Rainfall Variation Effect on Soya Beans Yield in Ushongo Local Government Area of Benue State, Nigeria

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ABSTRACT

This study examines the variations in rainfall characteristics and their impact on Soya beans yield in Ushongo Local Government Area of Benue State. Rainfall data for (2002-2012) were collected from the archive of the Nigerian Meteorological Agency (NIMET) at headquarters tactical air command Makurdi. Data on soya beans yield for eleven years (2002-2012) were obtained from the Benue State Agricultural and Rural Development Agency (BNARDA) Makurdi. From the rainfall data, the rainfall characteristics of onset, cessation and annual totals were derived. Partial correlation and multiple linear regressions (MLR) were used in analyzing the data in order to determine the effect of rainfall on soya beans yield. The result indicates low variability in rainfall characteristics. The result also shows that dates of cessation and annual rainfall totals have a relatively strong correlation with soya beans yield. However cessation was found to account more for the annual variation in soya bean yield. The study recommends establishment of more weather stations for more climatic data generation, seasonal forecast of rainfall characteristics and the application of climatic information by farmers to enhance productivity.

Keywords: *Rainfall, Variation, Soya beans, regression, cessation*

INTRODUCTION

Rainfall is the most important variable in agricultural production. Rainfall characteristics such as onset, cessation, duration and annual rainfall totals are important characteristics that control agricultural activities and production in many tropical countries including Nigeria. The concept of climate and agriculture has been extensively discussed, for example Lema (1978), Oguntoyinbo (1986), Ayoade (2004) and Cicek and Turkogu (2005) have all confirmed that climate parameters are closely interrelated in their influence on crops. However, of all the climate parameters affecting crop production and yield, moisture is the most important. Moisture is primarily gotten from rainfall which in the tropics is cyclic and fairly dependable (Ezedinma 1986). In the tropical environment, temperature is not a limiting factor to plant growth and that the seasonal activities of rainfall coupled with crop husbandry seem to be the issue (Oguntoyinbo, 1986). Ezedinma (1986) reports that water is the main constituent of the physiological plant tissue and a reagent in photosynthesis. Rainfall characteristics like onset determines the time of planting crops and the end yield of

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the crops. For instance if the onset of rainfall is too early or long or the duration of rainfall is too short, the effect of this situation would be drastic reduction in agricultural production. Rainfall aids occurrence and distribution of pest and disease which affect crops. Also, rainfall related hazards such as drought, hailstone, wind velocity, rainstorm and flood affect agricultural productivity in a given area. The mean precipitation amount for a month, season or year, hardly indicate the regularity or reliability with which given amount of rainfall can be expected. This is particularly the case in the low latitude and in relativity during areas where rainfall is known to be highly variable in its incidence particularly from one year to another. The variability of rainfall is an important consideration in the tropics where rainfall tends not only to be more variable than in the temperate region but also more seasonal in its incidence within the year (Ayoade, 2004).

It has been observed by Oguntoyinbo (1986) that period of low rainfall have witnessed crop failure resulting in food scarcity and famine. The 1969-1975 drought is a good example. In addition excessive rainfall, which result in flooding and erosion destroy farmland and crops. These hazards resulting from rainfall variability have in the years been a source of concern to both farmers and government. Several studies on crop climate relations have been reported in different parts of Nigeria (Sanginga *et al*, 2003; Tyubee, 2006; Adangbe and Ujoh, 2012). The result of these studies indicate that climate effects vary among crops and regions in Nigeria. It is in this view that this study wants to ascertain the effects of rainfall characteristics of onset, cessation/end and annual totals on soya beans yield in Ushongo local government area of Benue State, Nigeria.

MATERIALS AND METHOD

Ushongo local government area of Benue State is located between latitude $7^{0}00^{1}$ and $7^{0}20^{1}$ North of the equator and longitude $8^{0}32^{1}$ and $9^{0}20^{1}$ East. Generally, the relief is low but the area has Ushongo hill as the only highland, the general land configuration is less than 200 meters above sea level. The major drainage of the area is River Lessel, other streams that drain the study area are Agbudy, Ingye and Kuesar. Ushongo LGA is located within Aw climate and has the guinea savannah vegetation. The soil of Ushongo is predominately sandy though some areas have loamy soil and Fadama soil which occurs along stream floodplains. The data needs for this work were official records on annual soya beans output (tones), date/days of onset of the rainy season, date/days of cessation/ end of rainy season and annual rainfall totals (mm). Data on annual soya beans output (tones) for 11 years (2002-2012) was collected from the achieves of the Benue State Agricultural and Rural Development Agency (BNARDA). Data on rainfall was collected for same eleven years (2002-2012) from the achieves of the Nigerian Meteorological Agency (NIMET) at the Headquarters Tactical Air Command (HQTAC) Makurdi. There are several methods of computing onset and cessation of rains some of which are as shown by Ilesanmi (1972), Olaniran (1984), Omotosho (2002). However, Walter's (1967) method as modified by Olaniran (1988) is adopted in this study because it is relatively more realistic across the different ecological zones of Nigeria. The method calculates the onset of rainy season as:

$$\text{Days in the month} \times \frac{51 - \text{accumulated rainfall total of previous month}}{\text{Total rainfall for the month}}$$

The growing season begins when a location has received an accumulated rainfall of 51mm (Walter 1967) however, if this planting date is followed by a prolonged dry spell, such planting date is disregarded and new planting date is re-established using Walter's method (Olaniran 1988). In calculating the cessation of rainy session, similar formula is applied but monthly rainfall value is accumulated from December backward. The month that the accumulated total exceeds 51mm balances the end of the rainy season. Different onsets and cessation for guinea savannah ecosystem as put forward by Olanrewaje (2003) were identified. For rainfall onset, Olanrewaje (2003) describes the periods between early and mid April as normal onset, March downward as early onset and late April upward as late onset. Last week in October is described as normal rainfall cessation, September to mid October as early cessation and the period of November to December as late cessation. The study employs techniques of mean, standard deviation and coefficient of variability to analyse the variation in the study variables, tables and graphs were then used to present the result. Partial correlation and multiple regression analysis were used to examine the influence of the rainfall variables on soya beans yield. The regression model for the study has been computed after (Udofia, 2006) as:

$$y. = a + b_1 x_1 + b_2 x_2 + b_3 x_3 + \ldots b_n x_n + e \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Where:

y. = the value of the dependent variable (soya beans).

a =Y intercept

$b_1 b_2 b_3 \ldots$ bn are regression coefficients. Each b represents the amount of change in Y for one unit change in the corresponding X value when the other X values are held constant.

$X_1 X_2 X_3 \ldots$ Xn are the independent variables (i.e rainfall onset, cessation and annual totals respectively) and e = the error of estimate or residuals of the regression.

Coefficient of multiple determination (R^2) was used to determine the percentage explanation achieved jointly by the rainfall characteristics.

RESULTS AND DISCUSSION

Temporal Variations in Rainfall Onset: Years; 2002, 2003, 2004, 2007, 2008, 2009, 2011, and 2012 all experienced normal rainfall onset whereas years; 2005, 2006 and 2010 had late onset. This suggests that there was no early rainfall onset during the study period of 2002 to 2012, normal rainfall onset was high and late onset was low. The frequency of different onsets of rain during the study period of 2002 to 2012 is displayed on table 1.

Temporal Variations in Rainfall Cessation: Years 2002, 2003 and 2008 were classified as early rainfall cessation years because their rainfall cassation dates fall between September to mid October. On the other hand, years 2004, 2005, 2006, 2007, 2008, 2009, 2010,

2011 and 2012 had normal rainfall cessation years because their cessation dates fall in the last week of October. Looking at the frequencies of both onset and cessation of rainfall during the study period of 2002 to 2012 there was no early rainfall onset and no late rainfall cessation. This has effect on the length of growing season thus reducing the length of farming calendar. The frequency of different cessation dates during the study period of 2002-2012 is displayed on table 2.

Temporal Variations in Annual Rainfall Total: The highest rainfall was recorded in 2008 (1550.5mm) while 2003 had the least rainfall (762mm). The standard deviation of annual rainfall total from 2002 to 2012 is (256.3mm), and the coefficient of variability is 21.2% this suggest that annual rainfall from 2002 to 2012 is largely homogeneous. The variation in the annual rainfall totals during the study period of 2002-2012 is displayed on table 3.

Temporal Variations in Annual Soya beans Yield: The analysis of annual soya beans yield in the study area shows that the highest grain yield was recorded in 2012 (4.46mt) while a significantly low yield of 2.79 (mt) was recorded in 2002. The mean yield for the entire period of 2002-2012 was 3.66 (mt), the standard deviation of annual soya beans yield is 0.45 (mt) and the coefficient of variation (cv) is 12.3%. This suggest that the annual yield of soya beans from 2002 to 2012 in the study area is also homogeneous though there has been an increase in the yield of soya beans each year across the study period of 2002 to 2012. The variation in annual soya beans yield during the study period of 2002 to 2012 is displayed on table 4.

The magnitude of Variability in Rainfall Characteristics and Soya beans Yield: The descriptive statistics of the study variables shows that among the rainfall characteristics,, annual rainfall totals has the highest coefficient of variability (21.2%), followed by onset dates of rainy season (11.3%) and the least variability of (3.4%) was found to be dates of cessation of the rainy season. This indicates that the dates of cessation were more reliable and predictable whereas the annual rainfall totals were more unreliable and unpredictable in the study area. However, the soya beans yield has the coefficient of variability to be 12.3%. This could be accounted for by the joint effect of the variability in the rainfall characteristics studied and other climate and non-climatic factors not directly considered in this research. A comparative analysis of the study variables is presented on table 5.

Relationship between Rainfall Characteristics and Soya beans Production: To determine the relationship between each of the rainfall characteristics and soya beans yield, partial correlation technique was used to indicate the strength and weakness of the selected rainfall factors in influencing yield. In the partial correlation analysis the variables were identified as follows:

Soya beans =Y,
Onset dates= X_1
Cessation dates = X_2 and
annual rainfall total,= X_3.

The result of correlation between rainfall characteristics and soya beans yields. Presented on table 6 shows that dates of cessation (0.458) and annual rainfall total (0.326) had weak (significant) positive correlation with soya beans yield and onset dates (0.166) had a very weak positive correlation with soya beans yield . This implies that dates of cessation of rainy season and annual rainfall totals account more for the annual variations in soya beans yield than onset dates in the study area. This is because soya beans is not an early season crop and is minimally affected by onset dates but is significantly affected by cessation which can ensure partial maturity in times of early cessation or degradation/destruction of grain quality by late cessation.

Determination of Variations in Soya beans Yield in the Study Area: The effect of rainfall characteristics on soya beans yield in the study area was determined using the multiple Linear Regression analytical technique. The result shows that given a unit change in any of the rainfall characteristics while holding others constant, the highest variation in soya beans yield in the study area will be accounted by only the date of cessation (0.018mt). These means that, among the rainfall characteristics, date of cessation is the most important variable for the variation in soya beans yield and the yield is higher when the dates of cessation are not delayed. Also this agrees with the t-test analysis which indicate that date of cessation (x_2) is significant in influencing yield at 0.05 confidence level as it calculated t-test value of (0.967) is greater than its table value 0.366. Thus, cessation of raining season has been the major determinant of soya beans yield in the study area.

On the whole, these rainfall characteristics can be exploited to improve the yield of soya beans in order to boost production and economic status of farmers in the study area. The result gave a coefficient of multiple determinants (R^2) of 0.626, which is computed to be 62.6%. This means that 62.6% of the variation in the yield of soya beans for the past 11 years in the study area can be explained by rainfall characteristics. The remaining 38.4% of the variations in the yield of soya beans can be attributed to other unexplained factors such as soil characteristics, fertilizer application, seed varieties, pest and disease, and other climatic factors. The analysis is presented on table 7.

Table 1: Frequency of Different Onset of Rain (2002-2012) in Ushongo LGA

Onset of Rain	**2002-2006**	**2007-2012**	**Total**
Early	0	0	0
Normal	3	5	8
Late	2	1	3

Source: Fieldwork 2014

Table 2: Frequency of Different Cessation of Rain (2002-2012) in Ushongo LGA

Cessation of Rain	**2002-2006**	**2007-2012**	**Total**
Early	2	1	3
Normal	5	5	8
Late	0	0	0

Source: Fieldwork, 2014

Table 3: Statistics of Annual Rainfall Total

	Mean	Standard Deviation	Coefficient variance	Highest rainfall	Yr	Lowest rainfall	Yr
Annual rainfall totals (mm)	1207.4	256.3	21.2%	1550.5	2008	1762	2003

Source: Fieldwork, 2014

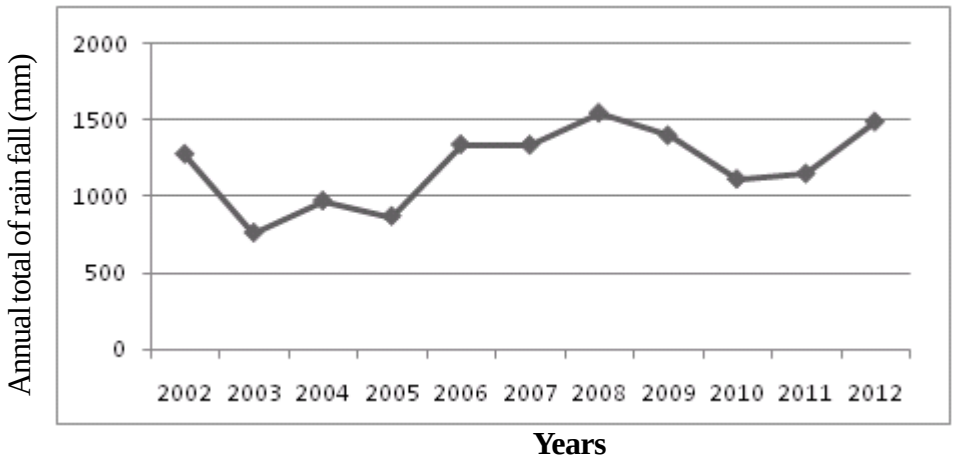

Fig. 1: Graph showing Annual totals of rainfall

Table 4: Statistics of Annual Soya beans Yield

	Mean	Standard Deviation	Coefficient variance	Highest rainfall	Yr	Lowest rainfall	Yr
Soyabeans yield	3.66	0.45	12.3%	4.46	2012	2.79	2002

Source: Fieldwork, 2014

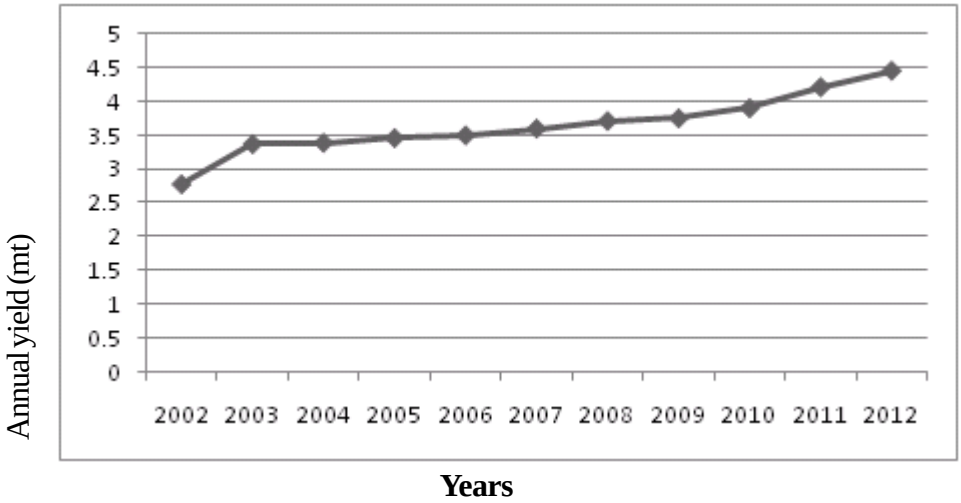

Fig. 2: Graph showing annual yields of soya bean

Table 5: Statistics of rainfall characteristics and Soya beans yield

Variable	Mean	Standard Deviation	Coefficient of Variability (%)
Onset dates (days)	104.7	11.8	11.3%
Cessation date (days)	29.75	10.1	3.4%
Annual Rainfall totals (mm)	1207.4	256.3	21.2%
Soyabeans yield (000 mt)	3.66	0.45	12.3%

Source: Fieldwork, 2014

Table 6: Correlation Matrix of Rainfall Characteristics and Soya beans Yield

Variables	**Y**	**X-$_1$**	**X_2**	**$X_{3'}$**
	1.00			
X_1	00.166	1.00		
X_2	0.458	0.515	1.00	
X_3	0.326	-0.203	0.232	1.00

Coefficient of significant at 0.05 conditions level (2-tailed)

Table 7: Coefficient of the Regression Analysis

Model	**Unstandardized Coefficient**		**Standardized Coefficient**		
Parameters	B	Std. Error	Beta	t	Sig.
Constant (a)	-2.124	4.474	-	-0.475	0.649
X_1	0.000	0.16	0.007	0.018	0.986
X_2	0.018	0.18	0.400	0.967	0.366
X_3	0.000	0.001	0.235	0.648	0.538

Source: Researchers' Computation, 2014

Coefficient is significant at 0.05 confidence level.

CONCLUSION AND RECOMMENDATION

The study analysed variation in three rainfall characteristics of onset, cessation and rainfall annual total on soya beans yield in Ushongo Local Government. The result shows that cessation of rainfall and annual rainfall total has significant effect on soya beans yield during the study period of 2002 to 2012. The study recommends establishment of more weather stations for more climatic data generation, seasonal forecast of rainfall characteristics and the application of climatic information by farmers to enhance productivity. Improvement in the yield of soya beans can be achieved through the commitment of farmers to adopt proper planting skills and application of agro-meteorological information.

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