Journal of Sustainable Development in Africa (Volume 12, No.1, 2010)

ISSN: 1520-5509

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EFFECT OF CLIMATE CHANGE ON COCOA YIELD: A CASE OF COCOA RESEARCH INSTITUTE (CRIN) FARM, OLUYOLE LOCAL GOVERNMENT IBADAN OYO STATE

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ABSTRACT

This Research work focused on the effect of climate change on cocoa yield in Cocoa Research Institute of Nigeria (CRIN) farm, Ibadan. For sustainable cocoa production, weather which is an uncontrollable variable is an important factor whose effect on cocoa is difficult to quantify in field environment. The effect of two major weather parameters rainfall and temperature were evaluated on cocoa yield over ten years. The study revealed that there is a weak inverse correlation in rainfall (0.0073), i.e. increase in rainfall resulting in decrease in yield. While positive weak correlation (0.2196) was established for temperature on yield. This study also revealed a strong positive correlation between yields/pods and temperature. This study showed that a combination of optimal temperature (29^0c) and minimal rainfall (900 to 1000mm) will give a better yield and improve production and the economy of both Cocoa farmers and Nigeria at large.

Keywords: Climate change, Cocoa yield, sustainable Cocoa production, Cocoa yield, optimal temperature

INTRODUCTION

Cacao tree belong to the family of sterculiaceae and the genus *Theobroma*. Its natural habitat is the lower storey of the evergreen rainforest. There are over twenty species in the genus but *Theobroma cacao* is the only one cultivated widely. Since its discovery in the 18th century at the Amazon basin, its

cultivation has spread to other tropical areas of south and central America, and indeed west Africa, which became the major producer from the mid 1960s (Opeke, 1987). Recently, with the application of molecular marker, cacao was reclassified to belong to the family Malvaceae (Alvenson *et al*., 1999).

Cocoa was introduced to west Africa in the nineteenth century and its introduction to Nigeria is believed to have taken place about 1874 through the Spanish Island Fernando Po (Ayorinde, 1966) when a local chief (Squiss Ibaningo) established a plantation at Bonny in the then Eastern region. The first recorded effort of the government in the development of cacao cultivation was the distribution of seedling up country for trial planting from the old botanical garden at Ebute-meta, Lagos in 1887 (Opeke, 1987).

One of the earliest commercial planting was made near Ibadan; and the cultivation of cocoa gained its first impetus in Ibadan province, which produced the bulk of Nigeria cocoa up to the early twentieth century.

The two major factors affecting crop yield are weather conditions and erosion (Wright, 1993). Thus, to improve the production of any crop there is need to understand the average weather conditions of such area (observed as the climate), whereby climatic parameters such as temperature, rainfall, humidity as well as sunshine hours affect the agricultural output of any region. Daily, seasonal, or annual variations in the values of the climatic element are of greater importance in determining the efficiency of crop growth (Ayoade, 2004).

A number of factors have an interrelated impact on the growth of cocoa plant. This factor ranges from the weather element of rainfall, temperature, sunlight and humidity to others such as soil nutrient status, pest and diseases, farmers planting practices and so on. It was observed that the higher the temperature (Maximum of 320c), the higher the yield, while the lower the relative humidity, the better the yield. Cocoa is known to produce well with minimal but sustained water availability throughout the year (Obatolu *et al*., 2003).

Meanwhile, yearly variation in the yield of cocoa is affected more by rainfall than any other climatic factors. Cocoa prefers calm conditions and persistent moderate wind can cause a severe damage to yield.

Being a very picky (i.e. selective plant), cocoa reacts badly to any incidence of extreme weather (Wood, 1985).

The International Cocoa Organization (2003) describe extreme weather to include weather phenomena that are at the extreme of the historical distribution, especially severe or unfavorable weather, they noted that temperature and rainfall are important factors that impacts on optimum yield.

Also, the amount of sunlight falling on the cocoa tree will affect its growth and yield, the most marked effect of humidity on cocoa is on the leaf area, the other effects of humidity concern the spread of fungal diseases and the difficulties of drying and storage of the product.

In general, the cumulative effect of temperature, rainfall, humidity, limits of altitude, and sunshine hour have impacts on the yield of cocoa.

Another danger to cocoa yield is prolonged dry season which encourages bush burning and this is always very disastrous. On the other hand, incessant rainfall for several weeks (as it normally occurs in July and September) easily leads to wide spread of black pod disease which is very contagious also this poses untold hardship to the farmers because it drastically reduce the yield.

Cocoa is highly sensitive to changes in climate, particularly to temperature due to its effects on evapotranspiration (Anim-Kwapong and Frimpong, 2005). Weather elements can also alter stages and rate of development of cocoa, pests and pathogen modify host resistance and result in changes in the physiology of host pathogens/pest interaction, the most likely consequences are shift in the geographical distribution of host and pathogens/pests altered crop (cocoa) yield and crop losses which, will impact on socio-economic variables such as farm income, livelihood and farm level decision making.

However, basic skills in cocoa production, coupled with an optimum motivation, are sensitive requirement for best practices and consequently high quality yield of cocoa is produced.

Cacao is still the highest foreign exchange earning crop in Nigeria in spite of its present problem in the world markets. The crop has contributed to the economy of the country for more than a century. Stallingo (1961) stressed the need to measure the reliable index of weather on the influence of crop yields. Similarly Rose 1936 recognized climate as the major factor affecting crop output, stressing that there is a need to measure temperature fluctuation as a dominant factor affecting crop yield. Thus, this study dwells on examining impact of rainfall and temperature on the production of cocoa. The findings from the study will serve as a framework for further research and guidelines for planners.

AIM AND OBJECTIVES

The aim of this research is to study the effect of climatic variables on cocoa yield. Hence, the following specific objectives are pursued as follows:

a. To examine the rainfall and temperature patterns of the study area within the period of 1999 – 2008.
b. To investigate the impact of extreme climatic variables on cocoa yields (Rainfall & temperature).
c. To assess the socio - economic implication of extreme weather conditions on cocoa yield.
d. Suggest ways of improving cocoa production.

STUDY AREA

Cocoa Research Institute of Nigeria (CRIN), Ibadan is located at Idi–Ayunre, a suburb of Ibadan, Oluyole Local Government, Oyo State, it lies on latitude 3^0 50" East of the Greenwich meridian and longitude $7^0$20" North of the equator.

CRIN was, until 1964 a sub–station of the defunct West Africa Cocoa Research institute (WACRI) founded by the British colonial administration in 1944 with its headquarters in New Tafo, Ghana. The Nigeria sub–station with its experimental plots at Owena and Moor plantation, Ibadan, was established in 1953 through a research committee regulated by the WACRI (Nigeria) in October 1962, the WACRI (Nigeria) was established. This was eventually replaced by CRIN, which was established in December 1964 by the Nigeria Research Institute Act, No 33 of 1964, and it took over all the assets and liabilities of WACRI, Nigeria. Since then, the institute has operated under the aegis of several bodies including the

Agricultural Resources Council of Nigeria (ARCN), the National Science and Technology Development Agency (NSTDA) and since 1980, under the Federal Ministry of Science and Technology as Shown on the National Science and Technology Act.

In 1971, the headquarters of the institute was moved from moor plantation Ibadan to its present location, which hitherto had been its main experimental station. It occupies a total land area of 1,165 hectare (about 11.61 square kilometer) which was provided by the government of the former Western Region from its Gambari Forest Reserve.

CLIMATE

Cocoa research institute of Nigeria (CRIN), Ibadan falls within humid tropical climate (Emielu, 1987). There is a pronounced wet season lasting for about six months and a pronounced dry season lasting another six months. Temperature here is high as mean annual temperature is about 25^0c. Mean annual rainfall may reach 1,200mm while the relative humidity could be as high as 76%. The dry season is marked by the coming of the harmattan brought by the northeast trade wind.

VEGETATION

This area is located in Equatorial rainforest also called Tropical rain forest which corresponds in distribution very closely with the tropical climate. The growth of luxuriant vegetation is aided by heavy rainfall which is well distributed.

Sunshine is abundant and the soil is generally loamy and well drained. As a result of this curious combination, the trees attain giant size, the forest in its virgin form consist of tall and robust trees which could reach up to 45-50 meters high, many of them have buttresses to support their enormous weight. At times the branches of the different trees intermingle and thereby form a canopy, which completely shut off sunlight from the ground. Examples of trees found here include Iroko, mahogany, Obeche, and other similar varieties of hard wood. Under these trees are dense layers of undergrowth composed of perennial shrubs, climbing plants and some annual weeds.

SOIL TYPE

Soil is the product of the environment acting on parent material for a certain length of time, so that similar soils will develop under similar condition of the environment, parent material and time. Environment includes climate, topography and biotic factors, the activity of animals and the effect of vegetation. And so the soil type here falls under the ferruginous tropical soil (Agboola, 1979). This is characterized by soils showing evidence of loam vertical movement of clay and not excessive leaching. It is ideal for cocoa because of its high natural fertility.

GEOLOGY

There are two distinct geological regions in Oyo State. First is the region of sedimentary rocks in the South, and secondly, the region of pre-Cambrian basement complex rocks in the north. The Sedimentary rocks are mainly of the post cretaceous sediment and cretaceous Abeokuta formation. The basement complex is mainly of the medium grained gneiss. These are strongly foliated rocks frequently occurring as outcrops. On the surface of this outcrop severely contoured alternating band of dark and light coloured minerals are essentially feldspar and quartz, while the dark coloured bands contain abundant biotic mica. A small proportion of the state, especially to the north east overlies the coarse grained granites and gneisses, which are poor in dark ferromagnesian minerals.

METHODOLOGY

SAMPLING FRAMEWORK

The methodology adopted by this work is collection of direct relevant data through the use of a carefully designed questionnaires administered to selected cocoa farmers. The demarcation of the study area was done after (Oloyede *et al.,* 2001). The plots of farmland were demarcated into nine (9) zones, in which zone one to five is for growing cocoa, six and seven zones is for kola and the last two zones is for coffee. Therefore, from the five cocoa growing zones, fifty (50) farmers were randomly selected and questionnaires administered in order to obtain information for the study. The data used for this study were obtained from two main sources. These are the primary sources and secondary sources.

The primary information was obtained through the administration of questionnaire and oral interview with the farmer.

The secondary information was obtained from the Cocoa Research Institute of Nigeria (CRIN). Data on cocoa yield or cocoa pod were collected from the production section, while temperature and rainfall data were collected from the meteorological department of Cocoa Research Institute (CRIN) for the period of (1999-2008) ten years.

SUMMARY OF FINDINGS

RAINFALL AND TEMPERATURE ON COCOA YIELD (POD)

The results of the analysis of various statistical methods used such as correlation, regression, etc reveals that;

1) The degree or strength of relationship of rainfall and Temperature on cocoa yield is 0.2481.
2) Both rainfall and temperature account for 6.2% of cocoa yield during the period under review (1999-2008). Thus, other variables or factors account for 93.8%.
3) The ANOVA table shows no significant difference on the effect of both on yield at $\alpha = 0.05$.
4) The regression model can estimate or forecast a yield of 464, 344 pods when the rainfall is 1000 mm and 28^0c: Y = 361.57 – 92.19 X, + 19863.29 X2.

RAINFALL AND COCOA YIELD (PODS)

1) Rainfall has effect on cocoa yield. The effect is a weak inverse correlation-increase in rainfall resulting in decrease in yield.
2) Rainfall accounting for 0.6% of the yield.
3) At $\alpha = 0.05$ there is no significant effect on yield.
4) The study shows that rainfall of 900-1000mm is recommended for better yield.

TEMPERATURE AND COCOA YIELD

1) The strength of relationship is 0.2196 and R2 is 4.8%.This shows that Temperature influences photosynthesis.

2) ANOVA table shows no significant effect or difference in terms of temperature and cocoa yield.

RECOMMENDATION

The research work has shown the various ways through which rainfall and temperature variation can affect cocoa production. The utilization of this research work can be useful to the agronomist, meteorologist and other related environmental management fields. The research has also shown that a rainfall of 900-1000mm and increased temperature is very important for cocoa production and better yield. Old cocoa plots, which largely dominate the western Nigeria like Ondo, Ibadan, Osun and Ekiti should be rehabilitated with new seedlings.

Also, the government should help the farmers buttress their knowledge through this research work so that when rainfall is very high in a particular year usually (July-September) the farmers are to quickly apply chemical sprays such as insecticides and fungicides so as to prevent major disease on cocoa production that year.

CONCLUSION

After carrying out all investigation on cocoa production, the following conclusions are made.

1) The amount of rainfall, its pattern of fall and its distribution is beyond the control of man. An economic amount of rainfall will improve production and the economy of Cocoa farmers in Nigeria.
2) Better spacing that will enable the canopies of the cocoa plants to be exposed to temperature is better than having them under heavy shades of other bigger trees.
3) Both moderate rainfall and enough temperature are important for cocoa production.

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