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Research paper

Assessing the impacts of inter-annual rainfall variability on cash crops' yield in Ondo state, Nigeria

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Abstract

The agriculture sector is of great importance to the development of any nation in Africa; hence, it is determined by the operating climatic mechanisms of such nation, especially rainfall. This study was carried out to assess the inter-annual rainfall variability impacts on cash crop yield in Ondo state for a period of twenty years (2000-2019). The study employed mainly secondary data which was analyzed using inferential statistics. Trend analysis was used to determine the pattern of rainfall and cash crops' yield for the period under review. Also it was revealed that there were fluctuations in the trend of rainfall and the yield of cash crops. The correlation analysis showed a significant relationship between rainfall and cash crops yield; but an inverse relationship with rubber yield specifically. On the other hand the regression analysis showed little impact of rainfall variability on cash crop yield. However, it was recommended that in this era of dwindling economy due to over reliance on crude oil in Nigeria, the government through National Orientation Agency and Non-governmental Organizations should keep persuading and enlightening Nigerians to venture into agriculture to save the country's economy and reduce poverty.

Keywords: *Assessment; Cash Crops; Climate Change; Rainfall Variability; And Yield.*

1. Introduction

Climate, with particular reference to rainfall, is known to be changing worldwide and there has been growing concern as to the direction and effects of these changes on settlement and infrastructures (Chaponneire and Smokhtin, 2006). Thus, hydrological resources such as streams, rivers and ponds that are mainly rain-fed are adversely affected by climate change. Climate change has caused a shift in the seasonal variability of weather and climate and thus a shift in the normal timing and length of wet and dry seasons and increase in the seasonal fluctuation of the water bodies.

Historically, there has been precipitation decrease in the humid regions of West Africa, including the southern Nigeria since the beginning of the century to between 10-25% per decade (Ojo et al., 2001). In Nigeria, this is evident by the late arrival of rains, drying up of streams, and small rivers that usually flow year round, and the gradual disappearance of flood-recession cropping in riverine areas (Adebayo, Dauda, Rikko, George, et al., 2011). These inconsistencies in rainfall have made it generally difficult for farmers (Macchi, 2008) and scientists (IPCC, 2001) to predict precipitation patterns. These fluctuations in rainfall patterns as reported by Adejuwon (2004) have put Nigeria's agriculture under serious threat and stress, since agriculture in Nigeria is mostly rain-fed. This implies that, any change in climate is bound to impact agricultural productivity and other socio-economic activities in the country. This aligns with findings made by Awosika et al. (1994) that rainfall has been the most important determinant of crop yield in Nigeria and other parts of West Africa.

1.1. Statement of the problem

Evidence is emerging that climate change is increasing rainfall variability and the frequency of extreme events such as drought, floods and hurricanes (IPCC, 2007). Boko et al. (2007) predicts that Africa is likely to be warm across all seasons during this century with annual mean surface air temperature expected to increase between 3^0C and 4^0C by 2099, roughly 1.5times average global temperature. Projections in Africa suggests that increase in temperature due to climate change will increase rainfall by 5-20% from December to February, and decrease rainfall by 5-10% from June to August by 2050 (Hulme et al., 2001; IPCC, 2007). Climate limits the production of agriculture. It is projected that crop yield in Africa may fall by 10-20% by 2020 due to climate change (Ajetumobi and Abiodun, 2010). This is because African Agriculture is predominantly rain-fed and therefore dependent on the vagaries of weather.

Climate variability especially rainfall in Nigeria has been well documented (Olaniran and Summer, 1989; Adefolalu, 1986; Odjugo, 2010; Ifabiyi and Ashaolu, 2013). Ondo state which is known for intense cash and food crops production is experiencing direct impact of climate change and variability on agriculture, ranging from pronounced rainfall seasonality, to severe and recurrent droughts, disrupting the usual pattern of seasonal water availability (Mortimore and Adams, 2001). Cash crop farmers in this study area have been put into precarious state because rain-fed agriculture is majorly practiced.

However, in the last decade, Nigeria has experienced economic recession and another one is looming as a result of the global pandemic effect of COVID-19 which has crippled the global economy. In the same vein, the crude oil market has fallen drastically as a result of market power tussle between Russia and Saudi Arabia, therefore affecting the revenue accrued from crude oil sales. Since majority of Nigeria's revenue comes from crude oil, the country has been hit hard in this case; maybe that's why the present administration has been calling for economic diversification with emphasis on agriculture. The agricultural sector is the largest foreign exchange earner after crude oil with cash crops being the highest among the agricultural products. Therefore, understanding the influence of climate change on agricultural production is needed with expected changes in rainfall pattern.

1.2. Aim and objectives

However, this study aimed at assessing the impact of rainfall variability on cash crops' yield in Ondo state. This is with a view to enhancing the present knowledge of rainfall variability impact on cash crops and to meet the ever-increasing demand for cash crops. This aim will be achieved with the following specific objectives, which are to:

i) examine the pattern of rainfall in the study area for a period of twenty years (2010-2019)
ii) examine the pattern and variation in cash crops' yield in the study area for the same period of years under review
iii) determine the relationship and influence of rainfall on cash crops' yield

1.3. Research questions

This paper tends to answer the following questions:

1) What is the pattern of rainfall anomalies in the study area for the period of twenty years, 2010-2019?
2) What is the magnitude of variation of cash crops' yield for the same period
3) What is the relationship between rainfall and cash crops' yield in the study area?

2. Methodology

2.1. Study area

Ondo state was created on the 3rd of February, 1976 and it is made up of 18 LGAs. The state lies between Longitude 4^0 30'' and 6^0 East of the GMT and Latitude 5^0 45'' and $8^0$15''N of the Equator. It has land area of 15,500km^2. It is located in the Southwestern part of Nigeria. The climate of the state is of the tropical rainforest type with distinctive wet and dry seasons with mean annual temperature of 27^0C and means annual rainfall of 2000mm associated with relative humidity of not less than 70%. The natural vegetation is of the high forest composed of many varieties of hard timber such as Milicia excelsa, Antaris Africana, Terminalia superba, Lophira procera and Hevea brasiliensis. Over most of the state, the natural vegetation has been very much degraded due to human activities. Tree crops cultivated in the study area include cocoa, kola, coffee, rubber, oil palm and, citrus while food crops include cassava, yam, maize, plantain, cocoyam, okro and vegetables. Large proportion of the population of the study area engages mainly in agriculture with few in the public service employment.

2.2. Source of data

Secondary data was used mainly for this study. Data on rainfall were collected from the Agro-climatological department, Ondo state Ministry of Agriculture, Fisheries and Forest Resources, Akure. Also data on Rubber, Pa lm Kernel, Cashew and Cocoa output was obtained from the department of Produce services, Ondo state Ministry of Natural Resources, Akure.

2.3. Method of data analysis

Inferential statistics was employed mainly for this work. Trend analysis was used to examine the trends of rainfall and cash crops output from 2000-2019. Correlation and simple regression analysis were used to estimate the relationship and effect of rainfall between/on cash crops output.
Thus:
Simple regression

$$Y = a+bx$$

$$a = y-bx$$

$$b = \frac{\Sigma(x-\bar{x})(y-\bar{y})}{\Sigma(x-\bar{x})^2}$$

Where Y = Cash crops' yield (Rubber, Palm Kernel, Cashew and Cocoa)
x = Annual rainfall
$\bar{x}$= Mean of rainfall
$\bar{y}$ = Mean of cash crops yield

Fig. 1: Map of Nigeria Showing Ondo State Source: Ondo State Surveys, Akure.

3. Results and discussion

3.1. Trend of annual rainfall (200-2019)

Figure 2 shows the trend of rainfall of the study area for a period of twenty years using time series. It was revealed that rainfall fluctuates across the year reviewed; the highest annual rainfall was recorded in the year 2010 while the least annual rainfall was recorded in the year 2004. This is in line with the Nigeria Meteorological Agency (NIMET, 2011) report that in August 2010, some places in the Southwest including Ondo state recorded rainfall values that were 200-300% higher than normal.

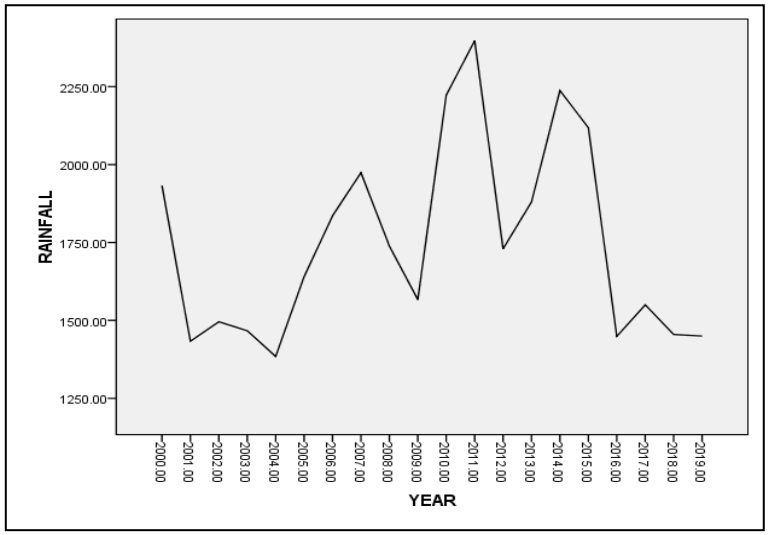

Fig. 2: Trend of Rainfall.

3.2. Annual yield of cash crops in the study area

Figure 3 shows the yield of rubber over the period under study. It was revealed that the highest yield of rubber was recorded in the year 2018 while the least yield was recorded in the year 2007. The time series analysis showed that there were fluctuations in the yield all through the year under review. There was an increasing trend from year 2012 to 2015 with a sharp downward trend from 2016 to 2019.

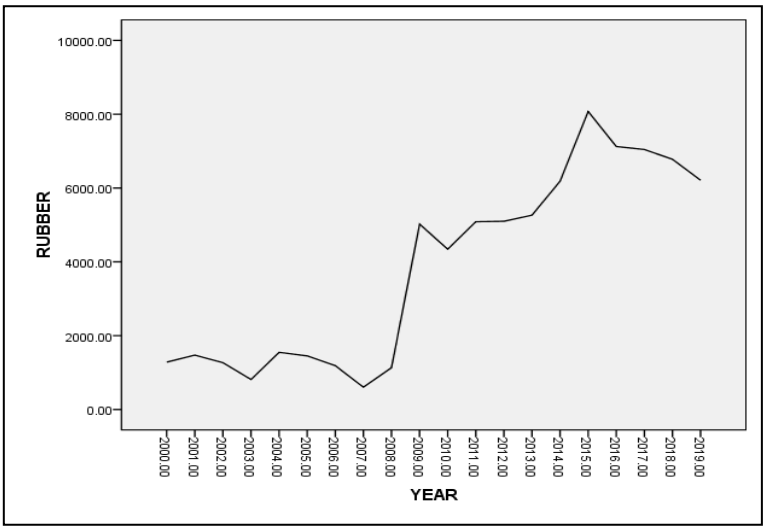

Fig. 3: Trend of Rubber Yield.

The yield of palm kernel (fig.4) shows fluctuating similarities across the twenty years. The least yield was recorded in the year 2000 while the highest yield was recorded in the year 2018. The time series analysis showed an increasing trend from the year 2000 towards year 2009.

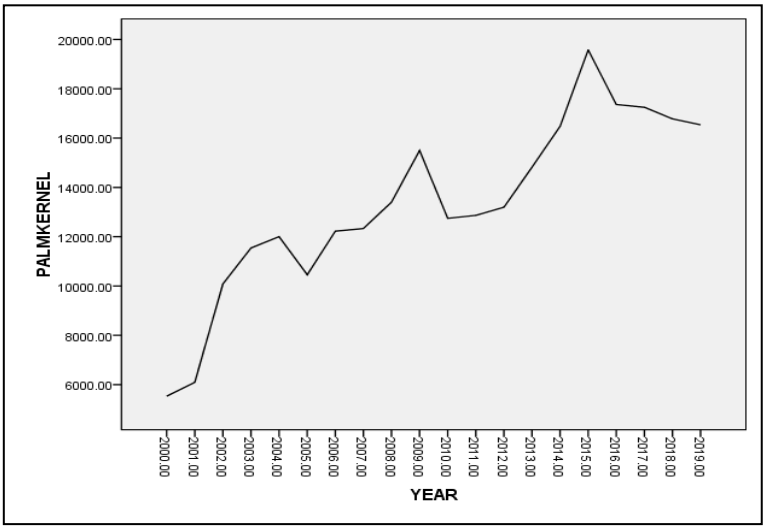

Fig. 4: Trend of Palm Kernel Yield.

Figure 5 showed an increasing trend of cashew yield briefly from the year 2003 to 2005 with the highest yield recorded in the year 2016. The year 2000 marked the least yield recorded in cashew output as shown by the time series graph.

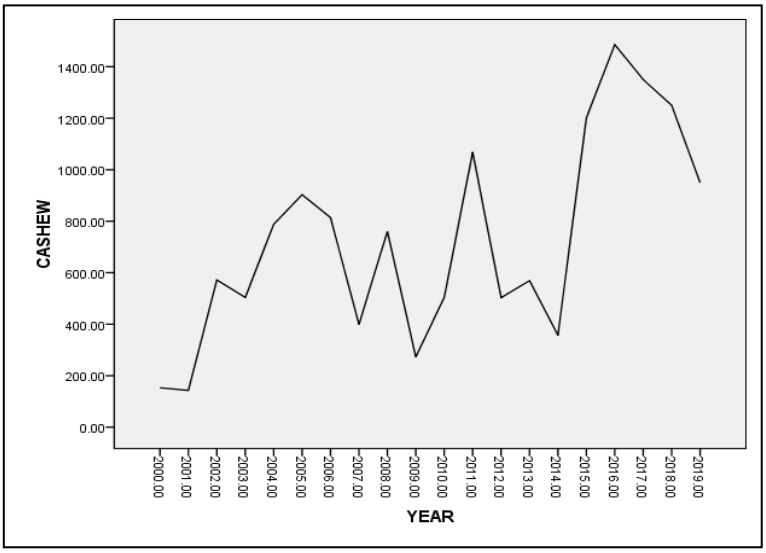

Fig. 5: Trend of Cashew Yield.

In the case of cocoa yield, the time series analysis as shown in figure 6 revealed the increasing trend of cocoa from year 2000 to 2004. However, there were fluctuations in the yield of cocoa afterwards. The year 2016 marked the highest record of cocoa yield.

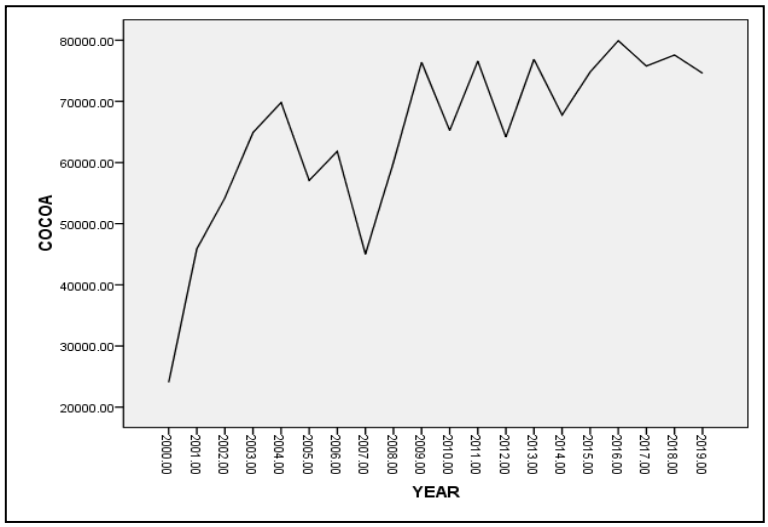

Fig. 6: Trend of Cocoa Yield.

Correlation Analysis of Independent and Dependent Variables

The correlation analysis showed that there is a significant relationship between rainfall and cash crops' yield. This is supported by the assertion that agriculture in Nigeria is rain-fed (FAO, 2003). It was also observed that rubber yield is inversely correlated with rainfall, this is in line with Perera and Ranasinghe (2013) that recorded an inverse relationship between rainfall and rubber yield in their study at Sri Lanka. It was reported that excess rainfall reduced latex yield.

Table 2: Correlation between Rainfall and Cash Crops' Yield

Independent Variable	Pearson Correlation	Dependent Variables			
		Rubber	Palm Kernel	Cashew	Cocoa
Rainfall	Value	1.000	.823	.598	.748
	Sig. (2 tailed)	-	0.000	0.007	0.000
	N	20	20	20	20
	Df	17	17	17	17

On the other hand the simple regression analysis showed that despite the relationship between rainfall and cash crops' yield, rainfall variability contributes little to the yield of cash crops in the study area. This corroborates findings by Ajadi et al. (2011) and Akinfisoye (2017) in their respective studies of impact of climate change on agriculture and cocoa productions. This may be due to influence of other factors such as soil, temperature, crop species, and the farming techniques adopted by cash crop farmers in the study area.

Table 3: Impact of Rainfall on Cash Crops' Yield (Regression)

Dependent Variable	R	R^2	Adjusted R^2	Standard Error of Estimate	Standardized Coefficient β	T	Sig
Rubber	.158	.025	-.029	2645.95918	.158	.681	.505
Palm Kernel	.082	.007	-.049	3709.94609	.082	.348	.732
Cashew	.137	.019	-.036	403.82400	-.137	-.587	.564
Cocoa	.065	.004	-.051	144453.20140	-.065	-.276	.785

Predictor: Rainfall

4. Conclusion

From the findings, it is concluded that there are anomalies in the trend of rainfall over the years. This is characterized with fluctuations across the years under review; this could impact the practice of agriculture in the study area. Also, like rainfall, the yield of cash crops in the study area reflected fluctuations across the years of study. The yields are marked with irregularities in tonnages recorded on yearly basis.

The study also concluded that there is a significant relationship between rainfall and cash crops production in the study area but with minimal impact of rainfall variability on the yield of cash crops. Rubber yield is inversely related to rainfall, this means an increase in rainfall may definitely lead to decrease in rubber yield.

Thus for agriculture to thrive and be sustainable, there would be need for farmers or intending farmers to understand the relationship between various parameters attached with rainfall like the onset, offset, variability and cash crops in order to have optimal production that would sustain the nation's economy.

5. Recommendations

Even with the little impact of rainfall on cash crops' yield, it is still imperative that:

1) Agricultural extension agents are still required to guide cash crops farmers on the various techniques of farming and the use of seed varieties and farm herbicides to boost yield.
2) In the face of dwindling economy, government through the National Orientation Agency (NOA) and non-governmental bodies should keep enlightening Nigerians on the advantages of venturing into agriculture to save the economy of the nation
3) Farmers should have access to small interest loans to acquire necessary farm machinery as well as seed varieties that could withstand rainfall variability and climate change.

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