ANALYSIS OF TRENDS IN MONTHLY RAINFALL PROFILE FOR KATSINA, KATSINA STATE (1946-2006).

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Abstract

This study examines the trends in annual totals and pattern in monthly distribution of rainfall in Katsina lat. $12^0 03^-$ N Long $08^0 32$'N. Daily records of rainfall over a period of 60 years(1946-2006) were used. The annual and the monthly rainfall data were subjected to normality test using Fisher's standardized co-efficient of Skewness (Z_1) and Kurtosis (Z_2). The result shows that over 85% of the data conform to the Gaussian normal distribution at 95% significant confidence limit. A linear regression technique was used to determine trend in both monthly and annual distribution. To further determine the trend, ten years and five years running mean were also used. The results show that, all the rainy months under study conform to the annual rainfall trends which started to decline in the 1960's. Monthly rainfall value shows an abrupt and frequent extreme variability between years with the exception of August. However, sometimes increase in monthly values reduces the frequency and intensity of such occurrence. This extreme variability is often described as catastrophic to crops at all stages of development.

Key words; Rainfall ,Annual, Monthly ,Skewness ,Trends

1. Introduction

In the tropics rainfall assume significance in nearly every phase of agricultural activity. From the timing of cultivation, planting and harvesting operation, to the timing of fertilizer application, variety selection and transplanting. The movement of the rainfall belt therefore provides a framework for the correct timing of these operations (Ilesanmi, 1972).The gross feature of rainfall pattern in Nigeria, as in parts of west Africa are usually considered in association with the inter-tropical discontinuity (Adejokun, 1965, Garnier, 1967 and Ilesanmi, 1969).The discontinuity is a moisture boundary separating the air of northern origin from that of the southern origin. The climatological significance of the ITD is that it provides a framework for following the south-north motion of the rain- bearing southerly air. The depth and motion of this moist air mass not only influences the rate of fall of rainfall, but also affects the duration and the spread of rains (Ilesanmi, 1972).

Rainfall in this region is low, highly erratic and unpredictable. Dry spells often occur at the beginning of the rainy season in this area and at times become disastrous to crops shortly after planting (Ati, 1996). . The start of the rain in the tropics is seldom abrupt, but is usually foreshadowed by a succession of isolated showers of uncertain intensity with intervening dry period of varying duration (Ojo, 1977, Ati, 2002).The break of the rainy season may be early in some years, greatly delayed in others (Bationo et al, 1997). Annual totals show a wide variation from year to year, whereas in any given year the incidence may show remarkable irregularities since the rains fall almost entirely as heavy showers or thunderstorms and this will greatly affect the yield of crops as observed by Anuforum and Okpara (2003).The annual rainfall variability is between 20-30 per cent in the Sudan savanna (Kassei and Afuakwa, 1993). Most of the researches in the Sudano-Sahelian region especially on annual rainfall amount show declining trend (Adefolalu, 1986b, Oladipo, 1989 and Anyadike, 1992).However, recent researches on trend especially those that encompasses data of mid 1990s and early 2000s indicate an increase in the annual rainfall amount. However, August rainfall is on the decline in the region (Ati, 2006).So if the annual rainfall is on the increase and August rainfall is on the decrease, then the rainfall structure might be witnessing changes in the region, as August is considered traditionally the wettest month in the region. This study attempts to investigate the pattern of monthly rainfall profile in Katsina. It has been observed that the quantity and quality in some months is critical to certain stages of plant growth, (Ilesanmi, 1972, Adebayo and Adebayo, 1998, Ibrahim et al, 2006).

2. Study area

Katsina is located on latitude $13^{0}01'$N Longitude $07^{0}41'$.The study area belong to the savanna bio- climatic type with alternating wet and dry season. It is characterized by a strong seasonality in rainfall and relatively high temperature (Iguisi, 2002).Rainfall is less than 1000mm per annum and occurs in only five months in the year between May and October. Rainfall is highly variable and onset of the rains is erratic (Ati, 2002). The daily sunshine duration is 8 hours. Air temperatures are constantly high with high evaporative demands. The potential evapotranspiration is only exceeded by actual rainfall from June to September and not very often in June (Mortimore and Wilson, 1965, Oguntoyinbo, 1983, Sivakumar et al, 1991, Falola et al, 1993).

The vegetation of the study area is of Sudan Savanna type, made up of short grasses 1-2 meters high and stunted trees. The predominant tree species are locust bean, and various species of Acacia and fig families (ficus), the dump palm, the silk cotton and baobab. A prolonged period of bush burning, over grazing, cultivation and tree harvesting for cooking purposes has considerably degraded the vegetation cover to open grassland, bare surface and scattered scrubs. The grass communities sprout up shortly after the onset of the rainy season, blossom and become luxuriant almost completely covering the ground surface towards the later part of the rainy season. The grasses wither and turn rustic brown in the dry season (Iguisi, 2002).

3. Materials and methods

Materials for the research includes record of daily rainfall for 60 years (1946-2006) from the stations spread and were sourced from the Nigerian Meteorological Agency (NIMET) Office Oshodi Lagos. The data from the stations were subjected to normality test to examine whether the data is normally distributed using the standardized coefficient of Skewness (Z_i) and Kurtosis (Z_2) defined by Brazel and Balling (1986) as
Skewness

$$Z_1 = \{[\sum_{i=1}^{N}(x_1 - \bar{x})^3 / N]/[\sum_{i=1}^{N}(x_i - x)^2 / N]^{3/2}\}/(6/N)^{1/2}$$

Kurtosis

$$Z_2 = \left[\frac{\sum_{i=1}^{N}(x_i - \bar{x})^4}{N} / \sum_{i=1}^{N}(xi - \bar{x})^2 N \right] / \sqrt{24/N - 3}$$

Annual and monthly rainfall totals were calculated by summing up the daily rainfall data for each year in the station within the period under study.

Linear regression technique was used to test for trends in the rainfall series (Annual and monthly totals) in order to determine whether there is any monotonic increases or decreases in the average values between the beginning and the end of the series
Five -year and ten-year running means were calculated to further specify the character of the rainfall totals (annual and monthly).
The computed means stand as long term means for the annual totals (for the entire period). The period under study was sub-divided into non-overlapping sub-periods (1947-1956, 1957-1966, 1967-1976, 1977-1986, 1987-1996, and 1997-2006).

The decadal mean were compared with long term mean and their significance tested using crammer’s test.

$$t_k = \left[n(N-2)/N - n(1+t^2{}_k)\right]^{1} /_2\, t_k$$

4. Discussion of results

The annual rainfall value in Katsina from 1946-2006 are normally distributed at 95% confidence limit. Regression line indicates a declining trend. Five year running mean indicate values above the long term mean in the first two decade. From then the value decline and remain below the long term mean with a sudden increase between 1977-1983.

The decadal means of annual rainfall shows the first two decade with high values above the long term mean. While the last four decades have values below the long term mean.

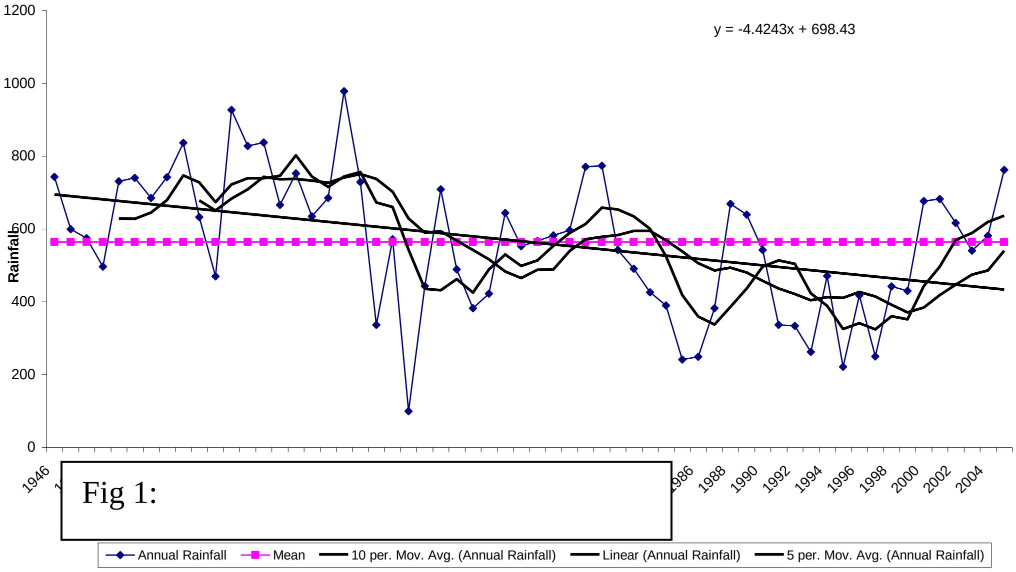

Fig 1: **Annual rainfall trend for Katsina**

Fig 2: **Relationship between decadal means and long-term mean for annual rainfall in Katsina**

The May rainfall values are normally distributed at 95% confidence limit. Regression line indicates a declining trend. Five year running mean from figure 1 indicates values above the long term mean from the beginning until early 1960's, then the value decline until early 1970's with a sudden increase between 1965-1968 and then the values remain below the long term mean with a sudden increase between 1992-1995.

Table 1: Statistics of Monthly Rainfall in Katsina 1946-2005**.**

	May	June	July	August	September	October
Mean	28.11967	68.7845	152.7472	208.7017	94.32819	10.80167
S/Dev	29.39122	41.53965	80.33017	87.33501	53.1479	19.23772
CV	104.5219	60.391	52.59028	41.84682	56.34302	177.9842
Skew	1.133265	0.316402	0.103044	0.575623	0.453303	2.049501
Kurt	0.640993	-0.75015	0.02087	-0.43257	0.385882	3.309658

Source: Authors' computation

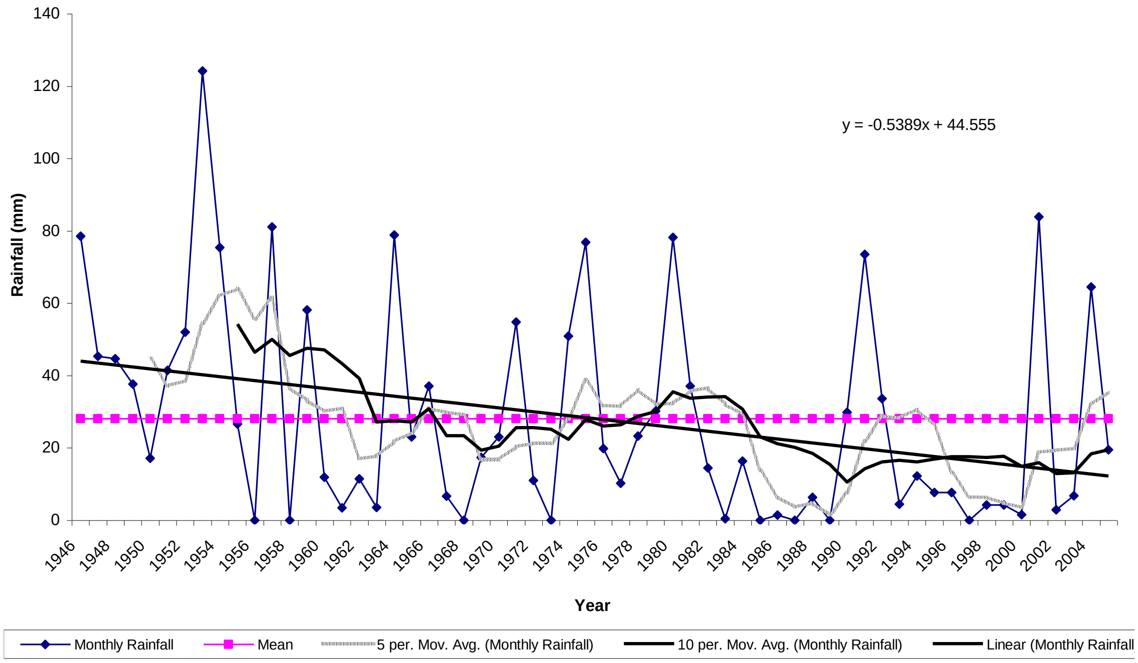

Fig 3: **Trends in May rainfall in Katsina for 60 years (1946-2005)**

The June rainfall values are also normally distributed at 95% confidence limit. Regression line indicates a declining trend. Five year running mean in figure 2 indicate values below the long term mean from the beginning with sudden increase in the first decade, then values decline below the long term mean in late 1960's and increase again in mid 1970's and the value decline below the long term mean in mid 1980's only to increase in the mid of the last decade.

The decadal mean of rainfall value shows high value above the long-term mean in the first, second and fourth decade. The third and fifth decade are having low values below the long term mean. The last decade had moderate value along the long-term mean.

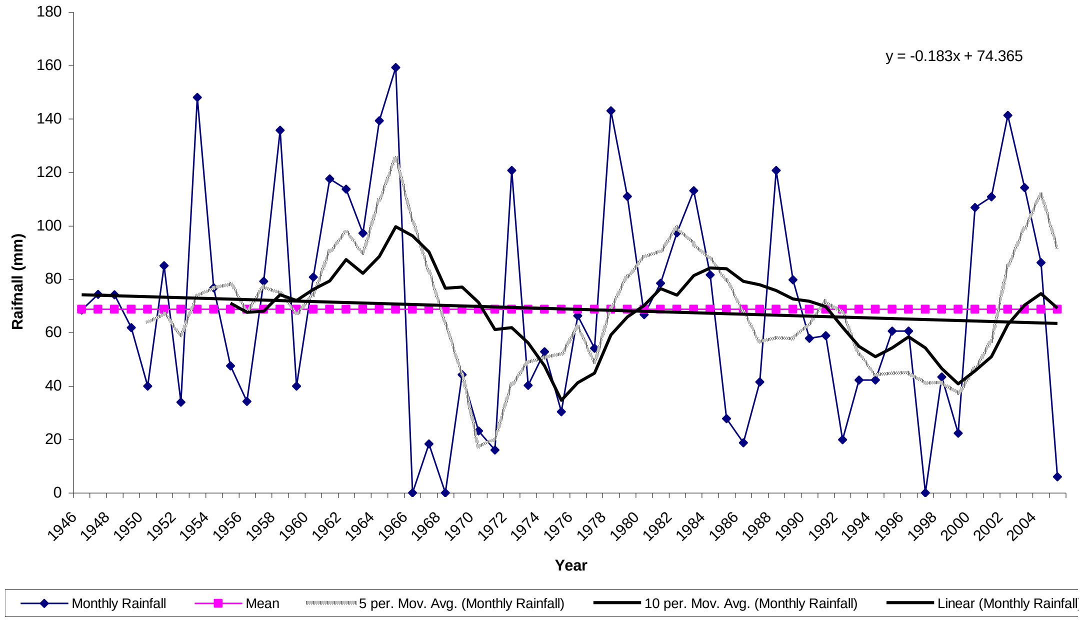

Fig 4: **Trends in June rainfall in Katsina for 60 years (1946-2005)**

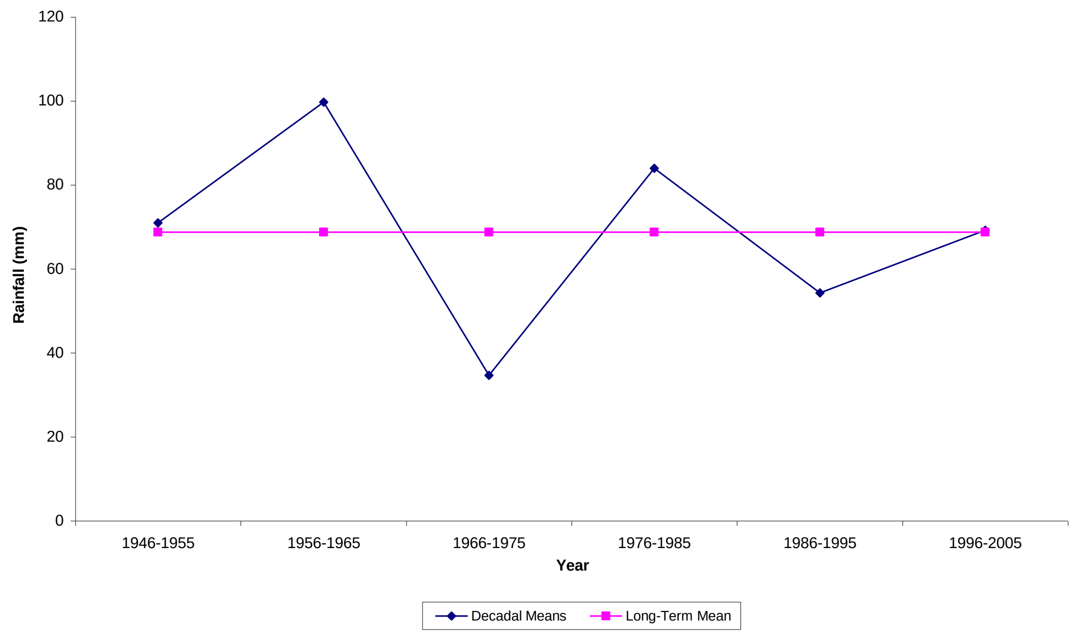

Fig 5: **Relationship between decadal means and long-term mean for June rainfall in Katsina**

The July rainfall values are normally distributed at 95% confidence limit. Regression line indicates a declining trend. Five year running mean in figure 3 indicate values above the long term mean in the first two decades. From then the values decline and remain below the long term mean until toward the end of the last decade with a sudden increase between 1977-1984.

The decadal mean of July rainfall value shows values above the long term mean in the first, second and fourth decade. The third, fifth and last decade indicates low value below the long-term mean. Fig. 6.

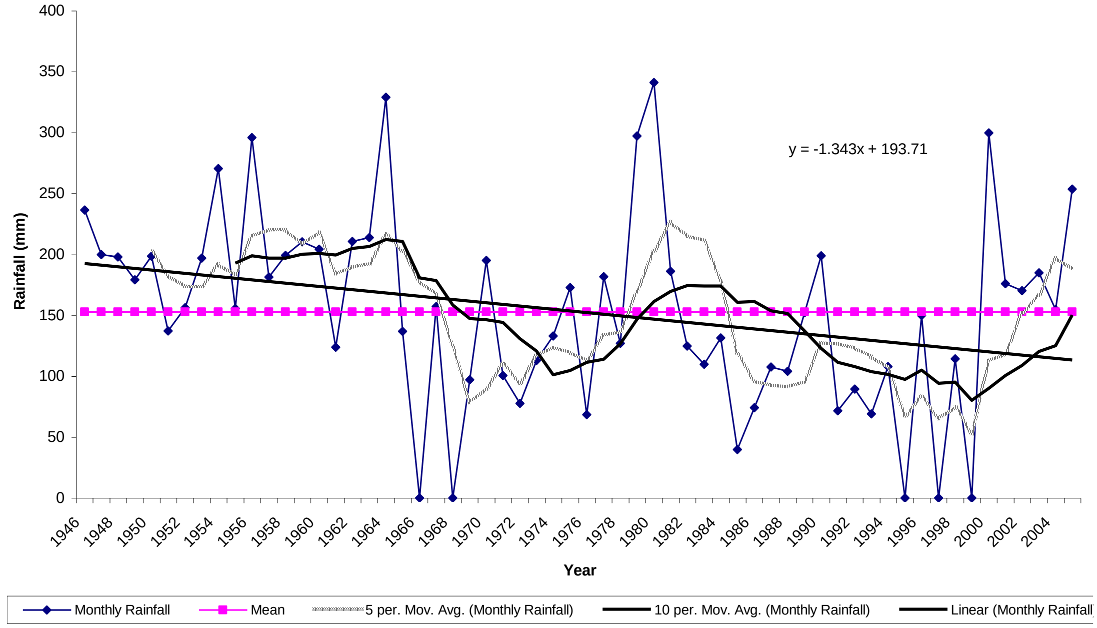

Fig 6: **Trends in July rainfall in Katsina for 60 years (1946-2005)**

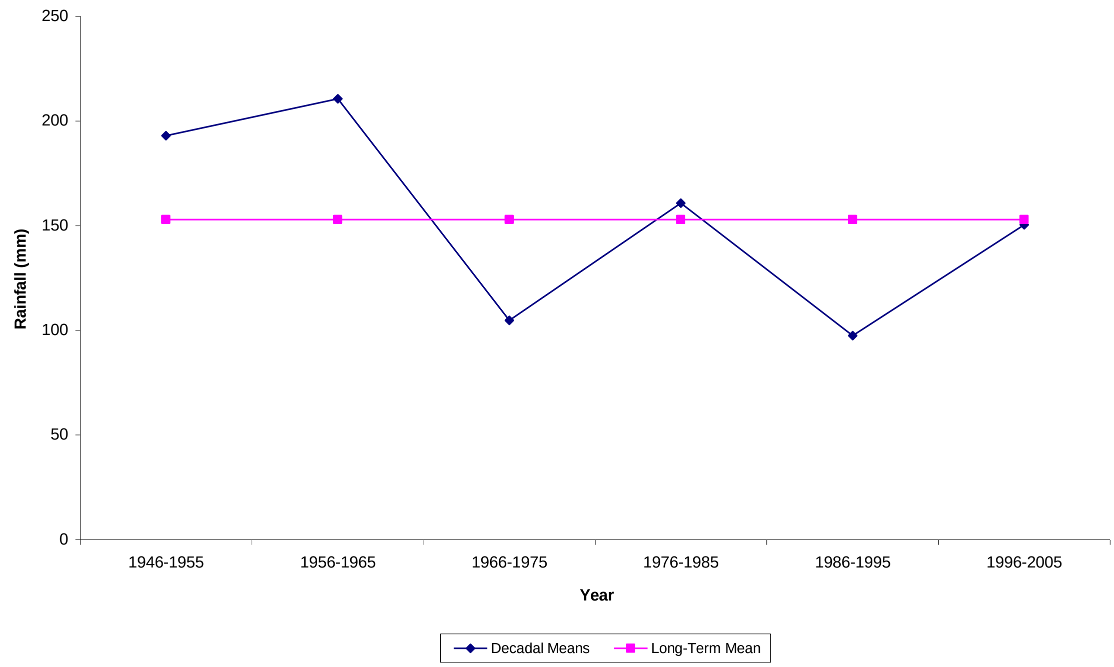

Fig 7: **Relationship between decadal means and long-term mean for July rainfall in Katsina**

The August rainfall values are normally distributed at 95% confidence limit. Regression line indicates a declining trend. Five year running mean in figure 4 indicates values below the long term mean from the beginning with a sudden increase the first decade.

From then the value remain above the long term mean until early 1970's. From then the value decline and remain below the long term mean with a sharp increase between1975 and 1977-1978

The decadal mean of August rainfall value shows the first three decade with high values above the long-term mean. While the last three decades have values below the long-term mean.

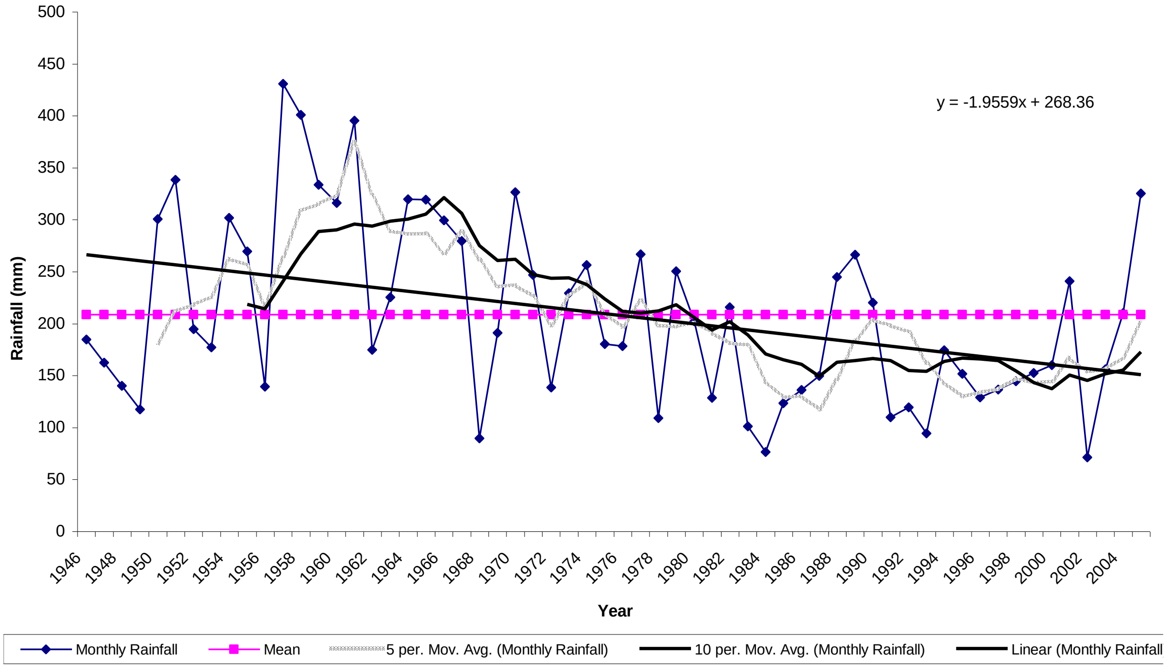

Fig 8: **Trends in August raiinfall in Katsina for 60 years (19462005)**

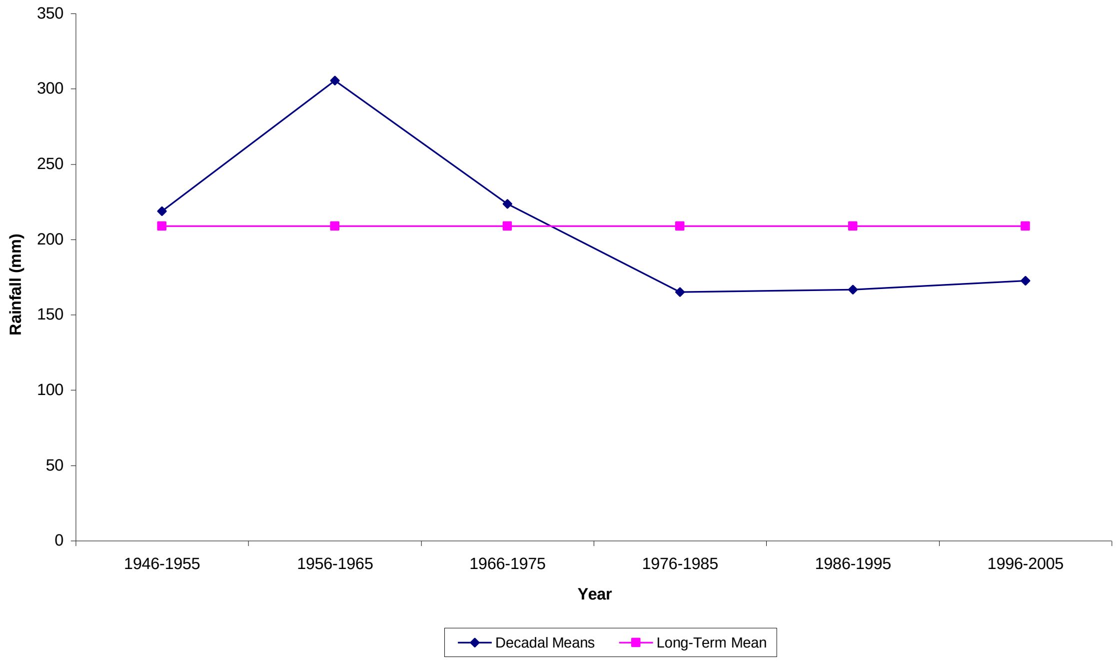

Fig 9: **Relationship between decadal means and long-term mean for August rainfall in Katsina**

The September rainfall values are normally distributed at 95% confidence limit. Regression line indicates a declining trend. Five year running mean in figure 5 indicates values above the long term mean in the first two decade. From then the value decline and remain below the long term mean until early years of the last decade with a sudden increase between 1977-1981.

The decadal mean of September rainfall value shows the first, second and the last decade with values above the long-term mean. While the third, fourth and fifth decade are having values below the long-term mean.

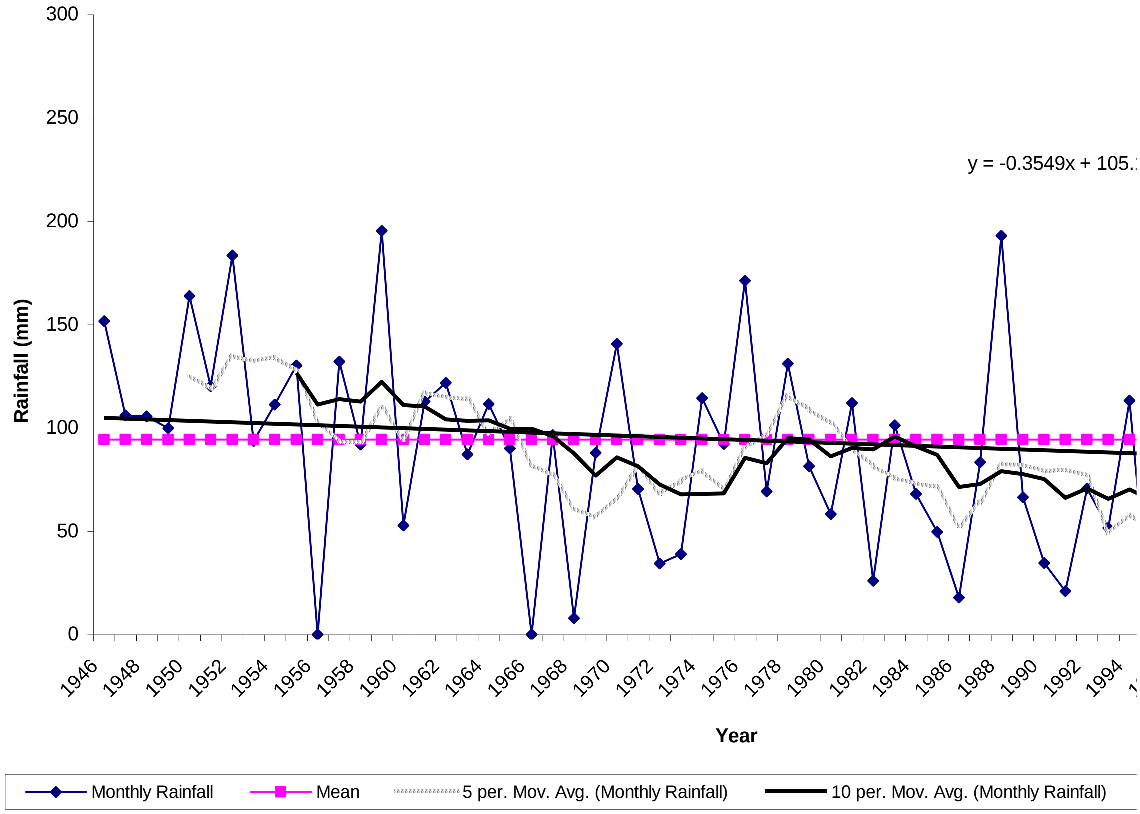

Fig 10: **Trends in September rainfall in Katsina for 60 years (1946-2005)**

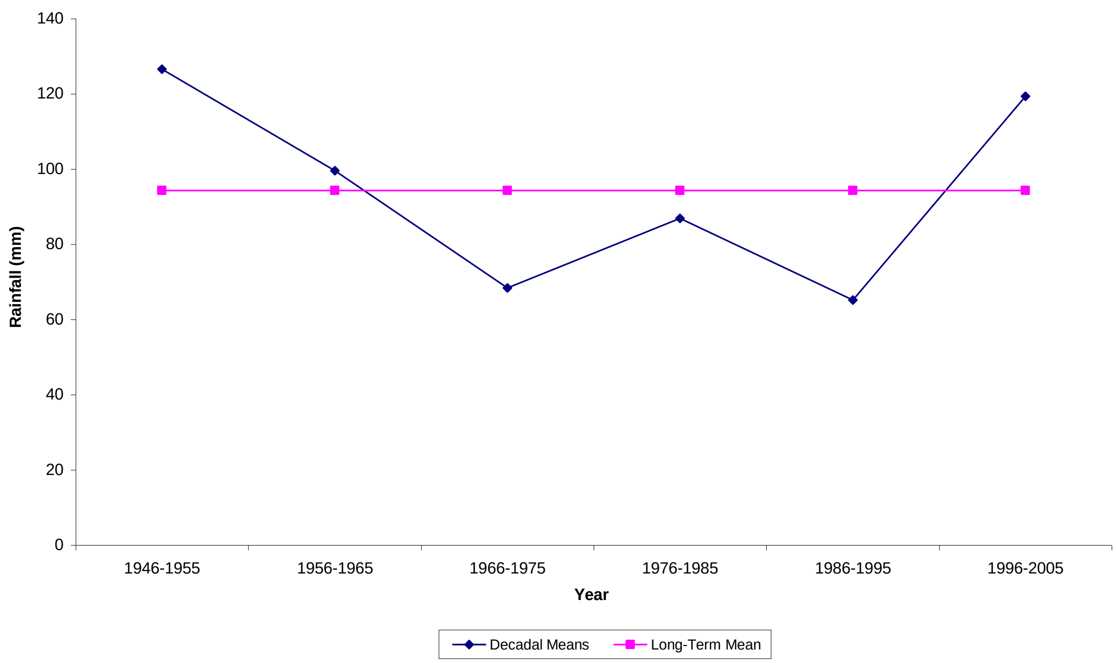

Fig 11: **Relationship between decadal means and long-term mean for September rainfall in Katsina**

The October rainfall values are normally distributed at 95% confidence limit. Regression line indicates a declining trend. Five year running mean in figure 6 indicates values above the long term mean in the first decade. From then the value decline below the long term mean in the second two decade with an increase between 1963-1968. The value decline again toward the end of the fourth decade and remain below the long term mean until mid of the last decade with a sudden increase between 1989-1995.

The decadal mean of October rainfall value shows high values above the long-term mean in the first and fourth decade. While the second, third, fifth and the last decade were having low value below the long-term mean.

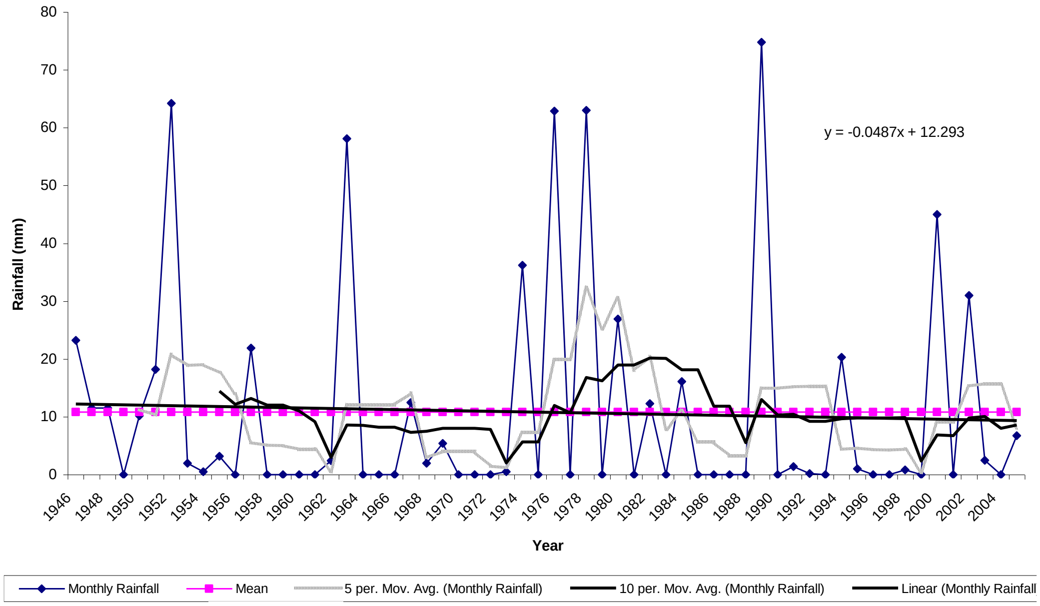

Fig 12: **Trends in October rainfall in Katsina for 60 years (1946-2005)**

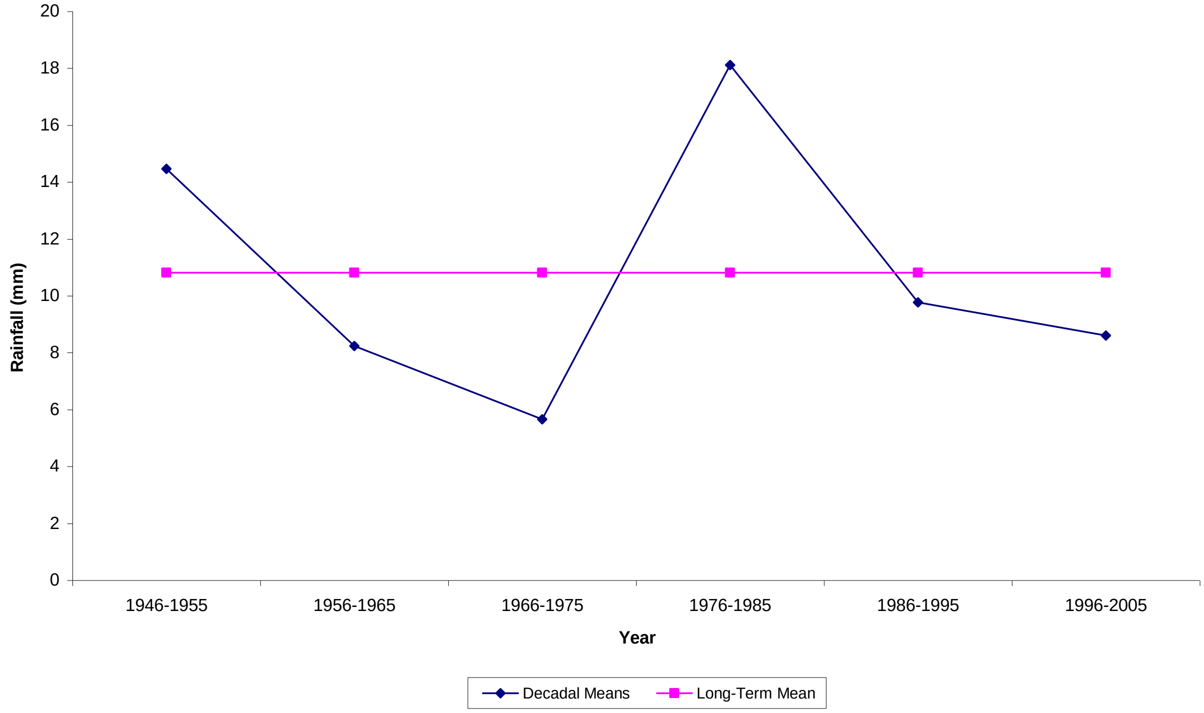

Fig 13: **Relationship between decadal means and long-term mean for October rainfall in Katsina**

5. Conclusion

All rainy months in the station conform to the annual trend of a declined trend. This indeed conform to the earlier findings in the region(Oladipo and Salahu,19 93).Decrease in May and October monthly rainfall value may shortens the length of the growing season, as both onset and cessation are determine by certain accumulated moisture value (Cocheme and Fraquin,1967;Walter,1967;Ilesanmi,1972;Benoit,1977 and Sivakumar,1988).Decline in May monthly value will lead to increase risk in determining optimum planting date. Because, the spread of rain, frequency and intensity are largely determined by the amount of rainfall received in that particular month (Oladipo and Salahu, 1993).This will lead to repeated planting on one hand and late sawing on the other. This will directly affect crops yield as rainfall may cease before crops reach maturity.

In general, government should constantly be monitoring rainfall variation in the region for proffer management of the recourses. Farmers should be provided with durable crops that can resist damaging dry spells as rainfall reliability are determined by the amount(annually or monthly).

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