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Research Article

An Analysis of the Impact of Rainfall Onset, Cessation and Length of Growing Season Variability on Crop Yields in Benue State, Nigeria

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Abstract: Rainfall has been described as one of the most critical factors of crop production in the tropics. And the most perceived impact of climate variability that bear direct impact on crop production in Nigeria are rainfall indices of onset, cessation and length of growing season. This paper attempts to analyze the impact of rainfall variability of onsets, cessations and length of growing season on yields of crops production in the study area. Hence of rainfall problem of food insecurity in the study area as a result of climate change, analysis of the impact of rainfall variability becomes imperative. In doing this, forty (40) years rainfall data and twenty (20) years' crops yields data of the study are were gathered from the meteorological units across the state and the National Bureau of statistics respectively. The data obtained were analyzed using both descriptive and inferential statistics of frequency, respectively. The data obtained were analyzed using both descriptive and inferential statistics of frequency, percentage, mean, Walter (1967) method of calculation of onset and cessation of rainfall dates. Pearson correlation technique was used to establish relationship between crop yields and rainfall indices. The findings revealed both temporal and spatial variation in the rainfall, indices of amount, onset, cessation and length of growing season. These variations were found to have impact on food production of the study area in various dimensions. The result of pearson correlation test between the crop yields and the variability of rainfall indices showed perfect significant correlation between crop yields and amount of rainfall but with less significant with length of the growing season. Mapping out of appropriate mitigation strategies to reduce the rate of greenhouse gases emission and encouragement to establish more additional synoptic weather station, were suggested.

Keywords: Analysis, cessation, crop, length, onset, rainfall, variability.

INTRODUCTION

Ithas been observed that rainfall is the most critical fact responsible for crop production in the tropics. This is because water availability for crop production is dependent on the seasonal patterns of rainfall onset, cessation, amount and distribution. Rainfall is the most critical agro-meteorological factors of agricultural production in the tropics (Olarenwaju, 2010). Also the importance of rainfall indices with the statement that rainfall onset and cessation dates can determine the agricultural practices of farmers, especially with a reliable prediction of rainfall onset and cessation times, and the thus the length of the growing season will greatly assist on time preparation of farmlands mobilization of seed/crop, manpower and equipment which will reduce the risk involve in planting too early or too late was stressed (Omotosho *et al*., 2000).

In the publication of the Nigerian Meteorological Agency (NIMET 2015) it was reported that both onset and cessation of rains have shown clear abnormalities in Nigeria, especially between 1971 and the year 2000. The onset of the raining season between 1941 and 1970 was mostly normal except isolated places, but between 1971 and 2000 more than 80% of Nigeria witnessed onset and cessation variability. To reduce the problem of this variability of rain onset and cessation dates on food production, especially in Benue State of Nigeria where the bulk of food produce in the country is found, this paper attempts to establish the relationship between rainfall amount, onset and

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cessation dates on crop production and yields in study area.

2.0 MATERIALS AND METHODS

The study area is Benue State of Nigeria, which was purposely selected from Guinea savanna for its prominent involvement on crop production. The study employs an empirical approach to crop – climatic factor of rainfall relationship. Two sets of secondary data of crop yields and rainfall indices of onset, and cessation days were collected and analyzed. The crop yield was obtained from the national Bureau of statistics for 20 years (1994 to 2013). While the rainfall indices were derived from rainfall record obtained from meteorological units of the three agricultural Zones of the state for forty years (1974 – 2013).

Onset, Cessation and Length of Growing Season

Several methods exist for estimation of the date of rain onset and cessation (Ati *et al.*, 2000). The study adopted the method of (Walter, 1967) which utilizes only the rainfall record that are measure directly. By this method, **onset date of the rain** is that time a place receives an accumulated amount of rainfall in excess of 51mm and not the first day the rain falls.

Cessation date: This is the date after which not 51mm of the rain is expected. Thus, the above formula applied in the reversed order by accumulating the total rainfall backward from December to obtain the actual date of the cessation of the rain. And calculated thus,

Days in the month X 51 – accumulated rains of the previous month

Total number of rainfall for the month.

Length of growing season: is the interval between the onset date and cessation of the rains.

2.1 Data Analysis:

Rainfall indices of amount, onset, and cessation dates that determine the length of the growing season of the area were analyzed with[4] which defines the onset and cessation date alongside with descriptive statistical techniques like mean, standard deviation as well as correlation technique to establish the degree of the relationship between crop yields and rainfall indices.

3.0 RESULTS AND DISCUSSIONS

Table 3:1 Rainfall onset and Cessation Dates in Benue State

Year	Onset dates			Cessation Dates		
	Zone A	Zone B	Zone C	Zone A	Zone B	Zone C
1974	28th March	11th April	17th mar	16th Oct	16th Oct	11th Oct
1975	29th March	12th April	16th Mar	16th Oct	16th Oct	14th Oct
1976	24th March	12th April	16th Mar	15th Oct	15th Oct	15th Oct
1977	30th March	31st Mar.	16th Mar	14th Oct	14th Oct	16th Oct
1978	27th March	12th April	16th March	16th Oct	16th Oct	19th Oct
1979	25th April	29th March	17th March	14th Oct	14th Oct	16th Oct
1980	17th April	26th March	18th March	25th Oct	25th Oct	13th Oct
1981	29th April	19th April	18th March	8th Sept.	8th Sept	9th Oct
1982	20th Feb	27th May	20th April	19th Oct.	19th Oct.	11th Oct
1983	9th May	8th May	8th May	12th Sept	12th Sept	8th Sept
1984	30th April	31st March	12th April	14th Oct.	14th Oct.	13th Oct
1985	9th March	26th March	12th March	8th Sept.	8th Sept.	16th Oct
1986	15th March 25th April		20th March	14th Oct.	14th Oct.	14th Oct
1987	21st April	10th May	19th April	16th Oct.	16th Oct.	14th Oct
1988	20th March	25th April	19th April	17th Oct.	17th Oct.	11th Oct
1989	16th April	26th April	13th April	12th Oct	12th Oct	9th Oct
1990	30th April	14th April	11th April	19th Oct	19th Oct	8th Oct
1991	14th April	14th April	29th March	10th Oct	10th Oct	8th Oct
1992	22nd April	23rd April	27th March	19th Oct	19th Oct	8th Oct
1993	21st April	29th May	15th April	8th Oct	8th Oct	24th Nov
1994	11th May	26th April	15th April	11th Oct	11th Oct	10th Oct
1995	13th March	18th May	30th March	10th Oct	10th Oct	7th Oct
1996	10th April	14th April	28th March	16th Oct	16th Oct	8th Oct
1997	12th April	7th April	6th April	15th Nov	15th Nov	8th Oct
1998	12th April	11th April	10th April	17th Oct	17th Oct	10th Oct
1999	27th March	13th April	14th April	10th Oct	10th Oct	7th Oct
2000	9th April	16th April	13th April	20th Oct	20th Oct	10th Oct
2001	25th April	16th April	7th April	7th Sept	7th Sept	20th Oct
2002	25th March	20th April	13th April	14th Oct	14th Oct	7th Oct

2003	18th April	17th April	23rd April	11th Sept	11th Sept	12th Oct
2004	17th April	21st May	16th April	11th Oct	11th Oct	8th Oct
2005	15th April	17th May	19th April	17th Oct	17th Oct	10th Oct
2006	30th March	5th May	17th April	15th Oct	15th Oct	9th Oct
2007	28th March	12th April	14th April	7th Oct	7th Oct	7th Oct
2008	6th April	8th April	7th April	19th Oct	19th Oct	18thoct
2009	12th April	8th April	10th April	6th Oct	6th Oct	15th Oct
2010	23rd April	11th May	16th April	6th Nov	6th Nov	10th Oct
2011	10th April	20th April	26th March	5th Oct	5th Oct	7th Oct
2012	21st April	11th April	10th April	8th Oct	8th Oct	7th Oct
2013	25th April	4th March	11th April	13th Oct	13th Oct	8th Oct

Source: field survey 2014

As seen from Table 3.1 there are variability in the onset and cessation dates of rainfall in the study area. The variability are both temporal and spatial across the state. It can also be observed that the dates of growing season vary from one agriculture development zone of state to another and from year to year. April was mean month of onset and October was mean month of cessation within the period under review.

An upward deviation from mean month implies a delayed onset of the rainy season, while a downward deviation from mean month implies an abrupt end of rainy season (Olaniran and summer, 1989).

An upward and downward deviation from mean month of onset and cessation of the rainy season could lead to shortened growing season, which (Odekunle, 2004) stated that will invariably affects crop production.

A critical calculation from the table of onset and cessation dates of rainfall in the study area will reveals that the state has longest duration of the length of growing season days of between 252 to 213 days across the three agricultural zones and shortest duration of 123 to 150 days.

Table 3:2 Mean of annual duration of the growing season and the decadal mean for all the zones of the state.

Agric. Zone	Long-term mean	1974-83	1984-93	1994-2003	2004-2013
A	189	187*	198	184*	185*
B	175	184	165*	174*	179
C	188	197	196	181*	180*

Source: Field survey 2014 * Decade with mean below long-term mean

A compares of the annual mean of the growing season of each zone with the decadal means (Table 3.2) shows that the state has about sixty seven (67%) of their decadal mean above their long-term mean in 1974-1993 decades with hundred percent failure in the subsequent decade of 1994-2003 and with about thirty three percent improvement in 2004-2013 decade.

This apparent variation in the length of the growing season among the three zones of the state shows a tendency towards a decrease in the annual growing season in the study area. Should such trends continued in the future, there would be a tendency for shorter growing season in the area for moisture loving crops for their optimum growth and development.

Table 3:3 Rainfall Indices and yields of crops in Benue State

Variables	No.	Min	Max	Sum	Mean	STD	Correlation
Annual rainfall	20	1145.9	1654.2	27673.6	1383.7	171.5	1
LGS	20	150	214	3609	180.5	9.46	.37
Yields crops							
Maize	20	111	164.6	3419.3	171	15.95	.68
Sorghum	20	151.4	239.2	3483.6	174	33.46	.77
Rice	20	232.1	331	4634.5	232	47.49	.010
Cassava	20	3421.5	3731.7	62002.2	3100.1	653.11	.070
Yam	20	1870.7	4283	58348.8	2917.4	61.45	.76

Source: Field survey 2014 Correlation is significant at the 0.01 level (2. Tall)

To assess the degree of relationship between yields and rainfall indices in the study area, a pearson correlation techniques was employed. The result of the correlation analysis in table 3.3 shows that the rainfalls correlated perfectly with the yield of maize, sorghum and yam in the study area, but with less correlation with the length of growing season. This result could be ascribed to the statement of (Adefolalu, 2007) that, what matters to crop is not the total amount of rainfall, but how effective it is in term of occurrence, spread,

intensity, and frequency. As false onset and cessation of rain which marks the length of growing season may lead to poor crop yields. Hence, in the study area, the total amount of rainfall is more important factor in crop production yields than the length of growing season. This implies that in the study area a perfect total amount of rainfall with effective and timely onset and cessation dates are more important than the long length of growing season with pronounced dry spell in between.

CONCLUSION

Based on the findings of this study, it can be deduced that all the rainfall indices correlate with crop yields at various degrees. However, total amount of rainfall appears to be a very critical rainfall indices influencing the yields of crops in the guinea savanna ecological zone of Nigeria.

Recommendations

- More meteorological units should be established within each ecological zone to capture localized cases of climatic variation so as to facilitate generation of climatic data for long term planning and growth of crops.
- Frequent and timely information of climatic fluctuations should be communicated to farmers for necessary adjustment.
- Farmers should be made aware of the danger of their socio-economic activities that leads to climate change and variability.

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