Assessment of the Effect of Temperature and Rainfall in Agriculture in Nigeria

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Abstract

The average annual temperature and rainfall data for four Agro-ecological zones in Nigeria were analyzed to ascertain their effects on the Nigerian Agricultural sector. The average annual temperature and rainfall data sets for Calabar, Ibadan, Enugu and Maiduguri which were obtained from the Nigerian Meteorological Agency (NIMET), Oshodi, Lagos and the National Bureau of Statistics (NBS) were compared with the Nigerian Agricultural Productivity data from the Central bank of Nigeria Statistical Bulletin, 2006 from the year 1980 to 2005, using the Trend Analysis method of data analysis. It was discovered that the trends from the average annual temperature in the four zones were uniform or constant over the years from 1980 to 2005 (i.e. ranging between 22˚C and 33˚C). When this temperature trend was compared with the Agricultural Productivity trend within the same period, it was clearly seen that the average annual Temperature has no effect on the annual Agricultural productivity in Nigeria. When the average annual Rainfall trends in the four zones from 1980 to 2005 were compared to the Agricultural productivity trend within the same period, there was a correlation between the two variables. This shows that, rainfall has significant effects on the Agricultural Productivity in the country. Areas located in the Southern part of the country which experience more rainfall have increased productivity in crops while the average annual rainfall values increased. Livestock productivity increased as the amount of rainfall reduced in the Northern region (Maiduguri).

Keywords

Meteorological parameters, climate, weather, statistical analysis, Nigeria.

I. INTRODUCTION

Climate is the average weather condition of a particular place over a long period of time, while weather is the condition of the atmosphere at a particular place over a short period of time. There are several elements that make up the climate and weather of a place. The major of these elements are: temperature, pressure, humidity, wind, and rainfall. In this work, the elements of most interest are rainfall and temperature.

In the coming decades, the World will experience higher temperatures and changing precipitation levels said a growing consensus in the scientific literature. The effects of these would result in low agricultural products. [1], [2] and [3] says research has shown that Climate change is already affecting crop produce in a lot of nations. [4], [5] said this is particularly true in low-income Countries, where climate is the primary determinant of Agricultural productivity and adaptive capabilities are minimal. [6] Many nations in Africa, which have their economics based largely on weather-sensitive agricultural productions systems like Nigeria, are particularly vulnerable to climate change

. The accelerating pace of climate change combined with global warming looms food security everywhere including Nigeria, and agriculture is very weak to climate change. While encouraging weed and pest proliferation, higher temperatures eventually reduces yields of desirable crops. The likelihood of short-run crop failures and long-run production declines as a result of increasing changes in precipitation (rainfall) patterns. Even though, there will be gains in some crops, in some regions of the world, be it as it may, the overall impacts of climate change on agricultural productivity are likely to be negative, threatening food security.

The various prolonged droughts that are currently experienced in some Northern regions and the devastating effects of recent flooding in the Niger Delta region of the country demonstrate this vulnerability. Thus, for a vast number of poor nations like Nigeria that are highly vulnerable to effects of climate change, it is crucial to understand farmers' responses to climatic variation, as this will help in designing appropriate coping strategies [7].

The release of greenhouse gases into the atmosphere is possibly, the most severe human have started to show the reality of the impact of climate change on agricultural development. These wide-ranging effects on many sector of human societies has been documented by a substantial body of research [10], [11].This work focuses on the effects of the variability of temperature and rainfall on agricultural productivity in Nigeria. This work tries to measure the relationship between the variability of rainfall and temperature in some major agro-ecological zones with the total crop and livestock productivity.

impact of climate change. [8], [9], stated that signs

II. AGRICULTURAL PRODUCTIVITY IN NIGERIA

Nigeria is made of 36 states and the Federal Capital Territory (Abuja), with six geopolitical zones namely the South-West, South-East, South-South, North-Central, North-East and North-West region. The North West is the highest populated zone with 25%, while the South East is the least populated with 9.7%. The country also has a very assorted agro-ecology characterized by numerous farming systems including Pastoral, Agro-Pastoral (millet/sorghum), Irrigated, Cereal-Root Crop Mix, Highland Temperate Mix, Root Crop, Tree Crop, and Coastal Artesian Fishing [12] as revealed in Table1.

Table 1: The Nigerian Agro-Ecological Zones by Regions

Region	States	Population (millions)	Agro Ecological Zones	Major Crops
North Central	Nasarawa, Niger, Plateau Benue, FCT, Kogi, Kwara,	20.4	Southern Guinea savannah, Derived savannah, woodland and tall grass savannah	Groundnut, Yam, Soya Maize, Rice, beans, etc.
North East	Borno, Gombe, Adamawa, Bauchi, Taraba, Yobe	19.0	Southern Guinea savannah, Northern Guinea savannah, Sudan savannah, Sahel savannah, marginal savannah, short grass savannah and montane.	Millet, Groundnut, Cowpea, Sorghum, etc.
North West	Sokoto, Jigawa, Kaduna, Katsina, Kano, Kebbi, Zamfara	35.9	Sudan savannah, Southern Guinea savannah, Sahel savannah and short grass savannah	Soya beans, Cotton, Sorghum, Millet, Cowpea, etc.
South East	Enugu, Imo, Abia, Anambra, Ebonyi.	13.5	Derived savannah, High forest, woodland and tall grass savannah and rainforest.	Coco Yam, Cassava, Oïl palm, Melon, Rice, etc.
South South	Bayelsa, Akwa-Ibom, Cross-River, Delta, Edo, Rivers	21.0	Derived savannah, High forest, Mangrove and fresh water swamp.	Cassava, Yam, Maize, Melon, etc.
South West	Lagos, Osun, Ekiti, Ondo, Ogun, and Oyo	27.7	Rainforest, Derived savannah, and Mangrove.	Cassava, Coco Yam, Maize, yam, Melon, etc.
Nigeria	36 States + FCT	140.4		

Sources: [13], [14]

III. MATERIALS AND METHODS

A) *Data sources*

The data used for this project are purely secondary data gathered from National Bureau of Statistic (NBS), Nigeria Meteorological Agency (NIMET) and Central Bank of Nigeria Statistical Report, Volume 17, 2006.

B) *Trend Analyses*

Trend analysis is the act of gathering information and trying to spot a pattern in the information. It is often used to predict future events. Trend analysis can be used to estimate uncertain events in the past.

In statistics, trend analysis is often referred to as techniques for extracting an underlying pattern of behavior in a time series which would otherwise be partly or nearly completely hidden by noise. These techniques are known as trend estimation, which can be undertaken within a formal regression analysis [16].

C) *Trend of annual rainfall data*

The time series plot in Figure 2 shows that the annual rainfall values reduced from Calabar to Enugu to Ibadan to Maiduguri. From Table 3, the highest rainfall from 1980 to 2005 for Calabar was 3900 mm, while the least rainfall was 2520 mm. its average is 3210 mm. In Ibadan, the highest rainfall was 1980 mm, while the least rainfall was 750 mm. Its average is 1365 mm. In Maiduguri, the highest rainfall was 800 mm, while the least was 300 mm. Its average is 550 mm. In Enugu, the highest rainfall is 2090 mm, while the least is 913 mm. Its average is 1501.5 mm.

The rainfall trend for the three southern states follows almost the same pattern. For Calabar, there is a decrease from 1980 to 1983, and then it maintained an average value of 2800 mm between 1984 and 1993 before there is an increase from 1993 to 1995. For Ibadan, the pattern is almost the same as for Calabar. It has a sharp decrease occurring from 1980 to 1982, and then has three other prominent sections of the plot which occur between 1983 and 1992, 1993 and between 1995 and 1997. For Enugu, the trend shows a sharp decrease from 1980 to 1983, then it has about four peaks occurring at 1984, 1990 and 1995, then it became constant from 2000 to 2005. For Maiduguri, the rainfall trend decreased gradually from 1980 to 1994 and became constant from 1995 to 2005. The rainfall values are very low compared to the other three southern agro-ecological zones.

IV. RESULTS AND DISCUSSION

A) *Trend of Yearly Temperature Data*

The mean annual temperature trend for the four stations is shown in Figure 1. The temperature of four trends is almost constant with little variations and the values occur within the range from 27.3˚C to 30.4˚C. Maiduguri had the highest average annual temperature values, followed by Calabar, Ibadan and Enugu. There is a slight noticeable increase in the trend around 1998 for Enugu and a noticeable increase in the temperature trend in Ibadan from 1990 to 1994. Maiduguri, the highest temperature from 1980 to 2005 was 31.6˚C, while the least temperature was 29.2˚C. The average is 30.4˚C. In Ibadan, the highest temperature was 28.7˚C, while the least temperature was 25.9˚C. The average is 27.3˚C. For Calabar, the highest temperature was 29.9˚C, while the least temperature is 26.7˚C. The average is 28.3˚C.

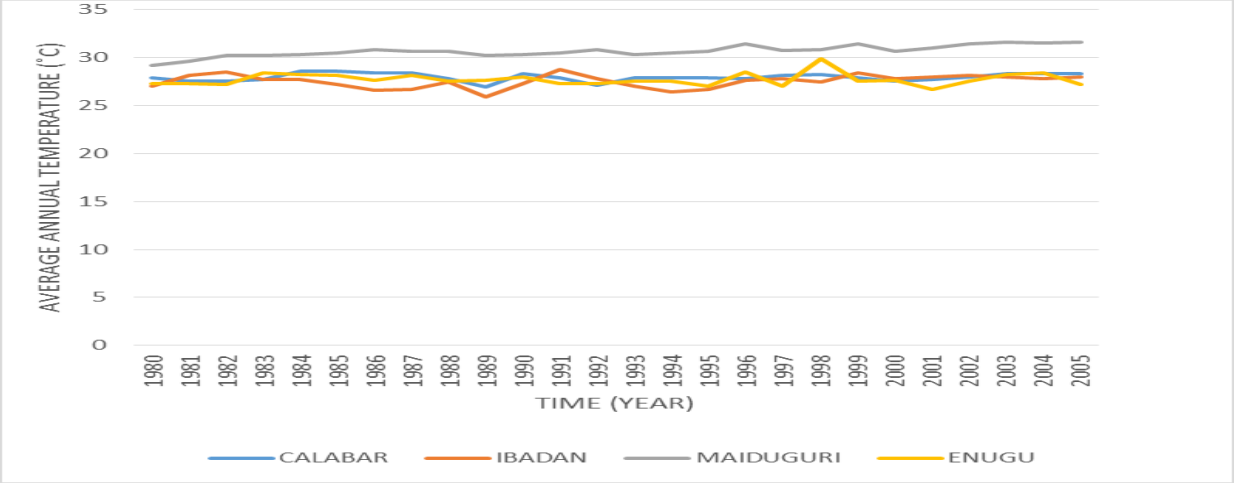

Fig.1: Time series plot for temperature data from 1980 to 2005

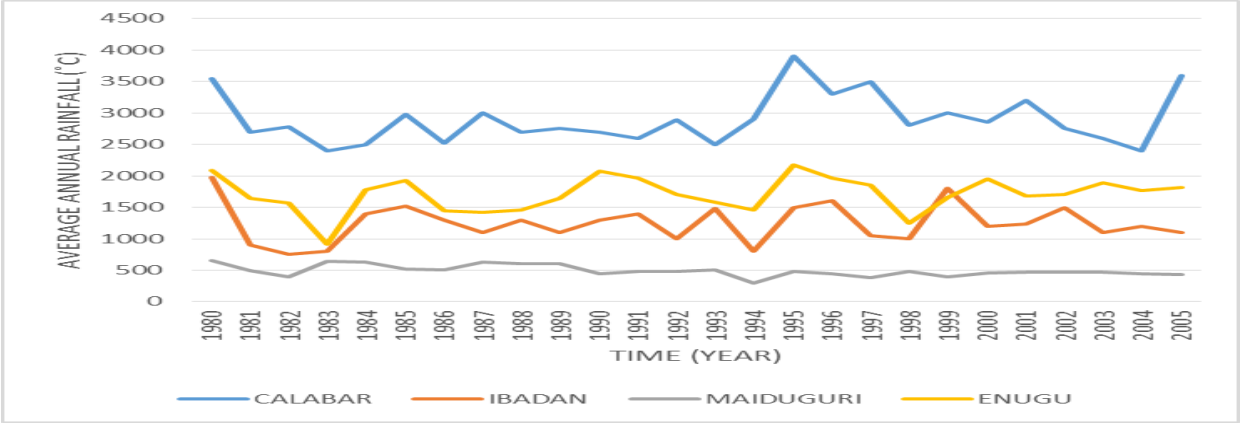

Fig.2: Time series plot for average annual rainfall data from 1980 to 2005

B) Trend of agricultural productivity

The time series plot in Figure 3 shows that crop productivity initially was constant from 1980 to 1985 and gradually increased from 1985 to 2000 then, there was a sharp increase from 2000 to 2001, before a steady increase from 2001 to 2005. For Livestock production, the plot shows a constant production from 1980 to 1989 with a little increase from 1990 to 2000, then another increase from 2000 to 2005. Crop productivity is affected in all the four agro-ecological zones, but livestock productivity is mainly affected in Maiduguri which is located in the northern part of Nigeria where Pastoral farming or Animal husbandry is practiced.

Comparing the trends in temperature in the different zones with the trends in Agricultural productivity, we notice that the temperature trend varied minimally or hardly varied. This shows that agricultural productivity depends more on the amount of rainfall than on temperature, as long as the annual average temperature of the area is within the range of 22˚C and 33˚C.

Comparing the trends of rainfall in the different agro-ecological zones, aside from that of Maiduguri with the crop productivity trend, we notice that at the initial stage, when the rainfall was generally low in the four regions, that is, from 1980 to 1993, the crop productivity trend was low, but from 1993 when the rainfall values increased, the trend for crop productivity gradually rose. This shows that increased rainfall generally favor crop productivity.

In Maiduguri, from 1981 and 1983, there were higher values of rainfall, which increased steadily within that period. Afterwards, there was a sharp decrease in 1994 and a gradual decrease from 1995 to 2005. It can be seen from the trend that from 1999 to 2005, the rainfall pattern became almost constant. This is reflected in the trend of agricultural productivity which showed that within this steady rainfall period, the livestock productivity increased steadily. The incidence of low rainfall, thus favor livestock production due to increase in the growth of pasture.

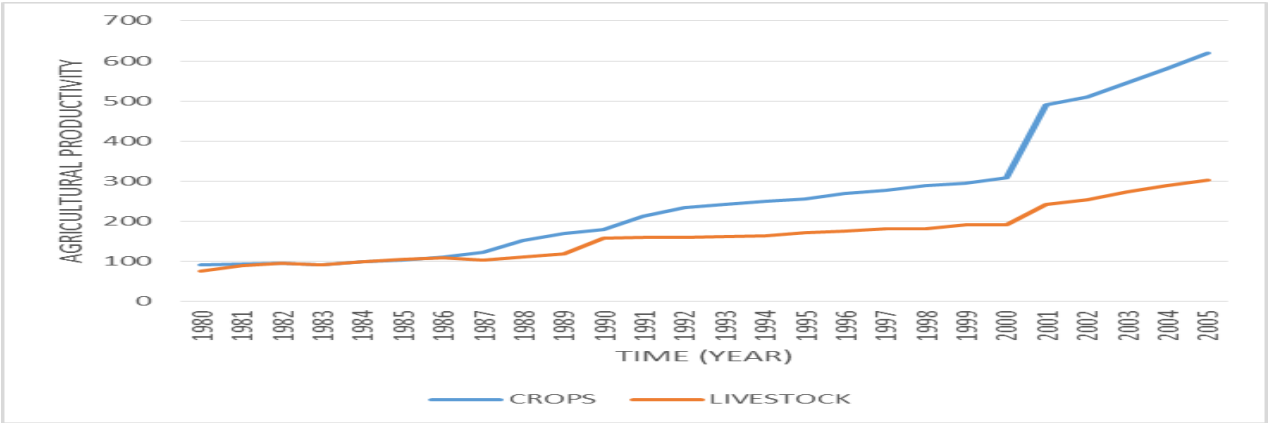

Fig.3: Time series plot for agricultural productivity from 1980 to 2005

V CONCLUSION

This work reveals that agricultural productivity is greatly affected by the amount of rainfall in an area. Increase in rainfall favors crop productivity for common crops like Maize, Yam and Millet which thrive better in the Southern regions of Nigeria, but decrease in the amount of rainfall favors the production of crops like groundnut which thrive better in the Northern regions of Nigeria. Lower rainfall values favor the growth of pasture which increases Livestock productivity. It has been shown from the time series plot for temperature that for the different zones considered; the average annual temperature is within a range (between 26˚C and 32˚C). This indicates that, as long as the temperature remains within this range, Agricultural productivity will not be affected.

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