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Research Article

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Effect of Rainfall Variation on Cassava (Manihot Esculenta) Yield in Owerri West Local Government Area of Imo State, Nigeria

Akagha, NU*, Onyebule, UO, Nnadi, CC

Department of Agricultural Technology, Imo State Polytechnic, Umuagwo-Ohaji, Nigeria

Abstract The study examined the relationship between rainfall variation and cassava (manihot esculenta) yield in Owerri West LGA Imo state, Nigeria. The study employed only the use of secondary data. Rainfall data was collected from Nimet, Sam Mbakwe International cargo Airport, Imo State. Data on cassava yield was collected from Agricultural Development programme Owerri respectively for a period of 7 years (2013-2019). Data was analyzed statistically using pearson's product moment correlation, Regression model and (SPSS version 21) from the results , the time series trend reveled a slight increase in annual cassava yield with R^2 of 0.0242 and produced a negative growth value of -865.51 on time series trend of annual rainfall. The study also revealed a weak positive linear correlation with R^2 of 0.021and p-value of 0.964 of cassava yield in Owerri West LGA within the years under study which is not significant. It was recommended that stakeholders concerned should ensure that other factors such as temperature, nutrient and soil fertility, farm practice and management are duly addressed for maximum productivity of cassava in Owerri West LGA and Nigeria in particular.

Keywords Climate, Effect, Rainfall, Variation, Cassava yield

1. Introduction

Agriculture is the production of food and fiber in all its form for human and animal consumption. Most African countries are particularly vulnerable to climate change because their dependence on rain-fed agriculture. The impact of climate variation is affecting many sectors, including agriculture and food security, health energy and infrastructure, biodiversity forestry resources and settlement patterns among others [3]. Climate variation has mixed effect on agriculture with some areas benefitting from moderate rainfall increase and others being negatively affected. Agricultural production in Nigeria suffers from yield uncertainties as a result, it has taken a declining role in the economy despite the fact that it contributes a reasonable percentage of the Nigerian economy [1]. Agriculture is the main source of food, raw materials and major employer of labour, employing about 60% of the population. It is a rain-fed system and hence vulnerable to climate variability [12]. Dominant crops cultivated in the country includes yam (*Dioscorea*), cassava *(manihot esculenta*), mazie *(zea mays),* millet *(pennisetum americanum*), Okra *(Abelmoschus esculentus*), rice *(Oryza glaberrima),* oil palm (*Elaeis guineensis*) among others. Cassava is not only a major staple crop for over 800 million people worldwide [2] it is also the third most important source of calories in the tropics after rice and mazie and also a major source of firm income to Nigerian farmers (5). Well known for its low input requirement and high resilience to unfavorable production conditions. Cassava has a high output of energy per area cultivated and this makes it a strategic crop for overcoming hunger [11]. Agricultural variation is the risk of negative consequences of climate change that are difficult to reduce through adaptive measures. Risks associated with variations includes, yield reduction that may result from small changes in climate, risk of profitability loss, risk of economic decline. However, the effects of extreme events on crop can be either direct or indirect [7].

Rainfall variation refers to any changes in rainfall pattern over a period of time, which may occur due to either natural or human activities [7]. It is an important element of climate that influences agricultural production. This is because the distribution of rainfall varies in time and space and its variation dictates the agricultural season calendar in the country [18]. Rainfall variation is the amount by which the actual rainfall at any location differs on average from its climatologically normal mean value, that being the mean of the temporal series of rainfall [1]. Studies have shown that rainfall is one of the important factor determining growth and cassava productivity. Several agricultural practices such as land clearing, harvesting and fertilizer application are influenced by climatic condition. The dominant of climatic parameters affecting cassava productivity are temperature, rainfall, dry spell, water deficit and sunshine periods per day in which rainfall more often becomes limiting factor for cassava development. The influence posed by rapid changes in rainfall in the cassava producing belt of Nigeria is a great challenge for most farmers, perhaps it is not surprising because cassava requires even distribution of rainfall throughout the year, as rainfall variation is predicated to have adverse effect on cassava yield [13]. Increase in rainfall variability would lead to frequent floods and drought resulting in variation in crop yield in different ecological zones. [6] suggests that crop production around the globe , especially in the Sahel region is expected to be badly affected by the climate change i.e. rise in temperature , drought and erratic rainfall. Global warming and consequently the unexpected weather variability can be harmful to agricultural sector through its negative impact on plant growth and development.

Cassava (*Manihot esculenta*) plants grow and produces well in Nigeria, however it has shown different growth behavior and yield in different years as a result of difference in the annual weather condition [4]. This is because climate variability has possibility of degrading soil and water resources and subsistence agricultural production practiced mainly by roots and tuber crop farmers [16]. The variability of rainfall is an important consideration in the tropics where rainfall not only tend to be more variable in temperature than in the temperate but is more seasonal in its incidences within the year. Rainfall could contribute to lower yield and tuber weight due to direct effect of El Nino which leads to drier conditions occurring and could result to increase in bush fire, haze, decrease air quality and crop productivity. Rainfall variability affects the production of traditional crops, increases crop diseases and causes drastic reductions in soil fertility [8-9]. Inter seasonal and inter annual variability method were used to monitor rainfall pattern in semi humid areas of Africa to assess the potential threat to food security [15]. Cassava yield potential is reduced when cassava are exposed to stress conditions which common among them is low moisture. Subjection of cassava to water stress can lead to absorption resulting to smaller tubers being produced and reduction in the mean weight respectively [14]. However there is a substantial evidence of adverse impact of change in rainfall pattern on the production of some major cereals [10]. Climate variation and agricultural production are interrelated processes that takes in a global dimension [17]. Despite all recent technological and scientific development, climate remains a major factor influencing agricultural production in Nigeria due to its dependence climatic elements. In other words crop yields with particular reference to cassava (*Manihot esculenta*) yields are still influenced by climate despite advanced technologies and scientific agricultural practices. Therefore this study was carried out to assess the effect of rainfall variation on cassava yield in Owerri urban south-eastern Nigeria.

2. Materials and Methods

Study Location

Owerri , the study area is located in the south eastern part of Nigeria, It is located within latitude $5^{\circ}29^{"}$N and 20° 612"N and longitude 7°1"E and $3.317^{"}$E and occupies a land area of about 295 square kilometers and population of about 99,265 at the 2006 census. It lies within the humid tropical climate with annual rainfall and temperature of over 2000 mm and 20 ºC respectively.

Method of Data Collection

Secondary sources of data was utilized for the purpose of this study. Data on annual rainfall and annual cassava yield for 7 years (2013-2019) was collected from Nimet, Sam Mbakwe International Cargo Airport Imo State and Agricultural development programme Owerri Imo State respectively and subjected to statistical analysis using the pearson's product moment correlation (PPMC) and Regression model. Time series trend was also

employed for the purpose of determining the annual rainfall and annual cassava yield. A time series describes the trend in the values of a variable over time. The analysis was done using statistically package for social sciences (Spss version 21).

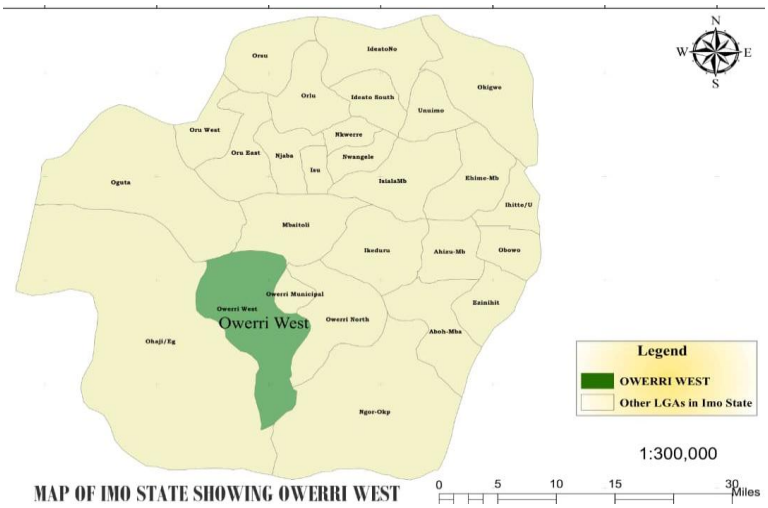

Figure 1: Map of Imo State showing Owerri west Local Government Area

3. Results and Discussion

The result of the annual cassava yield and rainfall in mm for the year under study 2013-2019 is shown below.

Table 1: Annual rainfall and cassava yield (t/ha)

Year	Rainfall mm	Cassava yield (t/ha)
2013	2799.3	14.6
2014	13745	15.56
2015	1790	15.86
2016	1980.5	15.9
2017	2015.06	15.75
2018	2769.5	14.67
2019	1963.2	15.6
Mean	3866 mm	15.42
Std dv.	4375.05	0.55073

Source: Nimet, ADP Imo State Owerri, 2020**.**

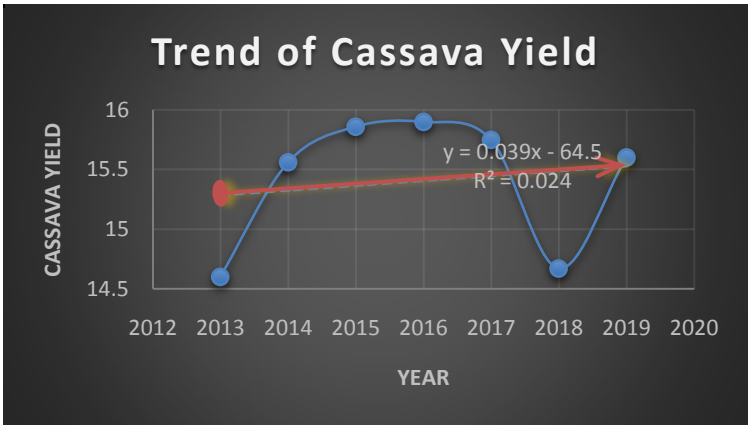

Figure 3.1: Annual time series trend of cassava yield (t/ha)
Source: Spss version 21 by authors, 2020

The time series trend chart above reveals a slight increase in cassava yield in the years under study. From the trend chart above form the year 2013 to 2014 a slight trend was experienced in cassava yield as 14.6t/ha and 15.56t/ha was recorded as annual yield in tons per hectare for the years under study. The years 2015, 2016, 2017 experienced no significant trend with annual yield recorded as 15.86t/ha, 15.9t/ha, 15.75t/ha with a slight decrease in 2018 which is temporal as yield increased in 2019. A linear trend was built on the yield of cassava for the period of study and it produced a positive growth value (slope)b= 0.0396 and constant value of -64.5 with R^2 of 0.0242. This means that for every unit increase in the year, the cassava yield increased by 0.0396. The trend chart shows that there is no significant trend in cassava yield in the years under study.

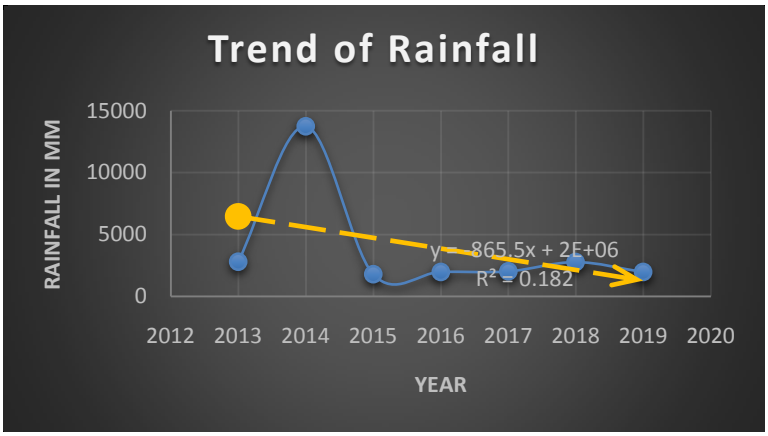

Figure 3.2: Annual rainfall time series trend
Source: Spss version 21 by authors, 2020

The time series trend of rainfall above shows a minimal trend in rainfall from the year 2013 to 2014 with annual rainfall recorded as 2799.3mm, 13745mm respectively. While a decline in rainfall was experienced in the years 2015,2016,2017,2018and 2019 with annual rainfall recorded as 1790mm, 1980.5mm, 2015.16mm,2769.5mm and 1963.2mm res respectively. A linear trend was built on rainfall for the years under consideration and it produced a negative growth value (slope) b= -865.51 and constant value of 2E+06 with R^2 of 0.1826. This means that for every unit increase in time (year) the rainfall reduces by 865.51mm.

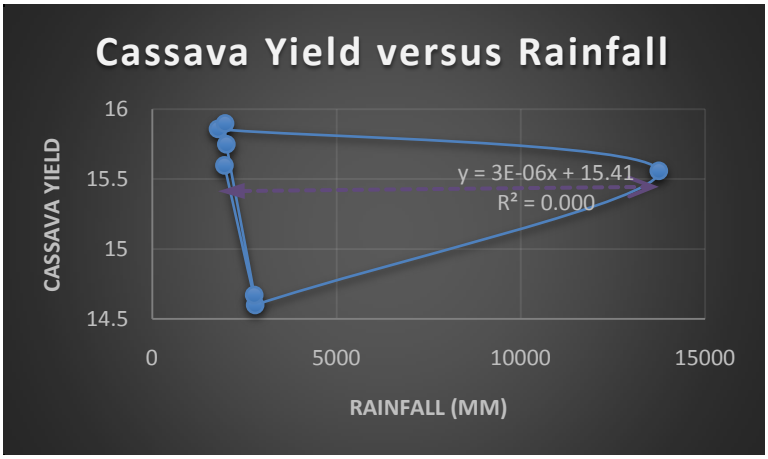

Figure 3.3: Relationship between Cassava yield and Rainfall
Source: Spss version 21, 2020.

The relationship between Cassava yield and Rainfall was studied using Regression model. It reveals that for every unit increase in rainfall, the yield of cassava increases by approximately 0.000003 (i.e. 3E-06). This is not significant (p-value = 0.964 is greater than critical value of 0.05). Since the model output is not significant, this means that the relative change in the cassava yield is not just due to the effect of rainfall.

From the result on determining if there is any significant effect of rainfall variation on cassava yield. The mean annual rainfall and annual cassava yield average for the period under study was arrived at 3866mm and 15.42

respectively. The coefficient of determination (also known as the R-square R^2) is the proportion of the variance in the dependent variable (Cassava yield) which is predicted from the independent variable rainfall. The coefficient was arrived at 0.021. The implication is that 21% of variation in cassava yield is explained by the variation in the predicator variable rainfall within the period under study (2013-2019) which shows a weak positive linear correlation and has no significant effect to the yield of cassava (*Manihot esculenta*).

However the adjusted coefficient of determination (R^2) is taken into consideration when the degree of freedom increases or decreases, it can be negative and its value will always be less than or equal to the R^2. From the analysis the adjusted coefficient of determination between cassava yield and rainfall was arrived at -0.199, this means that 19% of the total variation in cassava yield is explainable by variation in rainfall amount. The student 't' statistics for rainfall shows -0.048 with significance value of 0.946 at 0.05 level of significance, which shows a weak positive linear correlation for the years under study.

4. Conclusion

The study assessed the effect of rainfall variation on cassava yield and rainfall from 2013-2019. The relationship between cassava yield and rainfall was examined with regression model and it revealed that, the relative change in cassava yield is not only due to effect of rainfall. Whereas the extend of relationship between cassava yield and rainfall was assessed with Pearson's product moment correlation (PPMC) and it resulted in a value of 0.021 with p- value of 0.946 which is greater than 0.05 at 95% level of confidence. Rainfall has no significant effect on the yield of cassava within the years under consideration. Therefore the amount of rainfall does not alone determine the yield of cassava (*Manihot esculenta*) as other climatic factors which are not considered in this study contribute significantly to yield of cassava in Owerri West LGA of Imo State, Nigeria. Since only 21% of cassava yield is affected by rainfall amount, it was recommended that stakeholders concerned should ensure that other factors such as temperature, nutrient and soil fertility, farm practice and management are duly addressed for maximum productivity of cassava in Owerri West LGA and Nigeria in particular. Also areas recommended for further study include the effect of diseases affecting cassava yield.

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