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Overview of the Trend of Climate Change and Its Effects on Cocoa Production in Nigeria

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Abstract In the recent time, the issue of climatic change and its resultant effect on mankind has become a global phenomenon. This study found it quite imperative to examine the trend at which the changes take place and the implication of the changes on cocoa output. Data on climatic elements such as rainfall, temperature, humidity as well as cocoa output were collected. The data were analysed with descriptive statistics, regression analysis and correlation analysis. The heaviest rainfall was recorded between 1990-1994 while the highest temperature was recorded between 1995-1999. There was a sharp decrease in rainfall and sharp increase in temperature between 1995-1999. Between the period 1980-1994, rainfall kept on increasing while temperature kept on decreasing during the same period. There was a sharp decrease in humidity between 1980-1989. The result of regression analysis shows that rainfall and humidity significantly affected cocoa output while temperature did not. There was a significant correlation between cocoa output and rainfall as well as cocoa output and humidity. The study however recommended that in as much that rainfall significantly affected cocoa output, irrigation facility should be provided to make water available especially during the dry season. This will make water to always be available year round and this will boost cocoa production.

Keywords: *climate change, trend, cocoa output, temperature, rainfall, humidity*

1. Introduction

Climate is the effect of weather over a long period of time, usually twenty five years [1]. It is a major determinant of both the location and productivity of agricultural activities. Climate can be understood most easily in terms of annual and seasonal averages of temperature and precipitation. Rainfall and other climatic elements are major factors influencing variations in crop yields, production, soil utilization and conservation [2]. Climate is so important that it relegates all other factors especially the social and economic into relatively minor positions. Because of the variability in climatic changes, some agricultural crops and cropping systems have been developed for, adapted to these varied regimes of climate, soil, disease and pest [3,4]. Numerous studies have examined the impact of climate variations on agriculture using case studies, statistical analysis and simulation models [5,6,7]. These studies clearly demonstrated the sensitivity of both temperate and tropical agricultural systems to climate changes. Nigeria has two distinct climatic zones. Along the coast, the equatorial maritime air mass influence the climate, which is characterized by high humidity and heavy rainfall. To the North, the tropical continental air mass brings dry, dusty winds (hamattan) from the Sahara. Temperature varies considerably with the season. The main rains occur between April and October while the average rainfall ranges from 2497mm at Port Harcourt on the Niger Delta to 869mm at Kano in the Northern part of the country. The variability of these climatic elements however determines the suitability of a place to grow cocoa and even the overall output from the crop.

Cocoa which has been variously described as *"food of the gods"* by the Greeks was introduced into Nigeria in 1874 [8]. Since its introduction in Nigeria, its cultivation has gained prominence rapidly in the country such that in the early seventies, cocoa production has spread to all the agro-ecological zones in Nigeria. Presently, there are fourteen states producing cocoa in the country viz: Ondo, Cross River, Osun, Ekiti, Ogun, Oyo, Edo, Delta, Kwara, Kogi, Abia, Taraba, Adamawa and Akwa Ibom. The production of cocoa increased gradually from 3000 tons in 1910 and peaked at 307,000 metric tons in 1970/1972 cocoa season [9]. In fact, during the early 1970s, Nigeria was the world's second largest cocoa producer in the whole world [10]. However, as at 2010, cocoa production figure has jumped to 400,000 metric tons [15]. Cocoa as a major cash crop in Nigeria has contributed immensely to Nigeria's economy. For instance, it has since become the second largest foreign earner after crude oil [11]. The crop has contributed tremendously to infrastructural development in Nigeria and has provided job for the people. In fact, the crop has substantially imparted on about ten million people who live and work in the cocoa belt [12]. However, the modest growth in cocoa subsector has been traced to among other things including favorable weather conditions. Cocoa production is highly sensitive to climatic changes from length and intensity of sunshine, to rainfall and water application, soil condition and

temperature due to evapotranspiration effects. It has been reported widely that climate also plays a major role in altering the development of cocoa pests and pathogens and shifting their interactions [13]. Planting of cocoa is highly determined by the start of the rain and cocoa seedling mortality is encouraged by a prolonged drought. In bearing (mature) plant, the existence of drought can result in lower yield by way of reducing bean size and an increase in the level of mirid infestation. On the other hand, too much rainfall causes blackpod infestation. Black pod disease is one of the most serious diseases of cocoa in Nigeria. It is caused by a soil-borne fungus, *Phytophthora palmivora* and is prevalent only during the wet season. The disease is therefore worse in areas of heavy rainfall. Major damage from the disease is the rotting of both small and large pods. Choupons, seedlings (in the nursery) and leaves of trees are attacked and killed under specially severe disease conditions following long periods of cool and rainy weather. Losses due to black pod disease vary from place to place and from variety to variety [14]. As for sunshine, solar radiation is necessary to speed up the photosynthetic-rate. Apart from this, it produces solar energy for warming the soil, plants, air and metabolic processes. Sunshine is also necessary to reduce the water content of cocoa beans during drying thereby enhances the quality of cocoa beans. In general, climatic changes are major factors influencing variations in crop yields, production, soil utilization and conservation. Essentially, the study determines the trend of climate change within the period investigated; determines the impact of climate change on cocoa output as well as to know whether there is significant relationship between each of the climatic elements and cocoa output.

2. Methodology

The study was carried out with the use of secondary data. Climatic data as well as cocoa output data were obtained from Cocoa Research Institute of Nigeria (CRIN). The data collected include the annual output of cocoa, mean annual temperature, mean annual rainfall and mean annual humidity. The statistical tool employed to achieve the stated objectives are descriptive statistics, ordinary least square regression analysis and correlation analysis. Descriptive statistics was used to describe the trend of climatic change in Nigeria. Regression analysis was used to determine the effect of climate change on cocoa production. Implicitly, the model is stated as follows.

$$Y_c = \alpha_o + \alpha_1 T + \alpha_2 R + \alpha_3 H + U$$

Where:

Yc = Cocoa output (tones);

T = Mean annual temperature (^oC);

R = Mean annual rainfall (mm);

H = Mean annual humidity (mm);

U = Random error term;

α = Regression coefficient.

Correlation analysis was used to examine the relationship between each of the climatic elements and cocoa production

$$\partial xYc = \frac{n\sum XY - \sum X \sum Y}{\sqrt{n\sum X^2 - \left(\sum X\right)^2}\sqrt{n\sum Y^2 - \left(\sum Y\right)^2}}$$

Where:

∂ = Correlation coefficient;

Yc = Cocoa output;

X = Temperature, rainfall or humidity;

N = No of observations.

The following hypothesis was tested for:

H_0: β = 0 (There is no significant relationship between cocoa output and each of temperature, rainfall and humidity)

3. Results and Discussion

3.1. Trend of Climate Change

In Table 1, it could be observed that in 1980-1984; 1985-1989 and 1990-1994, while rainfall kept on increasing, temperature was decreasing in that order. During the period 1995-1999, there was a sharp reduction in rainfall (5622.3mm against 7284.5mm recorded in 1990-1994). Also, during the period, there was a sharp decrease in the temperature (137℃ as against 119℃ recorded in 1990-1994). However, the heaviest and the lowest rainfall were recorded in 1990-1994 and 1980-1984 respectively. Similarly, the highest and the least temperature were recorded in 1995-1999 and 1990-1994 respectively. The above claims were supported by the cumulative changes as revealed in Table 1. Changes in rainfall was the highest between 1990-1994 and 1995-1999 where the change was +1662.2. This was closely followed by the period between 1980-1984 and 1985-1989 where the cumulative change was +1569.6. The least change of -144.1 occurred between the period 2000-2009. As regards the temperature, the highest temperature change was recorded between the period 1990-1994 and 1995-1999 with the highest change of +18. This is very similar to rainfall where the highest change was recorded during the periods 1990-1994 and 1995-1999. Hence, since the major elements of climate are temperature and rainfall, then it could be affirmed that the highest climatic change during the periods observed took place between the periods 1990-1994 and 1995-1999. The least temperature change was recorded between the periods 1995-1999 and 2000-2004. Concerning the changes in relative humidity, it could be observed in Table 1 that the highest change was recorded between 1980-1984 and 1985-1989 while the least change was between 2000-2004 and 2005-2009. It could be recalled that a very high and the least change in rainfall was also recorded in 1995-1999 and 2005-2009 periods respectively. This is quite expected in as much that relative humidity is synonymous to rainfall.

Table 1. Trend of changes in climatic elements

Year range	Rainfall (mm)	Δs in rainfall	Temp (℃)	Δs in temp	RH (mm)	Δs in RH
1980-1984	4271.7	-	130	-	388	-
1985-1989	6641.3	+1569	128	+2	365	-23
1990-1994	7284.5	+643.2	119	+9	375	+10
1995-1999	5622.3	-1662.2	137	+18	370	-5
2000-2004	6096.9	+473.6	136	+1	375	+5
2005-2009	5952.8	-144.1	122	+14	375	0

Sources: CRIN Meteorological services centre

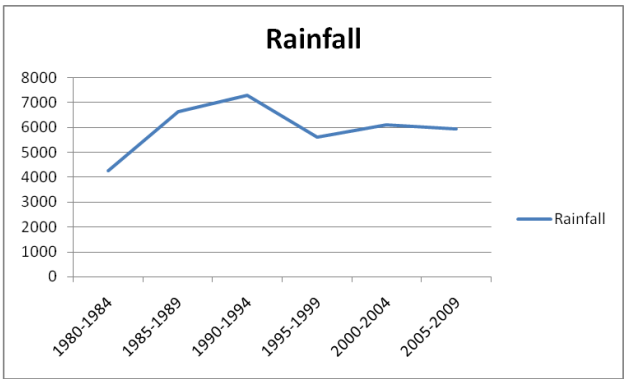

Figure 1. Trend of change in rainfall

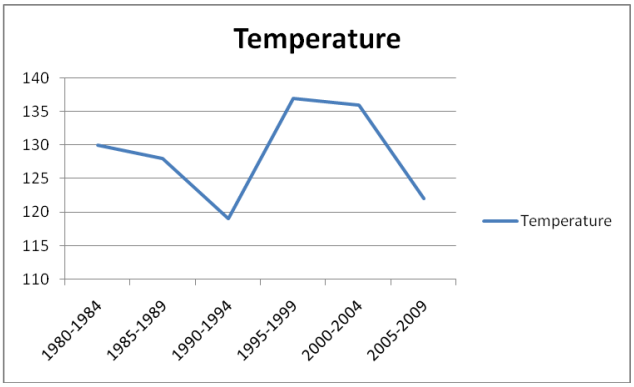

Figure 2. Trend of change in temperature

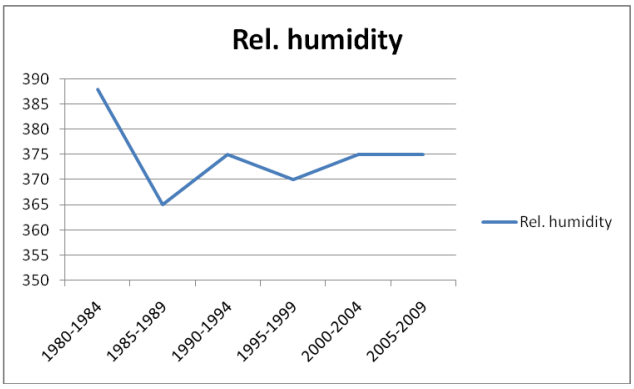

Figure 3. Trend of change in relative humidity

3.2. Effect of climate change on cocoa production

This was determined with the use of regression analysis. Double logarithmic model was chosen based on apriori economic and econometric criteria. Compared with other models, the coefficient of multiple determination (R^2) was highest (0.632), the F-ratio was highly significant (14.307) and the standard error was lower (0.437). The summary of the result is as shown in Table 2. The Table shows that out of the three variables investigated, only two (rainfall and humidity) affected cocoa production in the study area. Rainfall affected cocoa production at 10% significant level. This is due to the fact that rainfall provides moisture in the soil for the use of the crop, especially in the manufacturing of plant food during the process of photosynthesis. However, it could also be noted on the table that humidity is a significant factor affecting cocoa production ($p<0.05$). This is quite expected in as much that a cool environment would enhance the retention of soil moisture for the use of the crop. On the other hand, high humidity can enhance pest and diseases infection. The result shows that temperature was found not to significantly affected cocoa production ($p>0.1$).

Table 2. Result of Ordinary Least Square Regression Analysis

Variable	Estimate	t-value	Prob
Constant	-53.813	-1.851	0.076
Rainfall	-0.005*	-1.626	0.116
Temperature	0.809	1.464	0.155
Humidity	0.701**	2.197	0.037
R^2	0.632		
Standard error	0.437		
F-value	14.307		

Source: Computer analysis print out
* Significant at 10% level
** Significant at 5% level

3.3. Relationship between cocoa output and climatic elements

The values of correlation coefficient in Table 3 indicate that temperature and humidity move linearly in the same direction with cocoa output because of the positive sign of the coefficient. However, there is a stronger joint linear movement between humidity and cocoa output than that of temperature and cocoa output since the higher the correlation coefficient, the stronger the movement. In case of rainfall and cocoa output, they move in opposite direction because of the negative sign of the coefficient. However, correlation coefficient is an estimate, hence it has to be tested for to know whether it is significantly different from zero (as earlier stated in the hypothesis). The test was carried out by employing t-statistic [4].

The statistic $t = \frac{\beta\sqrt{n-2}}{\sqrt{1-\beta^2}}$,

Where: β = Correlation coefficient; n = Number of observations.

Using the values of the correlation coefficient in Table 3, the t calculated for the three relationships were obtained.

(i) Cocoa output and rainfall = -2.23
(ii) Cocoa output and temperature = 2.01
(iii) Cocoa output and humidity = 2.34

The tabulated t statistic at 0.05 level of significance for a two tailed test is 2.04 since the degree of freedom is 28. Therefore, in cocoa output/rainfall and cocoa output/humidity relationships, the t-calculated is greater than the t-tabulated, hence, the null hypothesis is rejected. Therefore, there is a significant relationship between cocoa output and rainfall and cocoa output and humidity. In case of cocoa output and temperature relationship, the t-calculated is lesser than the t-tabulated, therefore, the null hypothesis is accepted. Hence, there's no significant relationship between cocoa output and temperature [4].

Table 3. Result of the correlation analysis between cocoa output and each of the climatic elements

	Cocoa output/ Rainfall	Cocoa output/ Temperature	Cocoa output/ Humidity
Pearson Correlation Coefficient	-0.395	0.360	0.366

Source: Computer analysis print out

4. Conclusions and Recommendation

Based on the findings, the study concludes that the heaviest rainfall was recorded between 1990-1994 while the highest temperature was recorded between 1995-1999. There was a sharp decrease in rainfall and sharp increase in temperature between 1995-1999. However, during the period 1980-1994, rainfall kept on increasing while temperature kept on decreasing during the same period. There was a sharp decrease in humidity between 1980-1989. Rainfall and humidity significantly affected cocoa output while temperature did not and there was a significant correlation between cocoa output and rainfall as well as cocoa output and humidity.

It is however recommended that since rainfall is a very important factor in determining the level of cocoa output, then irrigation facility should be provided to provide water especially during the dry season. This will make water to always be available year round and this will boost cocoa production.

References

[1] Oluyole, K.A. and Adebiyi, S. The Effects of Climatic Changes on Cocoa Output in Nigeria. Journal of ScienceTechnology Research. Vol. 6, No. 3. Pp. 33-36. 2007.

[2] Akintola, J. O. Rainfall distribution in Nigeria 1892-1983. Impact publishers Nig. Ltd., Pp. 58. 1986.

[3] Haws, L.D., H.Inoue, Tanaka, A and Yoshida, S. Comparison of crop productivity in the Tropics and Temperate zone. In potential productivity of field crops under different Environments. Pp: 403-413. 1983.

[4] Oluyole, A. Kayode. The Effect of Weather on Cocoa Production in Different Agro Ecological Zones in Nigeria. World Journal of Agricultural Sciences. Vol. 5, No. 5. Pp. 609-614. 2010.

[5] Nix, H.A. Climatic Impact Assessment. Scope 27. Willy, New York. 1985.

[6] Thompson, L.M. Weather variability, Climatic Change and Food Production. Vol. 188. Pp. 534-541. 1975.

[7] Oluyole, K.A. and Usman, J.M. The Influence of Weather Variables on Coffee Production in Nigeria. Proceedings of 20th Annual National Conference of Farm Management Association of Nigeria. Pp. 576-580. 2006.

[8] Opeke, L.K. Tropical Tree Crops. Spectrum Books Limited, Ibadan, Nigeria. 1987.

[9] Opeke, L.K. Increasing Cocoa production in Nigeria during the Third Millenium. Occasional publication, Cocoa Assosiation of Nigeria (CAN), Akure, Ondo state, Nigeria. 2003.

[10] Gill and Duffus. Cocoa Statistics and Cocoa Market Report. UK, London. 1983.

[11] Central Bank of Nigeria. Statistical Bulletin. CBN., Abuja, Nigeria. 1998.

[12] Sanusi, R.A. and Oluyole, K.A. An Analysis of Cocoa Production and Export in Nigeria (1930-2003). Bulletin of Science Association of Nigeria. Vol. 26. Pp. 146-154. 2005.

[13] Anim-Kwapong, G.J. and Frimpong, E.B. Vulnerability of agriculture to climate change. Cocoa Research Institute of Ghana. (Retrieved online on 10/09/2008) http://www.nlcap.net/fileadmin/NCAP/Countries/Ghana. 2008.

[14] Oluyole, K.A. and Lawal, J.O. Determinants of the Occurrence of Black Pod Disease of Cocoa in Edo State, Nigeria: A Multivariate Probit Analysis Approach. Journal of Innovation and Development Strategy. Vol. 2, Issue 2. Pp. 1-4. 2008.

[15] General NBF Topics (2010). Increasing Nigeria's Cocoa Production. www.nigerianbestforum.com. Downloaded on 02/12/2012.