CEDTECH International Journal of Environmental Science & Biotechnology
Volume 5, Number 1, March 2024
http://www.cedtechjournals.org
ISSN: 2756-4541

IMPACT OF RAINFALL VARIATION ON CASSAVA PRODUCTION IN OWERRI NORTH LOCAL GOVERNMENT AREA OF IMO STATE NIGERIA

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ABSTRACT

The farming calendar of rain fed agriculture is determined by the rainfall of affected areas, and this calendar can be early or late in setting based on the period the rainfall sets in. Agricultural activities depend on the seasonal distribution of rainfall which varies due to irregularities in its onset and cessation. This study examined the effects of rainfall variation on cassava yields in Owerri North Local Government Area from 1995 to 2017. This study employed an expos factor research design and utilized secondary data of rainfall from synoptic station of evaluation unit and crop yield from planning department of `IMO Agricultural Development Project, Owerri, from 1995 to 2017. Both descriptive and inferential statistics were used in the analysis of data. The findings of the study show that rainfall had an almost constant trend with a 0.03 percent level of variation (r^2=0.03), while cassava yield had an increasing trend, with a 72 percent level of variation (r^2=0.7154) in the period under study. The results from linear regression analysis show that decrease in rainfall had a negative influence on cassava yield with a coefficient value of – 0.002. This implies that a decrease in rainfall affects cassava yield by – 0.002 percent. The result extract of Pearson moment correlation analysis between rainfall and cassava yield in the study area was arrived at – 0.036, indicating a weak negative linear relationship. The study therefore established that there is a positive association between decreasing rainfall and crop yield, and hence it recommends that investment should be made to supplement rain fed agriculture. This include use of irrigation, mulching, better practicable environmental policies and extension of weather forecast to rural farmers in order for this area, and the larger state to have sustainable agriculture, which is essential for food security, economic self-reliance, and improved nutrition and wellbeing for the people.

Keywords: *Cassava yield; Rainfall variation; Rain fed Agricultural practice; Owerri north*

INTRODUCTION

Rainfall determines the crops that can be grown, the farming systems, as well as the sequence and timing of farming operation in an area (Adejuwon, 2009). According to Rijks, (1991), and Ojo et al, (1986) in Nigeria, the last three decades, have been characterized by high variability, rainfall patterns, where the mean annual rainfall frequency have decreased while its intensity has increased. Rainfall characteristics such as amount, duration, intensity and variability influence agriculture and these characteristics vary with time and space, and hence have great implication on food security. In rain fed agriculture, rainfall duration and its seasonality determine agricultural or farming calendar and the type of crops grown.

In the South-East of Nigeria and Imo State for example, drought has been relatively less persistent, while rainfall is observed to be increasing and temperature increases and reduces moderately over the years compared with other states in the northern part of the country, Nnaji etc, (2012). In Owerri, the rainy season begins in April and lasts till October, with double maxima- with the first in June and second in September, with a little dry spell in between, known as the August break. Sequel to the incidence of climate variability, the August break has not been experienced in Owerri for some time (Okoroha, 2019). Rainfall in Owerri North is irregular, and sometimes unpredictable. It limits productivity in many parts through excesses and deficits often in the same location. At certain period, it falls beyond the absorptive capacity of the soils resulting into run-offs and floods (Nkwocha et al., 2012). The inter-annual variability of rainfall is evident in this study area, and this often results in adverse impact on the rate of crop yields, especially during the torrential rain and short dry spell, with wreaking impacts on food creation and related catastrophes and human suffering.

Farmers normally begin cultivation at the end of the dry season, usually from late February to March, when the rain begins to fall, as a result of the inconsistency in rainfall pattern, illiterate farmers are not well aware of the onset of rain quickly plant their crops after the first or second rainfall and definitely run into huge losses when the rains are delayed beyond the usual period due to climatic variation, which brings about scotching of crops with attendant huge economic losses to the farmers (Derek, Hayward, Julius, & Oguntoyinbo, 1987).

Onset of rainfall is also known as the starts of the growing season. It is the time a place receives an accumulated amount of rainfall sufficient for growing of crops. It is not the first day rainfalls in that location. Farmers do not plant at the first or second rain but want to know the best time to cultivate, while cessation means the termination of the effective raining season. It does not mean the last day of rainfall in that location but rather, when rainfall can no more be assured for cultivation (Binbol, 2017). The delay in the onset of rainfall in the study area resulted in late planting and encourages one cropping season and consequently causes early cessation of rainfall that lead to poor crop yields. Late onset of rainfall reduces the duration of rainfall hence causes insufficient water availability during the growing period, while early onset of rain and even distribution of rainfall led to early cropping and encourage farmers to engage in two planting season and subsequent increase in yield. Rainfall indirectly affects other factors such as weeds and pest infestation that destroy agricultural yields. (Okorie et al 2012).

Cassava (Mani hot esculent a) thrives in areas where the mean annual rainfall ranges from 500 to 500m. It was discovered that from the descriptive statistics that the mean annual rainfall in the study area is 252.7087mm, mean rainfall days is 130 days, while the mean temperature is 25^{0}C (Okoroha, 2019). The mean annual rainfall in the area is half the mean annual rainfall requirement of cassava, signifying water deficiency to the crop. Even though cassava can grow in areas with low and uncertain rainfall, further reduction and shift in rainfall months affect all stages of crop production and consequently food availability. This can lead to an unusual sequence of crop planting and replanting which may result in food shortages, poor harvest or crop failure. Farmers in the area of study are engaged in adaptation practices to survive rainfall variability. According IPCC, (2001), adaptation to climate variability and changes as adjustment to natural or human systems in response to actual or expected climatic stimuli and their effects which moderates harm or exploit beneficial opportunities. Farmers use different cassava varieties with varying planting dates, harvesting dates. Adjusting the timing of farm operations such as planting or sowing dates and treatment. Choosing crops and varieties better adapted to the expected length of the growing season.

Statement of the Problem

Owerri North Local Government Area has over the past decades witnessed variability of rainfall. These variations have great implication for food

security in Imo State, because if rainfall in the area is sufficient and well distributed during cropping season, crop production is enhanced. Weather forecast by Nigeria meteorologists (NIMET) most of the times is made with aviation sector or flood disaster at heart. No deliberate efforts are made with a view to improving food security through agricultural output. As a result, weather forecast by NIMET has not impacted the agricultural sector. Again there is paucity of data that investigates the impact of climatic conditions on cassava production in Owerri North Local Government Area. If adequate efforts are not made to uncover the threat of climate variation, which poses a significant danger to rural farmers, there will be continuous food crisis, poor quality and fluctuating food. This will be followed by massive unemployment and social vices. In order to know, the extent at which rainfall variation affects cassava yield, this study examined the effect of rainfall variation on cassava yield in Owerri North Local Government Area of Imo State Nigeria.

Aim and Objectives

The study assessed the effect of rainfall variation on cassava yield in Owerri North Local Government Area from 1995 to 2017. The specific objectives of this study are to;

(i) Examine the trend of rainfall in the study area.
(ii) Determine the effects of rainfall on cassava output in the study area.
(iii) Assess the relationship between cassava output and rainfall in the study area.

Significance of the Research

This work was carried out in order to reveal the need to consider climate variability (rainfall) during planting period, which affect cassava production.

The Study Area

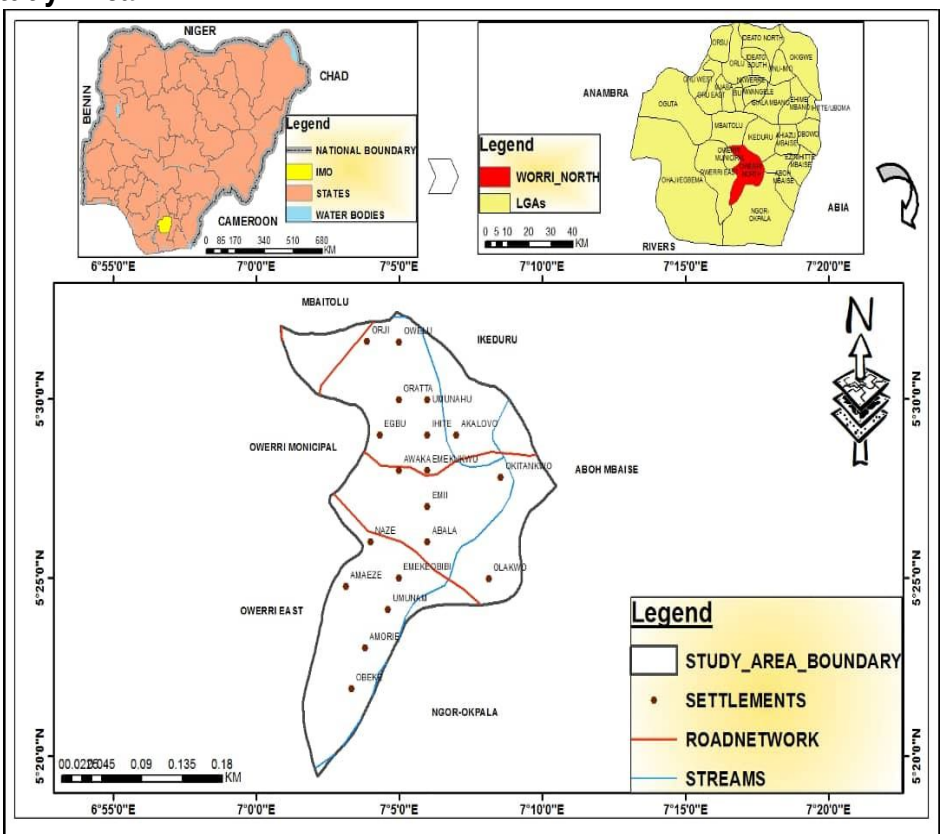

Figure 1: Map A: Map of Nigeria Showing Imo State
Map B: Map of Imo State showing her Local Government Areas
Map C: Map of Owerri North showing her communities
Source: GIS Mapping, 2017.

Owerri North Local Government Area is located between Latitude 5°20'0"N and to 5° 30' 0''N and longitudes 6° 55' 0" to 7°20' 0" E. It is bordered by Owerri municipal, Owerri East, Ngor-Okpala, Abom-Mbaise, Ikeduru and Mbaitoli. The climate and vegetation of Owerri North are as found within rainforest climate of southeastern Nigeria where the wet (rainy season is long approximately between March to October and very short dry season usually between November to February). Soils found in this zone are humid, tropical rainforest soil. Clayey loamy soils found in this area favors the cultivation of cash crops like, cocoa (thobroma cocoa), oil palm (elaeis guineensis) rubber (hevea brasiliensis)

The main occupation of Owerri North is farming. The soil is fertile though slightly acidic. The major food crops grown are cassava (man hotesculent

a), yam (dioscorea rotundata, alata, cayenensis) vegetables, maize (zea mays), plantain and Bananas (musa sapientum, musaparadisiac and musacavendishi). Farming in the area has been considerably reduced by urbanization. Due to rapid urbanization, the periods of fallow and consistent subsistence agriculture through shifting cultivation which is the major traditional method of agriculture has been greatly reduced resulting in a less dense or secondary forest.

MATERIALS AND METHODS

The materials used for this study are rainfall and cassava yield, while the data used is mainly secondary data. The data was extracted directly from the annual documentation of climatic variables (rainfall in particular) obtained from the Evaluation Unit (PM.ED) Planning Department Imo ADD and that of crop yield obtained from archive of Agricultural Development Program (ADP) Owerri, Imo State from 1995 to 2017.

Statistical Analysis

The data for this study were processed and analyzed quantitatively using both descriptive and inferential statistics with micro soft excel and SPSS statistical package version 23. The descriptive statistics employed in the study was the time series trend analysis, while the inferential statistics employed in the study was a regression, and correlation analysis to determine the effect of rainfall variability on cassava yield as well the relationship that exist between the variables under study.

Trend Analysis

Trend analysis was used to show trend and variation in rainfall and cassava yield from 1995 to 2017 in the study area, while a time series trend describes the variation in the values of variable through Time. Trend line shows pattern of growth in rainfall and cassava yield.

Regression Analysis

Regression analysis was carried out to establish the effect of rainfall variability on cassava yield the model for simple linear regression analysis is $Y=a+B_x+e$.

Where
Y = estimated dependent variable
X = value of the independent variable
a = the intercept of the regression equation
B = regression coefficient

e = the residual or random error terms

Thus, the functional relationship model of the effect of rainfall variation on cassava yield was given as CY = F(T)

Where CY = Cassava Yield

R= Rainfall

F = the functional notation

The Correlation

Correlation analysis was carried out in the study to establish the various degrees of relationship that exist between variables under consideration in the study, using Karl Pearson's product moment correlation coefficient.

DATA PRESENTATION AND ANALYSIS

The Trend of Rainfall in the Study Area

Table 4.1: Rainfall Distribution in Owerri-North Local Government Area of Imo State.

S/N	Years	Total Rainfall (mm)	Rain Days	Mean Rainfall (mm)	Percentage Mean Rainfall (mm)
1	1995	3117.30	160	259.80	4.5
2	1996	3218.35	163	268.20	4.6
3	1997	2815.10	161	324.60	5.6
4	1998	2980.00	162	248.30	4.3
5	1999	3212.40	165	267.70	4.6
6	2000	3014.50	156	251.20	4.3
7	2001	3112.10	158	259.30	4.5
8	2002	2214.10	114	184.50	3.2
9	2003	2165.30	109	180.40	3.1
10	2004	2069.60	106	172.50	3
11	2005	3195.30	159	266.30	4.6
12	2006	2833.80	161	236.20	4.1
13	2007	2942.80	168	245.20	4.2
14	2008	2809.60	160	234.10	4
15	2009	2153.10	107	179.40	3.1
16	2010	1913.10	143	159.40	2.7
17	2011	1565.70	127	130.50	2.2
18	2012	2588.70	137	215.70	3.7
19	2013	13745.0	119	1145.40	19.7
20	2014	1218.00	153	101.50	1.7
21	2015	1790.00	143	149.20	2.6
22	2016	1980.50	163	165.00	2.8
23	2017	2015.06	169	167.90	2.9
Total		**68669.41**	**3363**	**5812.30**	**100**

Source: Evaluation Unit (PM. E.D) Planning Department; Imo A.D.P HQRS Owerri, 2018.

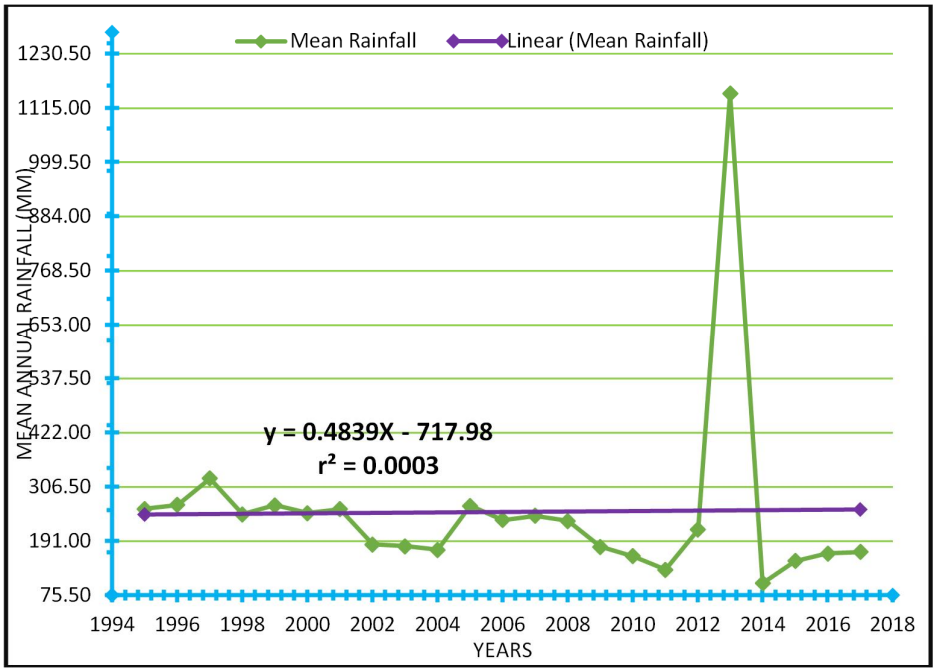

Figure 2: Graph of mean annual rainfall per year.
Source: Author's analysis, 2018.

Figure 2 above show the detailed account of the rainfall trend in Owerri north Local Government Area of Imo State. The trend plot in the chart shows a fluctuating trend mean rainfall in the study area. From the trend chart, it can be observed that from the period of 1995 to 1997 recorded and steady increasing trends in mean rainfall at 259.80 mm for the year 1995, 268.20 mm for the year 1996, and 324.60 mm. 1998 experienced a decline in annual rainfall in the study area, recorded at 2815.1 mm and 2980 mm respectively. In the year 1999, a significant increase in annual rainfall was experienced. This increase was stable and experienced through 2001. Within these three years, the following annual rainfall figures were recorded; 3212.4 mm, 3014.5 mm and 3112.1 mm respectively. From the trend chart, it can be observed that slight fall in coursed in the trend plot the occurred in the year 2002 and was steady through 2004. By interpretation, this implies a steady decline in annual rainfall within these years as compared to the preceding period of 1999 to 2001, at 2214.1 mm, 2165.3 mm and 2069.6 mm respectively. The period of 2005 to 2008

however, experienced an improvement in rainfall-compared to increase in annual rainfall at 3195.3 mm, 2833.8 mm, 2942.8 mm, and 2809.6 mm respectively.

While the improvement in annual rainfall experienced in the year 2005-2008 can be said to be a remarkable increase compared to the preceding three years (200 to 2004), the period of 2009 to 2011 recorded a steady decline in annual rainfall. This decline is made vivid, as depicted by the downward slope of trend plot in the figure above. During these period, the following amount of annual rainfall in the study area was recorded; 2153.1 mm, 1913.1 mm, and 1565.7 mm respectively. A look at the trend plot shows that an upward movement occurred in the year 2012. This upward movement by interpretation signifies an increase in annual rainfall in the year concerned. The year 2013 recorded a significant increase in annual rainfall in the study area. This increase is made vive by significant upward shift in the trend plot presented in the figure above. In this year, annual rainfall was recorded at 13745.0 mm. It important to state here that this year recorded the highest amount of rainfall in the study area across the entire period under consideration.

Compared to that of the preceding period (2013), the period of 2014 to 2016 recorded a decline in annual rainfall at; 1218 mm, 1790 mm and 1980.5 mm respective, while the year 2017 experienced an increase in annual rainfall at 2015.06 mm. Worthy of note here is that that the year 2014 recorded the lowest amount of annual rainfall in Owerri Local Government Area of Imo State across the period of 1995 to 2017, while the year 2013 recorded the highest amount of annual rainfall at 13745.0mm. The value of r^2 in the trend equation indicates a variation in trend of annual rainfall at 0.3 percent.

The Trend of Cassava Output in the Study Area

Table 4.2: Cassava Output in Owerri-North Local Government Area of Imo State.

S/N	Years	Cassava Yield (TON/HA)
1	1995	7.55
2	1996	8.20
3	1997	7.88
4	1998	7.90
5	1999	7.85
6	2000	13.24
7	2001	12.99
8	2002	13.90
9	2003	13.76
10	2004	14.02
11	2005	16.21
12	2006	14.81
13	2007	14.99
14	2008	14.94
15	2009	14.91
16	2010	15.08
17	2011	15.71
18	2012	14.47
19	2013	15.60
20	2014	16.65
21	2015	15.85
22	2016	15.90
23	2017	15.75
Total		**308.16**

Source: Imo A.D.P HQRS, Owerri, Imo State, 2018.

The trend of Cassava yield between the periods 1995 to 2017 in the study area was generated from the data presented in the table above and depicted in figure 3 below.

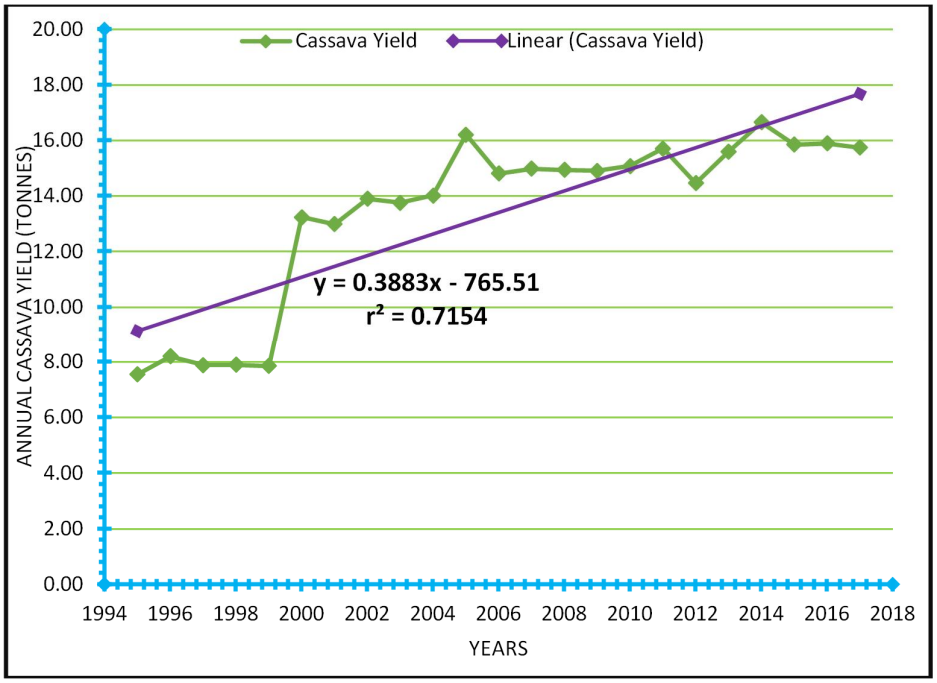

Figure 3: Graph of annual cassava output
Source: Author's analysis, 2018.

Figure 3 presents the effects of average daily rainfall on cassava output. From the graph, low rainfall leads to increase in cassava output as evident in the negative slope of the trend line and slope of line of best fit. Furthermore, the coefficient of determination revealed that 25 percent of the variability in cassava yield are due to rainfall. Slightly similar pattern was observed when cassava yield was plotted against total annual rainfall (Figure 4). The equation for the line of best fit for both figures and their coefficient of determination were both the same. However, the trend lines for the two plots are dissimilar. Figure 4 showed increase in yield with increase in rainfall.

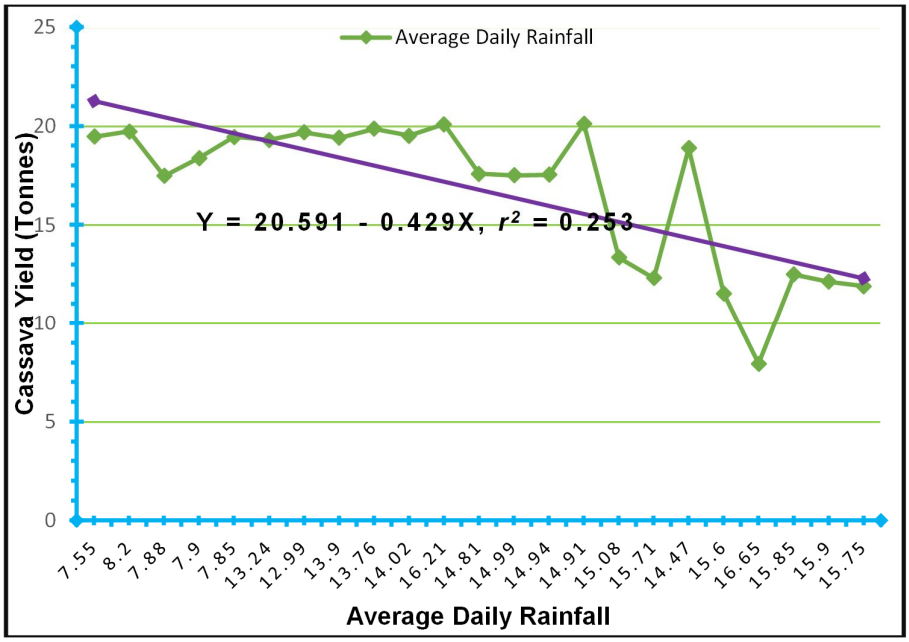

Figure 4: Graph of cassava output against average daily rainfall .
Source: Author's analysis

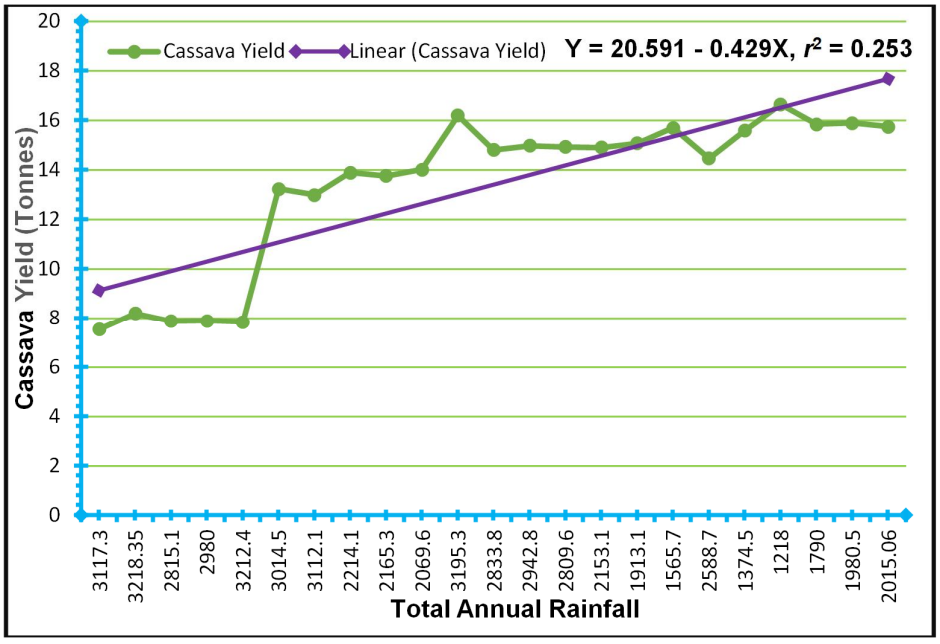

Figure 5: Graph of cassava output against total annual rainfall
Source: Author's analysis, 2018.

Table 4.3: Result Extract of Regression Analysis of the Study

Variables	R-Square (r^2)	Adjusted R Square ($\bar{R}^2$)	Std. Error Estimate	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	F	Sig
				B	Std. Error	Beta				
Constant	0.269	0.196	2.79121	-23.599	13.740		-1.717	0.101	3.688	0.043*
Rainfall				-0.002	0.003	-0.106	-0.548	0.5s90		
Temperature				1.301	0.480	0.522	2.709	0.014		
a. Predictors: (Constant), Temperature, Rainfall *b. Dependent Variable: Cassava Yield (TON/HA)*										

Source: SPSS version 17 linear regression analysis, 2018.

Table 4.4: Result Extract of Correlation between Rainfall and Cassava Output

Cassava yield		Rainfall (mm)	Cassava
Rainfall (mm)	Pearson Correlation	1	-0.036
	Sig. (2-tailed)		0.869
	N	23	23
Cassava Yield (t/ha)	Pearson Correlation	-0.036	1
	Sig. (2-tailed)	0.869	
	N	23	23

Source: SPSS version 17 Pearson Product Moment Correlation analysis, 2018.

The result extract presented in table 4.4 represents the relationship (correlation) between rainfall and cassava output in the study area. The Pearson Product Monument correlation coefficient was arrived at -0.036. The coefficient by interpretation indicates a weak negative linear relationship between rainfall and cassava output in the study area.

Discussion of Findings

This study investigates the impact of rainfall variation on cassava yield in Owerri North local Government of Imo State from 1995 to 2017. The findings reflect the realities of Owerri North Climatic conditions and in line

with similar studies that adopted descriptive and inferential statistical techniques using rainfall and temperature as the weather condition. This study found that inadequate rainfall has a negative significance on cassava output. This study shows a better and practicable environmental policy and improve agricultural techniques, alternative source of water such as irrigation farming, mulching should be applied to boost cassava yield since its evident that there is a reduction in rainfall in the state in order to achieve sustainable food security. This is similar to the findings of Susan and Vincent (2018); Orimolye, Israel, and Adigun (2017); Akpenpuun and Busari (2013) and Emaziye (2015). Trend analysis shows that rainfall has a decreasing trend and a moderate influence on the yield of cassava output. This is in line with the findings of Ropo and Ibraheem (2017) in their study of cassava and maize yield to varying spatial scales of rainfall and temperature in Port Harcourt. This finding also coincides with the findings of Ajiere and Weli (2018), in their study titled, well as the findings of Emaziye (2015).

CONCLUSION

In conclusion, rainfall variability affects cassava yield in Owerri North Local Government Area of Imo State. Cassava yield was inversely associated with rainfall. Cassava yield hits double digits from year 2000 and remained so since then. Government policies on agriculture (cassava in particular) since the nascent democratic rule in 1999 might explain the surge in cassava output from 2000. Besides, the fact that the crop yields are climate reliant, other variables such as farm administration systems, seed type, soil fertility, pest and planting period may contribute fundamentally to varieties in crop yield. This study will appreciate the recommendations outlined in this work to be disseminated to redress the depleting crop yield experienced by the farmers in Owerri North local Government Area for sustainable future. Subsequently, for future study specific technologies and administration styles may need to be developed to ensure the sustainability of agricultural products.

RECOMMENDATION

To ensure that the negative effect of rainfall variability on crop yield is reduced and cassava production generally enhanced in Owerri North Local Government Area, the following recommendations are made

(i) Climate change mitigation and adaptive measures should be adopted. These include use of resistant varieties, drought tolerant species, farmers should be trained and equipped with weather

forecast information to forestall hunger and food insecurity situation in the State.

REFERENCE

Adejuwon, S.A. (2004). Impact of climate variability and change on crop yield in Nigeria. Lead paper presented at the stakeholders workshop on assessment of impacts and adaptation to climate change. Held at the Conference Centre Obafemi Awolowo University Ile-Ife Osun State, Nigeria 20-21 September.

Ajiere S.I and Weli V.E (2018). Assessing the impact of climate change on maize (zea mays) and cassava (manihot esulenta) yield in River State. Department of geography and environmental management, University of Portharcourt, Choba River State. Atmospheric and climate science 8,274-285 https://doi.org/10.4236/acs.2018.82018

Akpenpuum, Timothy Denen. Busari. Rasheed Amao. (2013). Impact of climate change on tubes crops yield in Kwara State. Department of Agricultural and Sio-systems Engineering, Faculty of Engineering and Technology, University of Illorin Nigeria. American International Journal of Contemporary Research Vol.3 No. 10: pp.52-57.

Binbol N.I. 2017). Lecture Note on cessation and onset of rainfall (climatology) University of Jos.

Derek. Hayward, Julius Oguntoyin 60 (1987) Climatology of West Africa.

Emaziye P.O (2015). The influences of temperature and rainfall on the yields of maize, yam and cassava among rural households in Delta State Nigeria, Journal of Biology, Agriculture and Healthcare Vol.5 No.1

IPCC (Inter- Governmental Panel on Climate change) (2001). Climate change 2001 impacts, Adaptation and vulnerability, McCarthy, J.J Canzian, N.A Dokkeeh D.J and White K.S (Eds) Cambridge University Press.

Nwocha G.A, Anukan K.U, (2012) Guidelines for effective Swine enterprise (a management approach) pp.10-12.

Nnaji, A.O. (2012) Indications of current climatic variations on weather condition over Imo State, journal of Biological and Environmental Science pp.22-23.

Ojo S.O, M. Idiom and A.O Ojo, (1986): Consumptive water use of rain fed maize in Nigeria. Singapore Journal of Tropical Geography 7 (2) pp. 128-130.

Okorie, F.C, Okeke, I.C, Njoku, J.D and Duru, P.N (2012). Climate variability and Malaria incidence: Impact and Adaptation in Owerri Municipal of Imo State Nigeria: Advances in Education Research, volume 6, pp. 98-104.

Okoroha, S.U. (2019). M.Sc. Dissertation submitted to school of postgraduate studies department of geography. Nasarawa State University, Keffi.

Orimoloeye R.I and Adigun Ibraheem A. 2017). Response of cassava and maize yield to varying spatial scales of rainfall and Temperature scenarios in Porthacourt, retrieved from on 5th February 2018 from https://scialert.net/fulltexmobile/: doi-rjes. 2017, 137.142.

Rijks, D (1991). Climatic information for sustainable and profitable agricultural production system in the tropics. Foundation international pour LG Science. Burkina Faso, September, 1991.