country's ecosystem leading to ecological destabilization due to climate change impact in the semi-arid region of Northern Nigeria. Therefore, it is imperative to note that developments of agricultural technologies that are environmentally sensitive are panacea for sustainable and improved agricultural productivity in Nigeria. While new agricultural technologies that increase soil nutrient and do not contribute to change in climate should be encouraged, irrigation should also be given top priority especially the drying areas in Nigeria in order to maintain stability of supplied agricultural produce.

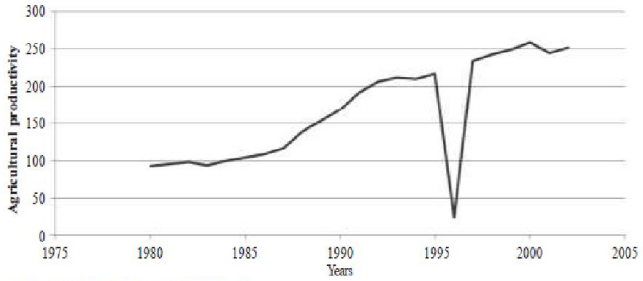

Fig. 1. Agricultural productivity index trend

Trend of Annual Rainfall

There is no gainsaying the fact that rainfall variability (inter-annual) and unreliability occurred in the country especially during the years studied. The period of 1990-1995 experienced the lowest of 693.64 mm while the highest is 1478 mm experienced around 1980. The mean rainfall is 1080.76 mm. This implies there is evidence of climate change especially since 1985. Figure 2 reveals the variability in this climate variable (rainfall).

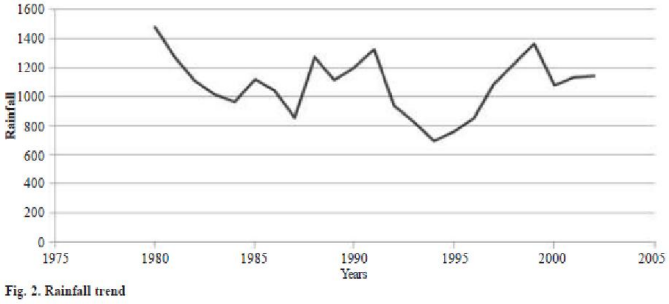

Fig. 2. Rainfall trend

Trend of Annual Temperature

The average temperature during the study period is 26.30C, while the maximum and the minimum are 26.940C and 25.060C respectively. Figure 3 indicates that temperature is relatively irregular. There is a sharp reduction in the annual temperature in year 1992 and since then it has been experiencing unsteady trend. There is variation in the temperature variable.

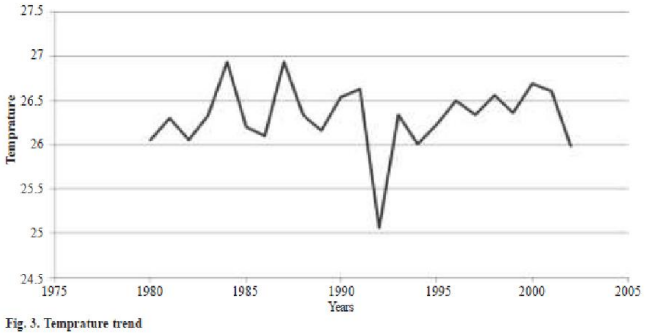

Fig. 3. Temprature trend

Conclusion

The study shows clearly that there is variability in Nigerian rainfall and temperature. The study has also established that the change in climate has significant effects on agricultural productivity. This is apparently shown in the rainfall variables. However, temperatures seem not a crucial climatic variable in determining agricultural productivity in Nigeria economy.

Recommendations

From the preceding, the following recommendations are hereby given

1. Nigerian government ought to give agriculture precedence (60%) over other sectors of the economy in view of its overwhelming benefits to the country's economy.
2. The on-going climate change effect can be abated if policy is meaningfully geared toward mitigation.
3. Agricultural productivity can be increased and sustained by developing agricultural technologies that are environmentally sensitive and friendly.
4. Agricultural innovations that increase soil quality and nutrients, but do not contribute to change in climate should be encouraged.
5. Owing to the fact that preceding year's climatic fluctuations affect the current productivity, recycling of this important climate factor (rainfall) should be encouraged in Nigeria in order to maintain a steady supply of agricultural produce.

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