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A comparative study between length of growing season, millet (*Pennisetum americanum* L) and sorghum (*Sorghum bicolor* (L) moench) yields in Kano state, Nigeria

Haruna Saleh and Murtala Mohammed Ruma

Abstract
This research focused on the comparative study between the length of growing season, millet (*Pennisetum americanum* L.) and sorghum (*Sorghum bicolor* (L) moench) yields in Kano State, Nigeria in the period spanning from 1981 to 2010. The data for the investigation are daily rainfall records, millet and sorghum yields sourced from Nigerian Meteorological Agency (NiMet) at Aminu Kano International Airport and Kano State Agricultural and Rural Development Authority (KNARDA) respectively. The study attempted to identify the level of length of growing season, millet and sorghum yields in ton/ha, examine the trend of length of growing season, millet and sorghum yields and compare their trends. Data collected analyzed using decriptive statistics and least square regression model. Descriptive statistics was used to compute cumulative pentad rainfall and an ogive of cumulative rainfall pentad. Using Pentad and Julian day calendars, an annual ogive of cumulative pentad was drawn using Microsoft Excel and determined length of growing season in the study period. Least square regression model was used to determine linear trend line and trend directions of length of growing season, millet and sorghum yields. Results obtained indicate that as the trend of length of growing season increases, the trends of millet and sorghum yieds decreases. Based on these results, it recommended that agricultural stakeholders should encourange farmers toward intensive agriculture rather than extensive by providing adequate agricultural inputs at subsidize price.

Keywords: Comparative, length of growing season, millet yields, sorghum yields, Kano state

Introduction

Length of growing season defined as the period of the year during which rainfall distribution characteristics are suitable for crop germination, and full development (Odekunle, 2004) [12]. It is a period of the year categorized as rainy or wet season. The length of the growing season varies spatially and temporally. The length of growing season can be determined by subtracting for each year, the date at which the rains start from the date that it ends (Madeoye, 1986; Zargina, 1987) [9, 23]. Oladipo and Kyari (1993) [13] in their study of growing season rainfall of Northern Nigeria indicated that the onset, cessation and length of growing season show latitudinal progress but with some disruptions due to geographic effect in the central area (Jos). Adefolalu (1993) [1] stated that the length of the growing season can be obtained by subtracting the onset pentad from the cessation pentad and multiplying by five. Aliyu (2009) [2] observed a downward trend in the duration (length) of the growing season in some locations in northern Nigeria from 1978 to 2007, with a significant variability in most of the stations north of latitude 9□N in Nigeria. Odekunle (2004) [12] also observed that rainfall during the crop-growing season determines crops germination, establishment and full development. He further defined growing season as period between onset and cessation of the rains. The length of the growing season (days) for a particular year considered as the difference between the Julian day number of the determined cessation date and determined onset for that year.

Studies conducted in Semi-arid parts of West Africa indicated that, there is a significant relationship between the start of rains and the length of growing season (Sivakumar, 1988). Thus, earlier onset most often leads to longer length of growing season and late onset shorter length of growing season. This is an indication that the length of growing season is more dependent on rainfall onset than its cessation (Omotosho, 1992) [17].

The length of growing season often determines which crops could grow in an area, as some crops require long growing seasons, while others mature rapidly. Among authors that have emphasized linkages of the growing season with reliable onset of rains are Dagga (1965) [7], Bello (1996), Olaniran (1983 and 1984) [14, 15], Ati, *et al* (2002) [4], Sawa and Ibrahim (2011) [20].

The Nigerian Savannah ecology is the major cereal production area in Nigeria. It accounts for about 665,600 square kilometers (about 67 million hectares), which also represent about 70% of the geographical area of Nigeria (Idem and Showemimo, 2004) [8]. The West African semi-arid tropics defined as those areas where rainfall exceeds potential evapotranspiration for two to seven months annually. This area encompasses the northern portions of Nigeria, with Kano State inclusived. Cereals occupy nearly 70 percent of total cultivated areas in this region and engage 50 to 80 percent of total farm-level resources (Matron, 1990) [11]. Millet and sorghum account for 80 percent of cereal production. During the last 25 years, growth in millet and sorghum production has been slow and the total output has been about one percent lower than the population per year. Average yield per unit area of millet and sorghum has declined during this period, and the small production increases have primarily resulted from expansion of cropped area. Matron (1990) [11] reported that, the potential for major increases in sorghum and millet supplies exist only in the Sudano-Guinean zone and to a lesser extent in the Sudanian zone. Sorghum is widely grown both for food and as a feed grain, while millet is produced almost entirely for food. Millet and Sorghum depend almost entirely on rainfall as their moisture supply. The amount and distribution of rainfall are important factors in determining the ultimate productivity of these crops. It estimated that Sorghum together with Millet accounts for over 60% of cereal production in Nigeria (Awoyemi, 1986) [5].

Millets and sorghum constitute a major source of calories and protein for millions people of Kano State and Nigeria at a large. The unreliable empirical knowledge between length of growing season, Millet (*Pennisetum americanum* L) and Sorghum (*Sorghum bicolor* (L) moench) Yields in Kano State often causes a great threat to agricultural productivity. Most a time these crops are planted without comparing their levels and trend with the levels and trend of length of growing season, consequently, often lead to uncertainty on the nature of their yields for many decades ago. It is against this background this paper aimed to compare length of growing season with Millet (*Pennisetum americanum* L) and sorghum (*Sorghum bicolor* (L) *moench)* yields in Kano State through the following objectives:

1. Identify the level of length of growing season from 1981 to 2010
2. Determine level of millet and sorghum yields in ton/ha in the study period
3. Assess the trend of length of growing season, millet and sorghum yields in the study period
4. Compare the trend of length of growing season with millet and sorghum yields

Materials and Methods

Study Area

Kano State extends from latitudes 10^0 3' N to $12^0$3'and longitudes $7^0$35'E to $9^0$20'E (Fig.1). It made up of 44 Local Government Areas. Out of which 38 are in the rural areas of the state. The total area of the state is about 20,780sq km (Research and Documentation Directorate Kano, 2009). The climate of Kano is also desccibed as seasonally arid. In southern Kano rainy seseason average is about 150 days, May to October. The mean annual rainfall in southern parts of Kano is about 1000mm and in the North, it is 635mm (Sara and Charles, 1988) [19]. The climate of Kano is described as Aw by Koppen, with both annual and seasonal variabilities, wet years and dry years may record between 850 and 750mm (Olofin, 1987:14) [16]

The Vegetaion of the study area is Sudan Savanna type. Olofin (1987) [16] observed that the natural vegetation of the study area is tropical grassland characterised by scattered trees, which hardly exceed 20 metres high. The soil of the region is tropical ferruginous rich in sand, while the zonal soils are also influenced by human munipulation to varying degrees (Olofin, 1987) [16].

Types of Data Utilized

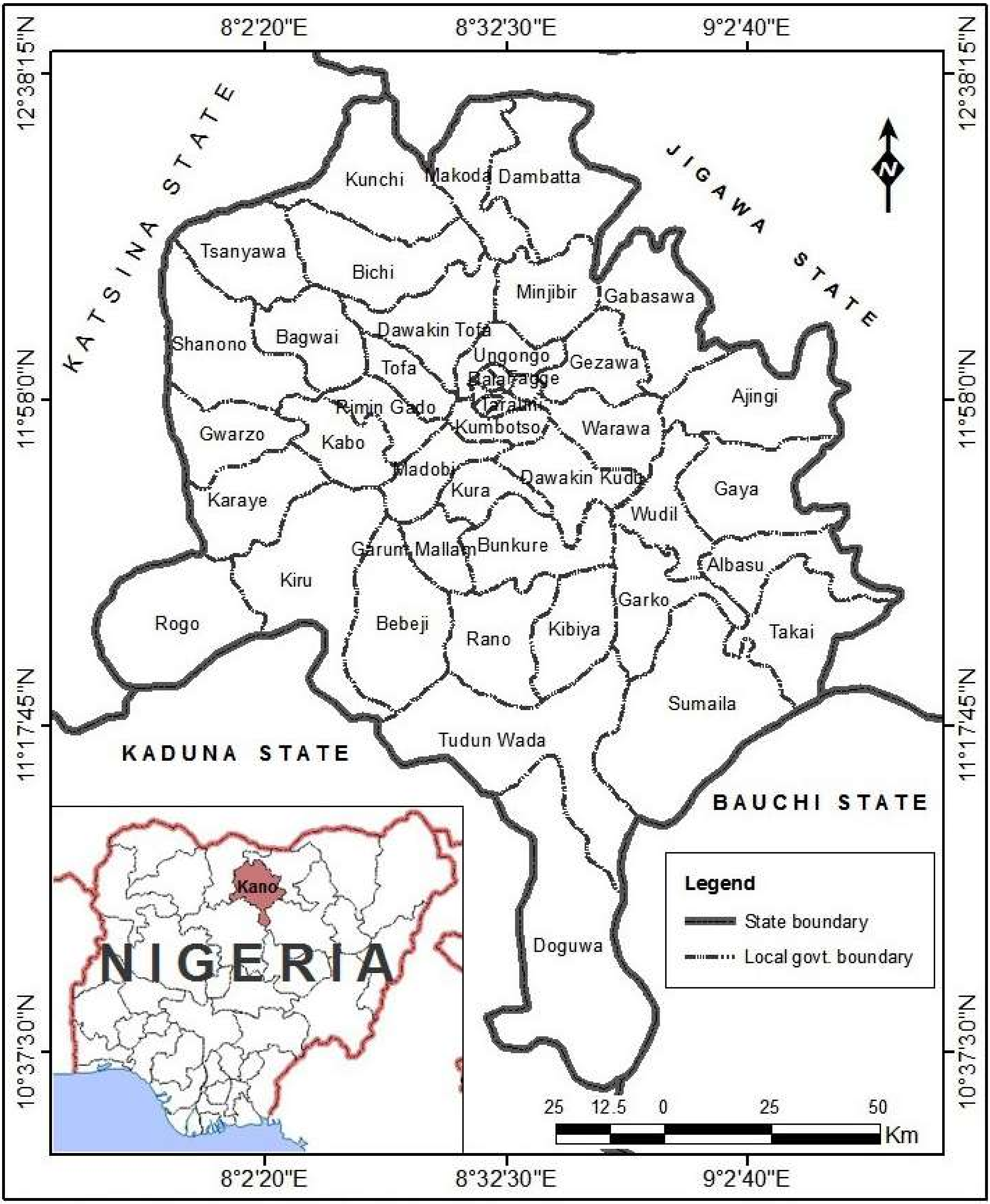
In this type of empirical study, daily rainfall records and annual records of millet and sorghum yields in ton/ha are required. The analysis of daily rainfall covers the period of study (1981 to 2010) and the length of growing season – 1st May to 31st October, for this is the period when this State receives about 95% of total annual rainfall (Anyadike, 1993) [3]. The analysis of millet and sorghum yields in ton/ha did not cover the entire study period due to nonavailable of one-year record of millet and sorghum yields. Therefore, analysis of these crops covers the period from 1982 to 2010.

Sources of Data

Daily rainfall data for the study area sourced from the Nigerian Meteorological Agency (NIMET) at Aminu Kano International Airport Kano, Kano State. While, the annual records of millet and sorghum yields in ton/ha are sourced from Kano State Agricultural and Rural Development Authority (KNARDA)

Derivation the Level of Length of Growing Season

Daily rainfall data for the period 1981 to 2010 for Kano State that sourced from the Nigerian Meteorological Agency (NIMET) at Aminu Kano International Airport used to derive the level of length of growing season based on onset and cessation dates of rains. A method adopted by Adefolalu (1993) [1] which was based on relative defination adopted to derive the level of length of growing season in the study area. Using this method, the onset and cesssation dates of rains determined by dividing each year into pentads, making 72 pentads. Using pentad calendar (Table 1) cumulative pentads rainfall then calculated for each year in the study period from 1981 to 2010. Cumulative pentad rainfall was plotted against the number of pentad giving an ogive for each year in the study area. The points on the pentad axis corresponding to the first and last points of the maximum inflexion on the rainfall ogive correspond to the onset and cessation pentads respectively. The last date in the onset pentad gives the exact onset date and the first date in the cessation pentad gives the cessation date of the rainy season. The gap between onset and cessation pentads gives the length of growing season.



Source: Geography Department UMYU Katsina. 2019

Fig 1: Map of Kano State (Study area)

Table 1: Pentad Calendar Table

January		Feb		March		April	
Pentad No.	**Dates**	**Pentad No.**	**Dates**	**Pentad No.**	**Dates**	**Pentad No.**	**Dates**
1	1st – 5th	7	1st – 5th	13	1st – 5th	19	1st – 5th
2	6th – 10th	8	6th – 10th	14	6th – 10th	20	6th – 10th
3	11th – 15th	9	11th – 15th	15	11th – 15th	21	11th – 15th
4	16th – 20th	10	16th – 20th	16	16th – 20th	22	16th – 20th
5	21st – 25th	11	21st – 25th	17	21st – 25th	23	21st – 25th
6	26th – 31st	12	26th – 28th	18	26th – 31st	24	26th – 30th
May		**June**		**July**		**August**	
Pentad No.	**Dates**	**Pentad No.**	**Dates**	**Pentad No.**	**Dates**	**Pentad No.**	**Dates**
25	1st – 5th	31	1st – 5th	37	1st – 5th	43	1st – 5th
26	6th – 10th	32	6th – 10th	38	6th – 10th	44	6th – 10th
27	11th – 15th	33	11th – 15th	39	11th – 15th	45	11th – 15th
28	16th – 20th	34	16th – 20th	40	16th – 20th	46	16th – 20th
29	21st – 25th	35	21st – 25th	41	21st – 25th	47	21st – 25th
30	26th – 31st	36	26th – 30th	42	26th – 31st	48	26th – 31st
September		**October**		**November**		**December**	
Pentad No.	**Dates**	**Pentad No.**	**Dates**	**Pentad No.**	**Dates**	**Pentad No.**	**Dates**
49	1st – 5th	55	1st – 5th	61	1st – 5th	67	1st – 5th
50	6th – 10th	56	6th – 10th	62	6th – 10th	68	6th – 10th
51	11th – 15th	57	11th – 15th	63	11th – 15th	69	11th – 15th
52	16th – 20th	58	16th – 20th	64	16th – 20th	70	16th – 20th
53	21st – 25th	59	21st – 25th	65	21st – 25th	71	21st – 25th
54	26th – 30th	60	26th – 31st	66	26th – 30th	72	26th – 31st

This method adopted in the derivation of length of growing season in the study area. The method utilizes daily rainfall data that makes it more accurate and precise method for determining the length of growing season. The typology of this method in 1981 for the study area presented in Fig. 2

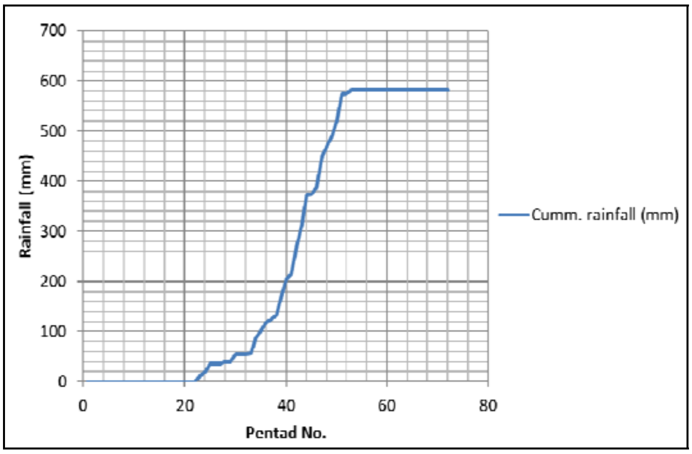


Fig 2: Ogive of cumulative pentad rainfall for 1981 for determination the level of length of growing season in Kano State

Data presented in Fig.2 reveal that the onset pentad falls on pentad 29 and the onset date of rainfall corresponds to 21- May in 1981 (Table 1). The cessation pentad falls on pentad 53 and the cessation date of rainfall corresponds to 25-September in 1981 (Table 1). Using Julian day and pentad calendar, the length of growing season in 1981 was 156 days (Table 2). Results for the other onset and cessation dates and length of growing season for the study period (1980 to 2010) obtained in similar manner using Julian day and pentad calendars.

Results and Discussion

The level of Length of Growing Season

Results on the level of length of growing season (LGS) in days for the study area in the study period 1981 to 2010 determined and presented in Tables 2. It could be observed that the level of length of growing varies within the study period. It was 156 days in 1981, 141days in 1982, 116 days in 1983, 161days in 1984, 136 days in 2004, and 161days in 2005 among other.

Table 2: The Level of Length of Growing Season at Kano from 1981to 2010

Years	LGS (Days)
1981	156
1982	141
1983	116
1984	161
1985	146
1986	110
1987	125
1988	115
1989	110
1990	90
1991	131
1992	131
1993	116
1994	85
1995	131
1996	146
1997	151
1998	156
1999	136
2000	136
2001	115
2002	131
2003	116
2004	136
2005	161
2006	141
2007	161
2008	130
2009	115
2010	181
Mean	133

Source: Data analysis, 2013

Level of Millet and Sorghum Yields in Ton/ha

Results on the level of millet and sorghum yields in ton/ha for the study area determined and presented in Table 3.

Table 3: Millet and Sorghum Yields in Ton/ha

Year	Millet Yield (Ton/ha)	Sorghum Yield (Ton/ha)
1981	NA	NA
1982	0.62	4.28
1983	3.59	2.14
1984	4.17	1.69
1985	4.24	2.54
1986	2.62	2.43
1987	4.77	2.24
1988	4.91	3.31
1989	3.04	2.48
1990	4.22	1.96
1991	1.38	4.27
1992	1.17	2.07
1993	1.90	1.85
1994	5.81	2.46
1995	2.08	3.29
1996	2.98	2.06
1997	3.56	2.42
1998	3.44	3.93
1999	1.33	1.77
2000	1.11	1.50
2001	1.57	1.96
2002	0.96	1.60
2003	1.75	1.44
2004	1.00	1.00
2005	1.00	0.98
2006	1.45	1.29
2007	1.28	1.37
2008	1.00	1.33
2009	0.95	1.93
2010	1.75	2.53

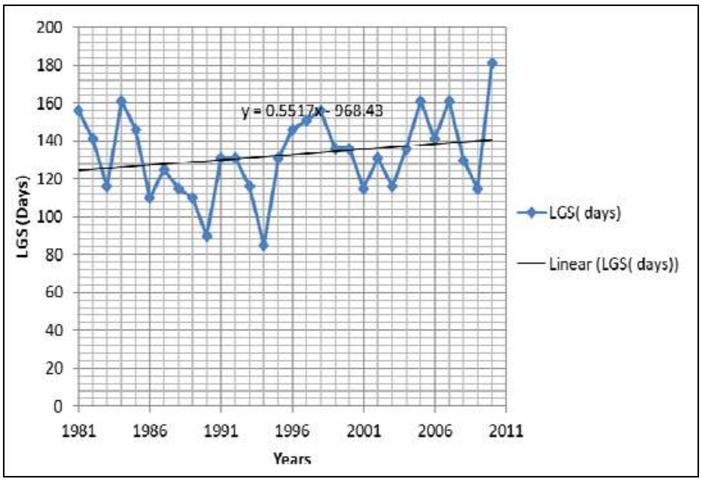
N: Not Available

Source: KNARDA, 2013

Data presented in Table 3 indicate the average millet and sorghum yields in ton/ha for Kano State from 1982 to 2010. Within the period of study, only record of 1981 of these crops was unavailable. The results indicate temporal variation in the level of millet and sorghum yields in Ton/ha among the studied the years. For instance the level of millet yield was 0.62Ton/ha in 1982, 3.59Ton/hs in 1983, 5.81Ton/ha in 1994 among other. The sorghum yield was 4.28Ton/ha, 2.14Ton/ha and 2.46Ton/ha in 1982, 1983 and 1994 respectively and among other.

Trend of Length of Growing Season

Results on trend of length of growing season for the study area obtained and presnted in Fig.2



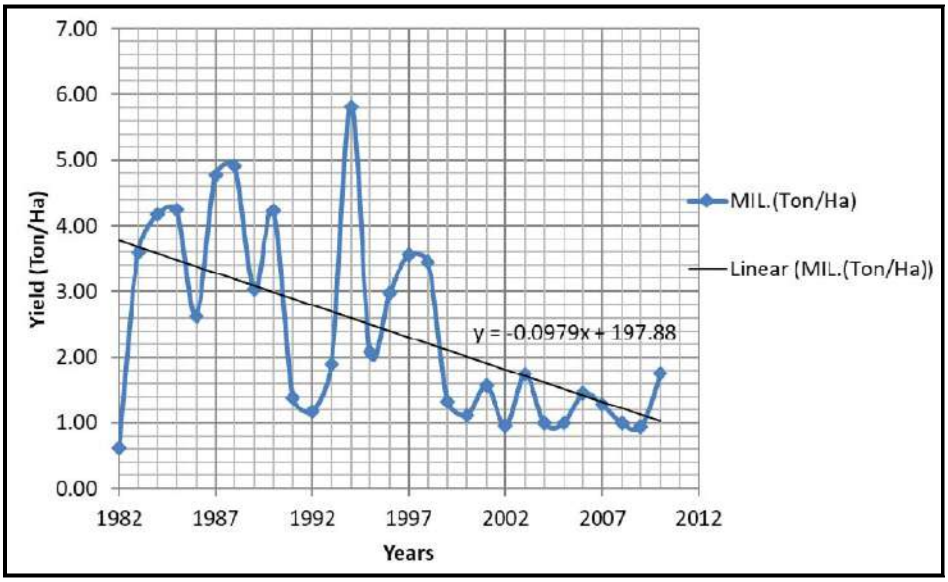
Source: Data Analysis, 2013

Fig 2: Trend of Length of Growing season in State Kano (1981 to 2010)

Data presented in Fig.2 reveal that the linear trend equation of the length of growing season in days is y = 0.5517x – 968.48. The slope, of the linear trend equation indicates positive direction, meaning increasing trend in length of growing season in the studied period. It could be observed that the longest length of growing season recorded in the study preiod was 181days in 2010.

Trend of Millet Yields in Ton/ha

Results on trend of millet in Ton/ha determined and presented in Fig.3



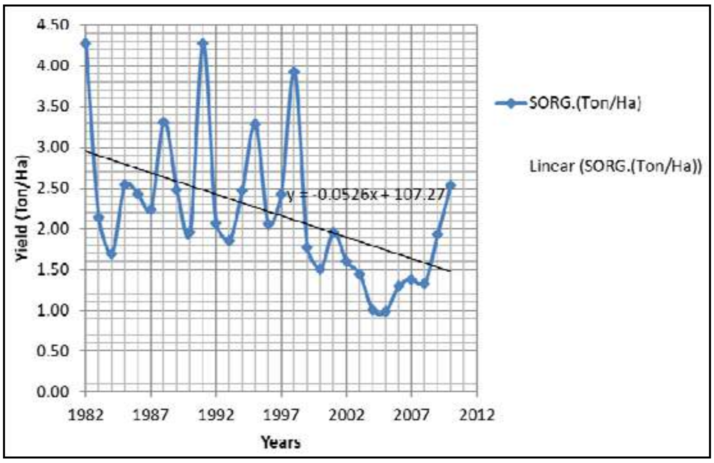
Source: Data Survey, 2013

Fig 3: Trend of Millet Yield of in Kano State from 1982 to 2010

Data presented in Fig.3 indicate the trend and linear equation of millet yieds in Ton/ha for the study area from 1982 to 2010. It could be observed that the linear trend equation is y = -0.0979x + 197.88. The slope of this linear trend equation indicates negative direction, meaning decreasing trend in millet yields in the studied period. The highest millet yield recorded was 5.81Ton/ha in 1994 and lowest 0.62Ton/ha in 1982

Trend of Sorghum yields in Ton/ha

The trend of sorghum yields in Ton/ha, for the study area from 1982 to 2010 analyzed and the result presented in Fig.4.



Source: Data Analysis, 2013

Fig 4: Trend of Sorghum Yields in Kano State from 1982 to 2010

Data presented in Fig.4 indicate the trend and linear trend equation of sorghum yields in Ton/ha in Kano state from 1982 to 2010. The linear trend equatin is y = -0.0526x + 107.27. The slope of this equation indicates negative direction, meaning a decreasing trend in sorghum yields in Ton/ha during the observed period. The highest recorded yield was 4.28Ton/ha in 1982 and lowest 0.98Ton/ha in 2005.

Comparing the Trend of Length of Growing Season with Millet and Sorghum Yields

Comparing the trend of length of growing (Fig.2) and millet yields (Fig.3), results obtained indicate that the linear trend slope for length of growing season was in positive direction, while for millet yields was in negative direction. This means as trend of length of growing season increases the trend of millet yields decreases over the study period. This type of scenario applies to the trend of length of growing season (Fig.2) and sorghum yields (Fig.4). As the trend of length of growing increases, the trend of sorghum yields also decreases over the study period. The longest length of growing season in Fig.2 was 181 days in 2010 compared to the highest sorghum yield of 4.28 Ton/ha in 1982 (Fig.4). In contrast, 181 days of growing season in 2010 (Table 2) corresponded to 2.53 Ton/ha of sorghum yields (Table 3) in 2010 respectively. Similarly, the longest length of growing season was 181 days in 2010 compared to the highest millet yield of 5.81 Ton/ha in 1994 (Fig.3). In contrast, 181 days of growing season in 2010 corresponded to 1.75 Ton/ha of millet in 2010 (Fig.3) respectively. These findings indicate that year with longest length of growing season do not correspond with the years of highest millet and sorghum yields in the study period.

Results obtained in Table 2 and 3, Fig.2, 3 and 4 indicate inter – annual variation in the level of length of growing season, millet and sorghum yields in the period of study in Kano State. The longest length of growing season recorded was 181 days in 2010 and shortest 85 days in 1994. These results do not as expected corespond with the highest and lowest yields of millet and sorghum in 2010 and 1994 respctively. Instead the highest yield of millet 5.8Ton/ha was recorded in 1994 not in 2010 and the lowest 0.62Ton/ha in 1982 not in 1994. Similarly, the highest yield of sorghum 4.28Ton/ha was recorded in 1992 not in 2010 and the lowest 0.88Ton/ha was in 2005 not in 1994. This means having longer length of growing season is not necessary to have high yields and shorter to have lower yieds for the observed crops. Data presented and analyzed in Fig.2 indicate an increasing trend in the length of growing in Kano State. This result is in contrary with that of Aliyu (2009) [2] who observed a downward trend in the duration (length) of the growing season in some locations in northern Nigeria from 1978 to 2007, with a significant variability in most of the stations north of latitude 9□N in Nigeria. The result is however in line with Climate models that consistently project an increase in global mean precipitation of between 3% and 15% as temperature increases from 1.5 ^{0}C to 3.5 ^{0}C (Schneider *et al* 1990) [21]. Therfore, an increasing trend in the length of growing season in Kano state could probably be due to an increase in temperature that resulted to increase in rainfall amounts. Beside these, data analyzed in Fig.3 and 4 reveal deceasing trend in both millet and sorghum yields respectively in the study period. Result for deceasing trend on sorghum yield was in line with Maikasuwa M., A. and Ala A.L., (2013) [10] who studied trend analysis of area and productivity of sorghum in Sokoto State, Nigeria from 1993 to 2012 and reported that growth trend of sorghum yield for area was negative (-0.015). Meaning the growth trend of sorghum yield was decreasing in Sokoto State. The similarity of this result between Kano and Sokoto states could probably because these states are almost having the same climatic conditions.

Conclusion

Kano state is one of the states in the northern part of Nigeria characterized by scanty distribution of rainfall compared to any other state in the southern part. In recent decades, many researches revealed that, Sudan Savanna Ecological Zone of Nigeria in which Kano is situated is wetter than before. This could probably happen because of the impact of climate change. The Consequence of climate change is what might cause an increase in the trend of length of growing season in Kano state. The decrease in the trend of millet and sorghum yields instead of increase as obtained from the foregoing could be due to other agricultural production factors. Based on these, it is concluded that agricultural stakeholders should encourange farmers toward intensive agriculture rather than extensive by providing adequate agricultural inputs at subsidize price.

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