

VARIATIONS AND TRENDS IN THE LENGTH OF THE HYDROLOGIC GROWING SEASON IN SOKOTO STATE, NIGERIA

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ABSTRACT

This paper examine the pattern of the Hydrologic Growing Season in a part of North western Nigeria in relation to crop Production and yield. It makes use of daily rainfall data obtained from Sokoto Agricultural Development project data were also obtained from the Nigeria Meteorological services Oshodi (SADP) in two agro-climatic Zones of the state Daily rainfall data were also obtained from the Nigeria Meteorological Services Oshodi for a period of 30 years (1974-2003). The data were used to estimate the onset and cessation dates of the rains using the accumulated rainfall approach from which the mean length of the Hydrologic Growing Season was derived. Phonological aspect of rainfall indicates that expected dates of onset of rains vary from May 20 in the Western zone to June 24 in the extreme northern zone of the state. Mean cessation dates range from August 30 to September 24 while the mean length of the Hydrologic Growing season is approximately 91 days. A decreasing pattern of occurrence in the length of the Hydrologic Growing season is detected and adoption of more efficient strategies for alleviating or avoiding the adverse effects of the shortfall on agricultural practices is suggested

Key: hydrologic growing season,

INTRODUCTION

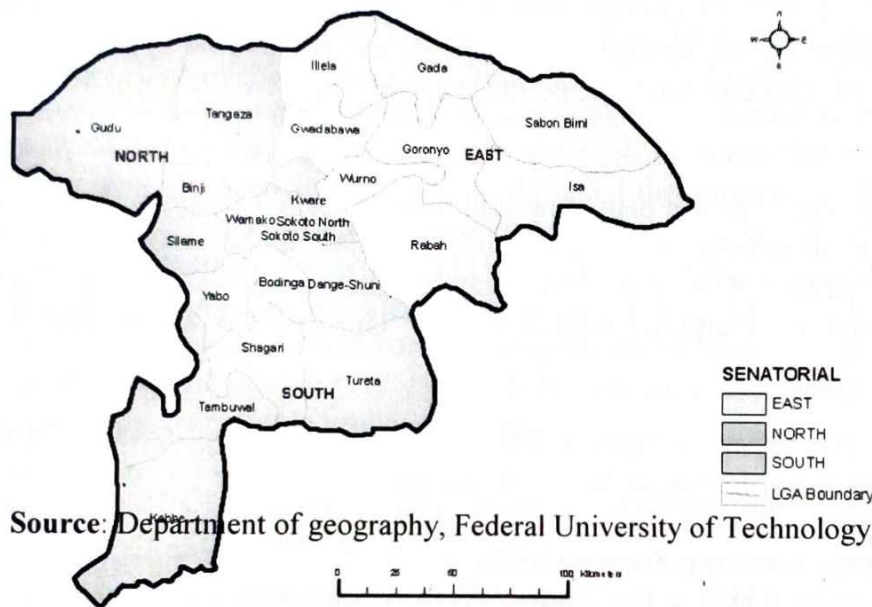
It needs not be over emphasized that of all agro-meteorological parameters, rainfall is the most critical to agricultural activities in the tropics, but 'the main problem lies in accurately predicting the time of onset and cessation of the rains (Fasheun, 1983; 02). However, in Nigeria until the 1969-73 drought planners give little or no attention to rainfall effectiveness indices. Emphases were laid on variation in total annual rainfall values which provide inadequate bases for planning. As stated- by Adefolalu (1985) it is not the total annual rainfall that is important but its seasonal variability as a function of its characteristics: onset, peak, cessation, length of the rainy season and precipitation intensity during onset and cessation phases.

Onset and cessation dates of the rains are derived parameters from which the effective length of the rainy season (which in this study is synonymous with the Hydrologic Growing Season (I-IGS) can be estimated (Hesanmi, 1972; Ojo, 1977; Adefolalu 1986; Olaniran et al, 1990). It is important to note that if in a given year, there is late onset and ready cessation of the rains there will be a shortfall in the normal length of the Hydrologic Growing season which might consequently lead to poor yield or total crop failure. A significant shortening in the length of the Hydrologic Growing Season has been mentioned by several authors who have analysed Sudano- Sahelian precipitation data for the last 20 years (Demaree and Chadily, 1988). The realization of this therefore called for sub synoptic study of rain rail effectiveness indices of onset and cessation dates of the rains from which the length of the Hydrologic Growing season shall estimated fur improved Crop production and planning in Sokoto State.

The Study Area

Sokoto State is located to the extreme northwestern part of Nigeria. It lies between latitudes 12°00 and 13°58 north of the equator and between longitudes 4°-081 and 6° 54 east of the Greenwich Meridian. It shares boundary with Zamfara State to the east and Kebbi State to the south and west. The State has an international boundary with the Niger Republic along its northern side. It has a land area of about 32,000 sq Km. the state is divided into 23 local government areas. Sokoto state has a tropical wet and dry climate. Dry season lasts for seven months (October to April) while the wet season spans from May to September. Mean annual rainfall in the State ranges from 500mm in the north to 700mm in the extreme southern part of the state. The mean monthly temperature varies from 13°C in December through February to as high as 30°C in August. The vegetation of the area is characteristically Sudan Savanna type.

MAP OF SOKOTO SHOWING THE LOCAL GOVT. AREAS.



Source: Department of geography, Federal University of Technology, Minna

MATERIALS AND METHODS

Daily rainfall data from Sultan Abubakar Airport and Sokoto agricultural Development project (SADP) for ten rainfall stations spread over the two agro-climatic zones of the State were collected and analysed. The Stations serve as representative of the irrespective ecological Zones. The daily data were used to derive the onset and cessation date from which the length of the Hydrologic Growing season was derived in accordance with the following methods.

Onset, Cessation and Length of Hydrologic Growing season (HGS)

Onset refers to that time when a place receives an accumulated amount of rainfall adequate for planting of crops provided that a dry spell of five days or more did not occur in the week following and preceding the date of onset (Bello, 1996). It is therefore not the first 'day rain falls. Cessation is the termination of the effective rainy season when rainfall can no more be

assured and does not imply the day rain fell, the length of the Rainy Season that in this study is synonymous with the Hydrologic Growing Season is the difference between the cessation date and the onset date.

Computational Techniques

Various statistical methods have been employed to determine these rainfall parameters from either monthly or daily rainfall data (Walter, 1967; Oshodi, Griffith, 1972; Ilesanmi 1972; Adefolalu, 1989). A tested statistical method of rainfall Ogive used by Adefolalu (1989) which utilizes 5-day rainfall pentad is adopted in this study because of its accuracy. The five day rainfall (PR) cumulative frequency value is written in the form.

$$t = 5(n+1) + 5$$

$$PR (S.P = n) = PR (S.P = n - 1) - [RR (t,S)]$$

$$1 = (5n-1) = 1$$

Where:

PR (t,s) = recorded rainfall for a particular day (day=t) at location (station=S), P = each 5-day pentad ascribed values 1, 2, 3,...., 73 (Since there are approximately 365 days in a given year $365/5 = 73$). To obtain the Ogive, rainfall values are plotted against the appropriate pentad numbers. From the Ogive; two characteristic points are used to derive the onset and cessation dates.

Onset

Before the start of rains, the five days pentad rainfall value has zero and thus the plot will be along the abscissa and shall remain zero until the first recorded rainfall amount computed for the appropriate pentad number. After this initial positive value the next pentad rainfall values will increase in response to additional rainfall values. The onset is at the first point of inflexion.

Cessation

As earlier explained in this paper, cessation refers to the effective rainy season. It is marked by the last inflexion point on the Ogive before it becomes parallel or the second (and last) time to the abscissa. Thus, it normally lies somewhere before the last day rain is received.

Length of the Hydrologic Growing Season (HGS)

Hydrologic Growing Season which in this study is synonymous with the length of the Rainy Season (LRS) when soil moisture surplus Occurs (Duckham, 1974), HGS is obtained as follows.

$$HGS(s) = \phi(s) - \theta$$

$$HGS = \text{Hydrologic growing season}$$

$$\phi = \text{Cessation date while}$$

$$\theta = \text{Onset date of the rains at location, S.}$$

RESULTS

As suggested by Bello (1996) onset and cessation of the rains can be categorized into Early, Normal and Late. Results reveal that rains will start between May 10 (Earliest) and June 24 (Latest) in any onset dates of the rains. Earliest onset is between May 20 to May 30, normal onset is between May 30 to June 15. There are variations within the two zones under study. In the central part of the state comprises Dange, Tureta, Yabo, kware, Bodinga, Binji, Wammako, Sakata and Silamelocal government areas, the onset is between may 20 to May 30. In the northern zone made up of Wurno, Kware, Goronyo, Rabah, Sabon, Birni, Isa, Tangaza, Ilela, Gada, Gwadabawa and Gudu Local Government Areas, the rains are expected between may 30 and June 10 (Earliest) late onset is between may 30 and June 24.

Cessation Dates of the Rains

The cessation dates of rains appear to follow the same pattern as the onset dates. Cessation dates are also divided into three categories: Early, Normal and Late. Generally, rain will cease between September 14 (Earliest) and September 24 (Latest) in any cessation dates. In the study area cessation date is between August 09 and August 29. Late cessation dates occur between September 30 and October 10. The length of the Hydrologic growing season varies from less than 100 days in the extreme northern part to over 120 days in the extreme southern part of the state.

Variations and trend in the length of the Hydrologic Growing seasons (HGS)

Figure 2a-d shows the yearly computed dates of onset, cessation and HGS for Sokoto state for a 30 year period and to observe the trend. The graphs for the dates of onset of the rains over the state indicate a persistent early onset of rains during the period 1975-81. The succeeding years of 1982--86 are characterized by persistent early onset of the rains. The rest of the year up to 2003 experience fluctuating trend in the onset dates within the mean onset dates of June 15. The curve for the dates of cessation of the rains indicate that except for the years 1976, 1984, 1986, 1987, 1995 and 1999, the remaining years in a 30 year period experienced persistent early cessation of the rains than the normal cessation dates around the mean date of September 14. The length of the HGS indicates that half-of the period period is marked by lower than normal HGS of 91 days and the remaining half by above normal HGS. It should be noted that early onset and early cessation or late onset and early cessation can lead to a shortfall in the length of the Hydrologic Growing Season (HGS) and consequently crop failure and poor harvest. This needs to be carefully taken in to cognizance in planning for crop performance and water harvest as rightly noted by Suleiman (1998). The linear trend derived by the equation of $y=96-0.3:2x$ indicate a decreasing pattern of occurrence in the length of the hydrologic growing season.

Table 1: Onset (A) cessation (B) Dates in pentades and lengths of the Hydrologic Growing season (HGS) in days

Year	A	B	HGS
1974	34.4	51.2	85
1975	27.8	50.8	116
1976	32.8	56	116
1977	32.8	50	87
1978	32.4	51.6	96,
1979	31.8	54	87
1980	29.6	49.6	95
1981	28.4	48.4	76
1982	37.2	53.6	105
1983	33.4	50.6	86
1984	32.8	52.4	105
1986	33.6	54.8	86
1986	35	50	88
1987	31.2	49.8	118
1988	32.2	49.2	90
1989	33	49.2	85
1990	33	51.2	82
1991	28.4	49.4	105

1992			
1993	32.8	50.2	93
1994	37.8	51.8	93
1995	37.6	49.2	94
1996	30.6	48.2	107
1997	27	50	74
1998	35.4	51.6	85
1999	34.8	51.6	85
2000	31.2	48.8	101
2001	29.6	49.6	96
2002	30.8	48.8	96
2003	30.8	49.6	95
Mean	32.4	48.8	78
		50.6	91

Source: Compiled by author (2006)

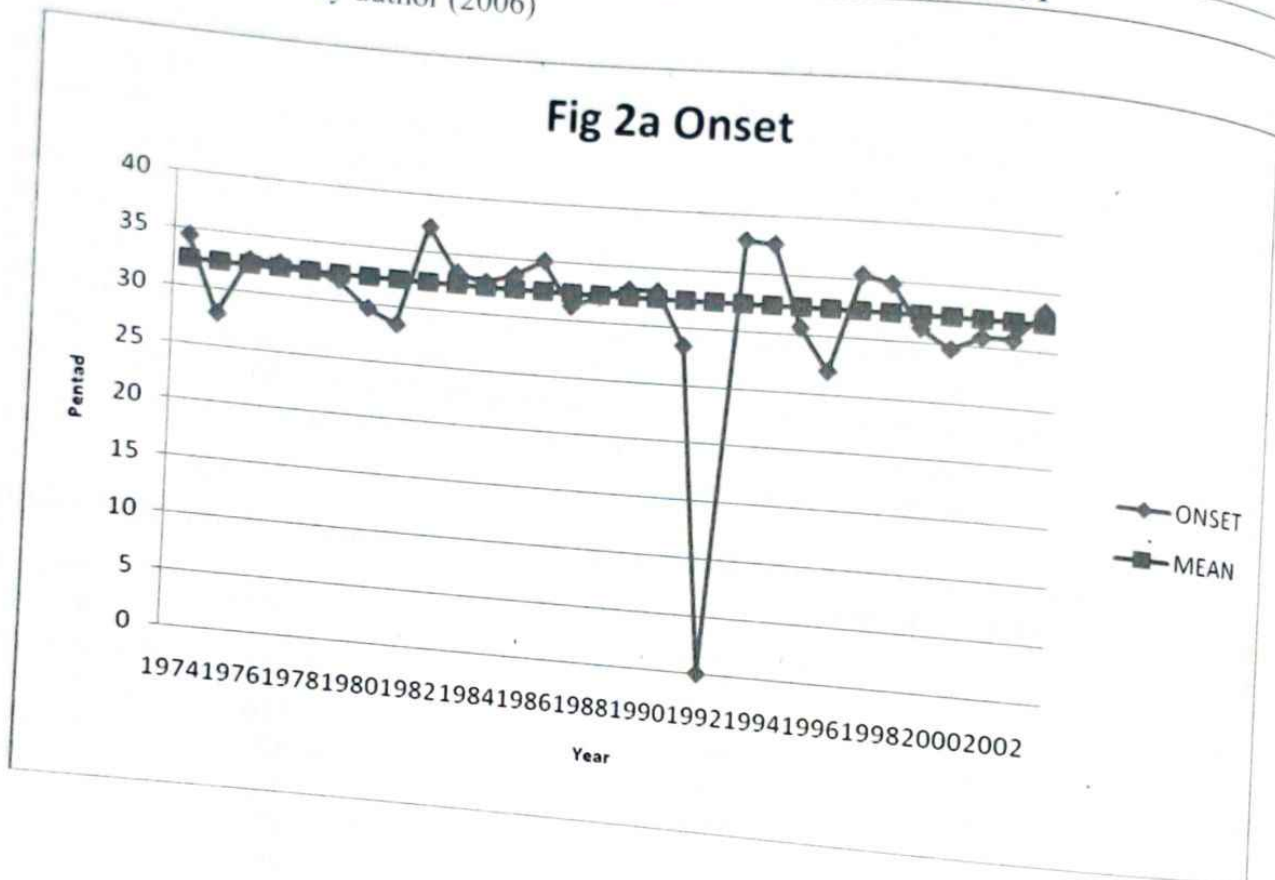


Fig 2b Cessation

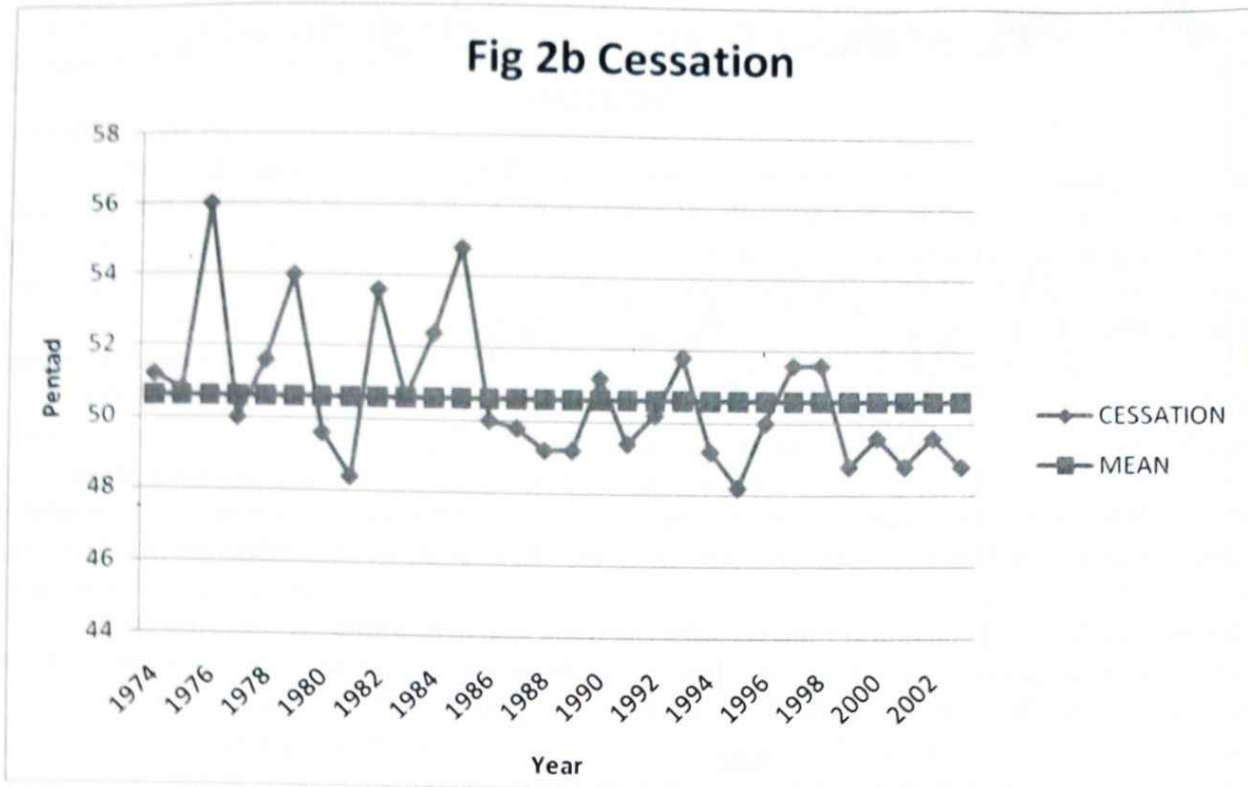


Fig 2c Length of Hydrologic Growing Season

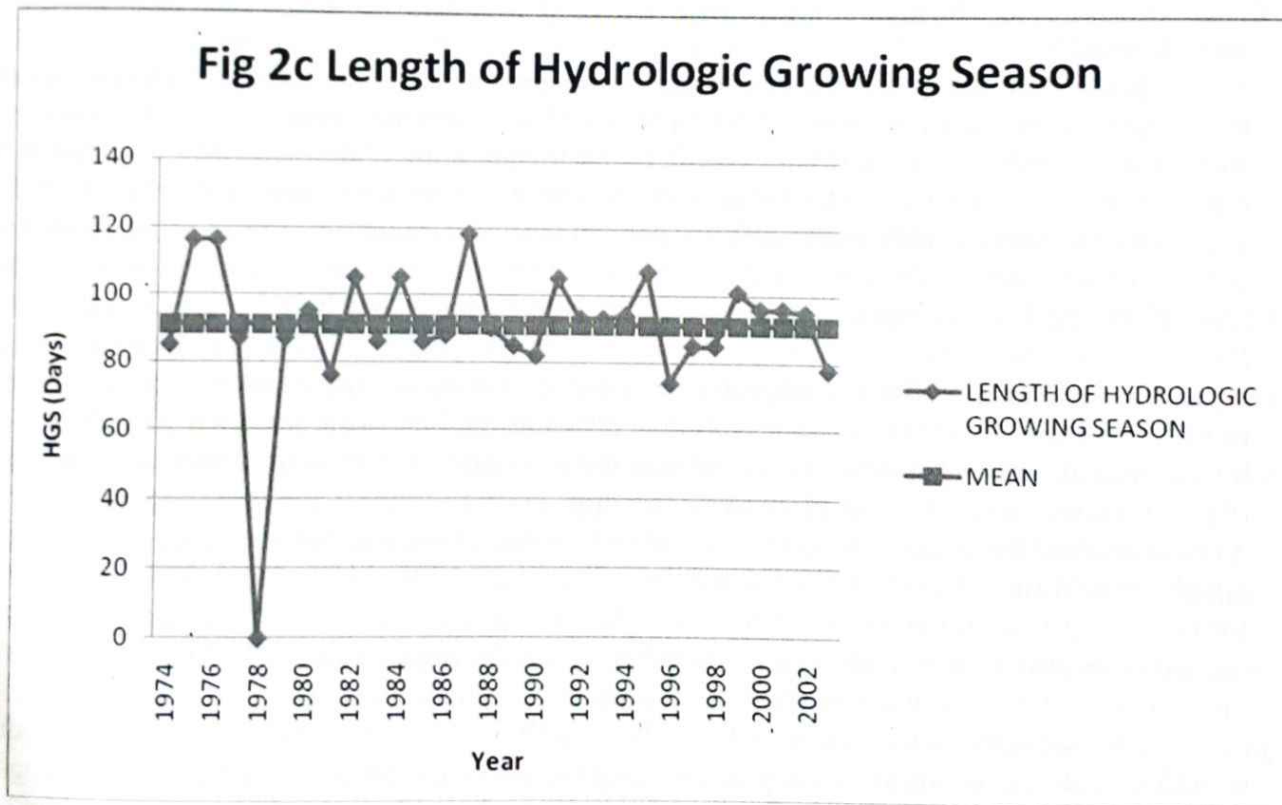
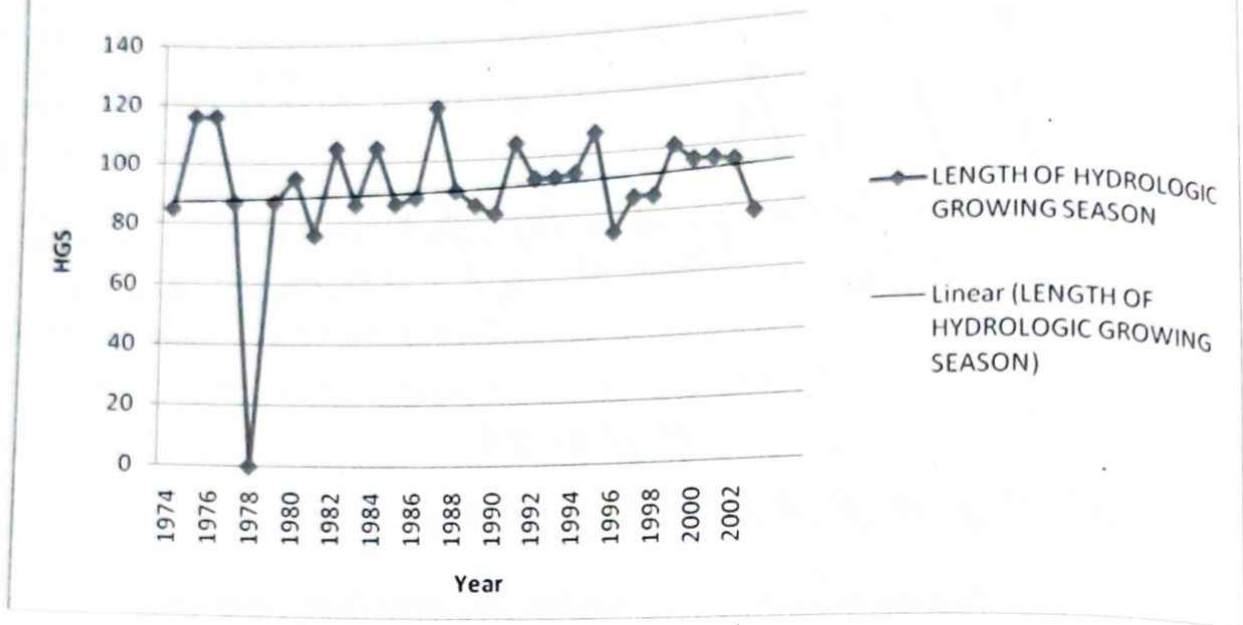


Fig 2d Linear Trend of Hydrologic Growing Season



DISCUSSION

It has been noted that the Hydrologic Growing: season in the Sahel is synonymous to the Length of the Rainy Season (LRS). In terms of soil carrying capacity, it is the period of surplus soil moisture when rainfall exceeds evapo-transpiration (Adefolau:1989). Be that as it may, it is an important parameter for agricultural and water resources management.

In his studies (Olaniran, 1987a) pointed out that planting simultaneous with the defined onset dates of the rains is positively correlated to crop yield even in the transition zone from the Guinea -Sudan (to the south)to the Sudan-Sahel belt (to North where the Hydrologic Growing Season is fairly coincident with the Length of the Rainy Season (LRS). It has also been observed that there is higher tendency for occurrence of early cessation of the rains following each other in succession than either normal and late cessation (fig. 2b). This implies that the early cessation of the rains is more consistent than normal and late cessation (fig 2b). However in the case of onset of the rains normal onset of the rains appeared to' be more consistent than either early or late. This of course shows a disturbing trend as it implies a high probability of occurrence of shortfalls in the length of the Hydrologic Growing Season for normal agricultural activities in the state. According to Huda *et al* (1981). If a shortfall in the duration of the rainy season (HGS coincides with the rainy season (HGS) coincides with the crop growth period, it might result in a substantial reduction in yield.

The agricultural implication of the above is that there should be intensification on the adoption of strategies for alleviating or avoiding the adverse effects of shortfalls in the length of the Hydrologic Growth Season in virtually all the ecological zones of the state. This can be particularly achieved through manipulation of crop varieties extended to all crop grown in the state, which should be made readily available to the local resource users. This observation is in corollary with that of Bello (2001:137) who noted that "Selection of cultivars with appropriate phonologies that synchronize the crop's growth cycle with the period of effective

water availability is recommended to avoid agricultural drought and failure of crops to mature at the end of the growing season.

CONCLUSION

The study analyzes the significance of rainfall effectiveness indices most critical to plant growth in Sokoto State. A fluctuation in the length of the Hydrology Growing Season is analyzed. It has also been emphasized that shortened length of the Hydrologic Growing Season could damage plant development and consequently affect yield. When onset of rains is delayed or there is premature cessation occurring simultaneously in a single rainy season, it can lead to abnormally short. Hydrologic Growing Season.

In general, since there is higher tendency for normal onset and early cessation of rains in the state, the beginning of the growing season in the state should be concentrated around the mean onset date of the rains in order to avoid crop failure arising from incidence of dry spells that is a normal characteristics at the commencement of rain season. This is in addition to the selection of crop cultivars that are drought resistant and making these available to local farmers.

Furthermore, for more efficient supplemental irrigation, knowledge of the estimation of the water equivalent to avert drought which is a criterion [or satisfying the potential evapotranspiration condition of each ecological zone in the state is required for optimum crop production. Water equivalent to avert drought according to (Flohn et al, 1974) is the exact amount of water that will be required to irrigate a field for effective plant growth development and yield. In addition, both the state and the federal governments should intensify their irrigation projects by concentrating more on medium and small scale dams than hitherto large scale ones which are not only costly in material terms but in human terms as well.

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