ANALYSIS OF RAINFALL ONSET, CESSATION AND LENGTH OF THE GROWING SEASON AND ITS VARIABILITY EFFECTS ON CROP PRODUCTION IN KARASUWA LOCAL GOVERNMENT AREA, YOBE STATE, NIGERIA

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Rainfall, onset date, cessation date

ABSTRACT
The study is on the Analysis of rainfall onset, cessation and length of the growing season and its variability effect on crop production in Karasuwa Local Government Area, Yobe State, Nigeria. The study used secondary data that collected from NIMET office, Nguru station. The data is for mean monthly rainfall from 1992-2022. The data were analyzed using Walter 1967 method of calculating onset, cessation data and length of the growing season. The result of the study reveals that rainfall variability leads to cause rainfall late onset, early cessation and shortened the length of the growing season in the study area. The earliest onset dates for rainfall in the study area was early onset date in 30 May 2002 from the 30 years of the study. The late onset date within the 30 years of study is 9 July which usually occurs in 1992, 1993, 2009 and 2015 respectively. On 4th August 2011 is the earliest cessation date at Karasuwa Local Government Area that occurred and the late cessation date of rain occur on 28 October 2019 which is the highest within the 30 years of the study. the lowest length of the growing season is determining on 2004 (46 days), 2007 (51 days), 2015 (56days) and other years like 1993, 1995, 1998, 2001,2008, 2009, and 2020 respectively which the length of the growing season is below average and it affect the crop production in the study area. The study recommend Farmers should change/shift their planting period to appropriate time since the onset date has changed in order to avoid crop damage at the early stage, Government should provide the farmers with early matured crop and improved crop varieties, mitigation/adaptation action is highly needed in order to cope with the problem.

Introduction

Food and Agricultural Organization (FAO, 2017) defined the start of the growing season as the date when precipitation exceeds half of the potential evapotranspiration. Cessation date means termination of the effective raining season. It does not imply the last day rainfall, but when rainfall can no longer be assured or be effective for crop production. Length of Growing Season is the period between the onset and cessation dates, which is the difference between the onset dates and the cessation dates of the rainy season. Agricultural activities and production becomes extremely vulnerable to the variability of the onset, cessation dates and length of the growing season (Dodd *et al.,* 2001). Land clearing, crop selection, seed planting and crop harvesting requires the knowledge of rainfall onset and cessation (Abaje, *et al.,* 2014)

The knowledge and variation of rainfall onset, cessation and length of the growing season both at national and international level is paramount, as many agricultural activities and planning for sustainable food yield depend on rainfall for land preparation, seed/crop planting and harvesting. Also, observed that the irregularity of onset and cessation of the rainy season across many regions over the years had made it difficult for farmers to optimize the seed planting period and adjust to the length of the growing season. The resultant effect is the decrease of agricultural yield and an increase in the risk of hunger. In most tropical regions, rainfall onset and retreat dates are important parameters in the agricultural calendar Odekunle (2004). Many regions over the world are expected to experience substantial modifications as a result of climate variability. These changes are expected to affect the onset and cessation of the rainy season which has become irregular over the years (Salack, *et al.,* 2011).

A delay of 1 or 2 weeks in the onset is sufficient to destroy the hopes of a normal harvest while a "false start" of planting, encouraged by a false start of rainfall may be followed by prolonged dry spells whose duration of two weeks or more may be critical to plant germination and growth (Ndomba, 2010). Iortyom, *et al.,* 2017) in their study, reported that early cessation of raining season has more effect on crop yield as compared to onset of raining season, especially when the crop is approaching its fruiting stage, they require more water for growth. Early cessation affects the development of the crop. Variability in the length of the growing season is dominant in the tropical areas, and is indicative of crop failure risk (Vreiling *et al.,* 2013). The variability in the rainy season onset and cessation could pose socio-economic and developmental challenges as they threaten food security and induce poverty. Annual rainfall, onset, cessation, number of dry days and temperature had statistically insignificant effects on the variability of the yields of crop production.

Yobe state, being an agrarian state; there are delayed onset date of rains particularly in Northern part of the state (where study area is located), increase in the number of dry days during the raining season and increase in temperature. The area has serious problem of crop failure, or low production caused by climate variability particularly the delayed onset of rains, shortened the length and frequency of dry spells during the growing season. (Saleh, 2014 cited in Galadima& Nandi 2016).

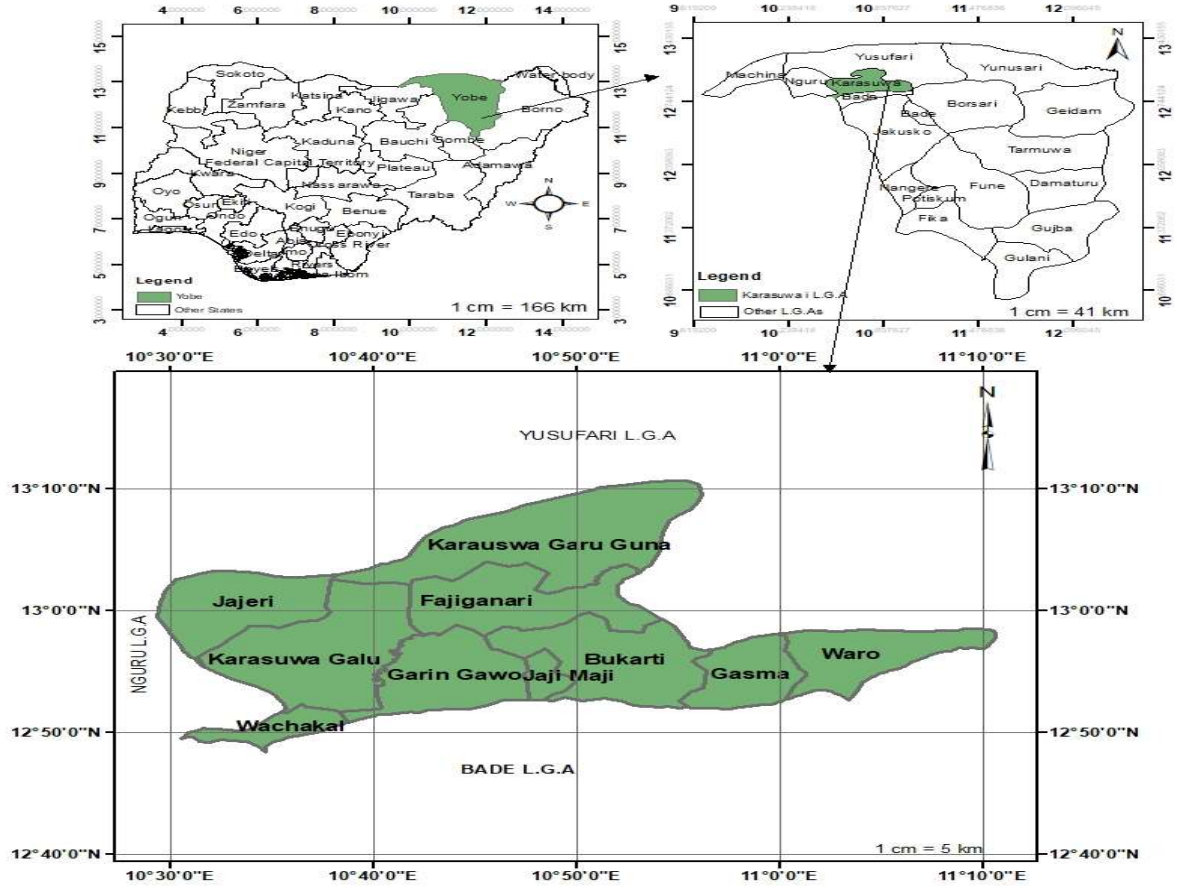
Methodology

Study Area

Karasuwa Local Government area is located at latitude 12053' 57'' N - 130 00' N. North of the equator and longitude 10 0 47'E – 10 0 48 '28''E. East of Green which Meridian. It has a land area of 1,162km2, (Thomas, 2017). Karasuwa Local Government area shares a common border with Nguru Local Government to the west, Bade Local Government to the East and South, and Yusufari Local Government to the north. Also, Karasuwa local government have ten (10) political ward which includes, Karasuwa, Jaji-Maji, Bukarti, Gasma Karasuwa Galu, Wachakal, Jajeri, Faji-Ganari, Garin-Gawo and Waro Ward (see figure 1).The climate of Karasuwa is characterizes with rainfall ranges from 250-500mm and up to 750mm. There are two seasons in this area; the wet and dry season. Karasuwa mean annual temperature is about 280c. The coolest months are December and January with average temperature of 210c.the hottest months is April and May during this period temperature reach up to 35^0c – 40^0c, (Orounye, 2009).

Figure 1:

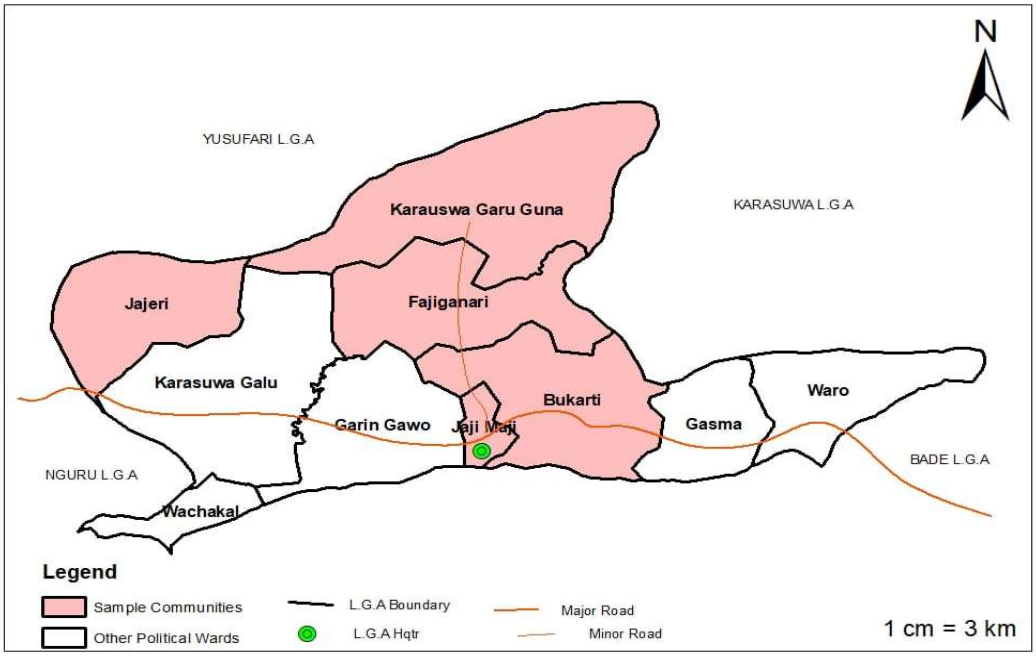
Map of Nigeria showing Yobe state, Map of Yobe state showing Karasuwa LGA and Map of Karasuwa LGA showing the 10 political wards



Source: *GIS Lab, Department of Geography, Yobe State University, Damaturu (2023)*

Figure 2:

Map of Karasuwa local Government showing the sample wards



Source: GIS Lab, Department of Geography, Yobe State University, Damaturu (2023)

Method of Data Collection

The sources of data for this research are collected from secondary data. The secondary data was collected from NIMET office, Nguru station. The data is for mean monthly rainfall from 1992-2022. Also the study used other materials such as journals, records, textbooks, maps, and any related note on the concept.

Method of Data Analysis

Method of data analysis for this research was analyzed using Walter 1967 formula method of calculating pattern of rainfall onset, cessation and length of the growing season, which is express as:

Onset Date = D (50.8-F)/R

Where; O.D= Onset Date

D= the number of days in the first month with effective rainfall threshold of 51mm

F= is the accumulative total rainfall of previous month

R= the total rainfall of the month with rainfall equal or greater than 51mm

Cessation = D (50.8-F)/R

Where; C= cessation

D= the number of the days of the last month of the year on which a total rainfall of equal or greater than 51mm is recorded

F= is the subsequent month amount of rainfall that proceed the last month record 51mm

R= is the total amount of rainfall recorded in the last month that record a rainfall amount of equal or greater 51mm

Length of the growing season = is the number of days between onset and cessation date.

Results and Discussion

Table 1

The table showing the onset date, cessation *date and length of the growing season in the study area*

Year	Onset Date	Cessation Date	Length of the growing season (Days)
1992	9 July	17 September	70
1993	9 July	8 September	61
1994	18 June	5 September	79
1995	7 July	10 September	65
1996	24 June	19 September	87
1997	3 July	13 September	72
1998	6 July	9 September	65
1999	2 July	24 September	84
2000	27 June	9 September	74
2001	2 July	7 September	67
2002	30 May	8 September	101
2003	16 June	17 September	93
2004	19 June	4 August	46
2005	10 June	23 September	105
2006	9 June	27 September	110
2007	3 July	23 August	51
2008	5 July	11 September	68
2009	9 July	13 September	66
2010	17 June	13 September	88
2011	5 June	3 August	59
2012	1 July	12 September	73
2013	3 June	22 August	80
2014	13 June	6 September	85
2015	9 July	3 September	56
2016	3 June	14 September	103
2017	13 June	19 September	98
2018	12 June	17 September	97
2019	5 June	28 October	145

2020	3 July	3 September	62
2021	6 July	22 October	108
2022	24 June	20 September	88

Source: Author's Analysis 2023

The presented data detail the onset date, cessation date, and duration of the growing season for each year spanning from 1992 to 2022. A thorough analysis of these results yields several key insights relevant to understanding the dynamics of the growing season and its implications for agricultural practices and ecosystems.

The dataset reveals notable variability in both the onset and cessation dates of the growing season across the examined years. Onset dates range from May 30th, observed in 2002, to July 13th, recorded in 2017. Similarly, cessation dates vary from as early as August 3rd in 2011 to as late as October 28th in 2019. Such fluctuations underscore the dynamic nature of seasonal transitions and the influence of climatic factors on the timing of favorable conditions for plant growth.

The length of the growing season exhibits considerable diversity, with durations ranging from a minimum of 46 days in 2004 to a maximum of 145 days in 2019. This wide range underscores the variability in the availability of suitable conditions for agricultural activities and ecosystem processes. Understanding these variations is paramount for effective agricultural planning and resource management.

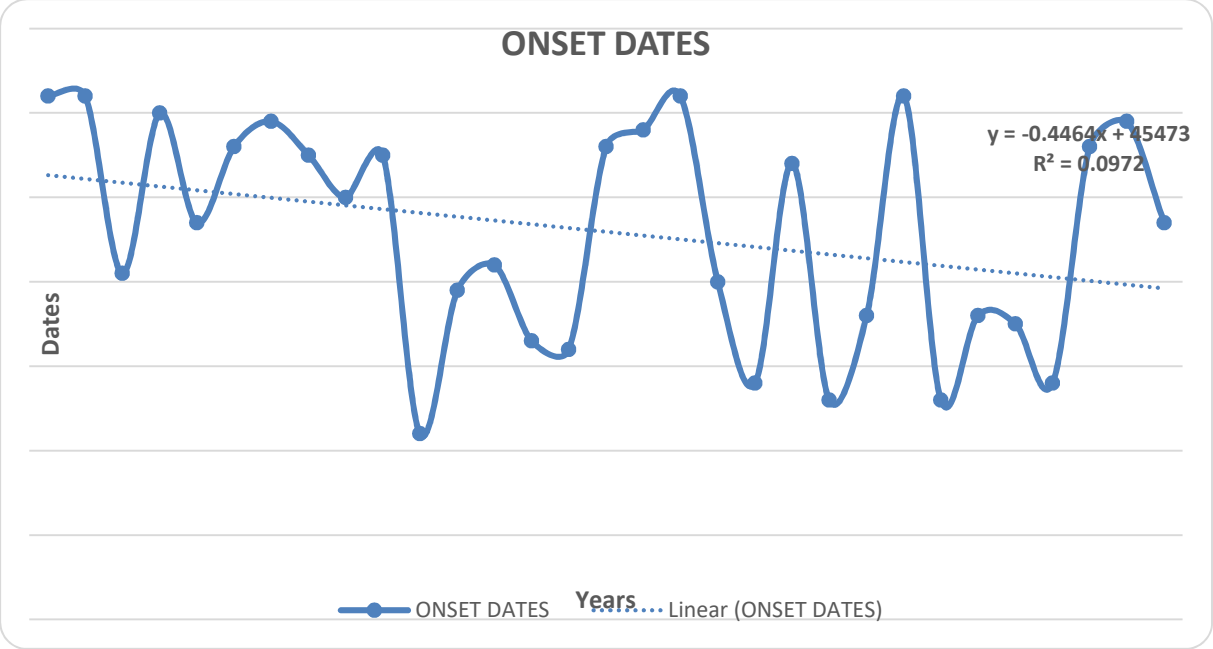
An examination of temporal trends suggests the presence of fluctuations in the onset, cessation, and length of the growing season over the studied period. Further analysis is warranted to discern any discernible long-term trends and their implications for agricultural productivity and ecosystem dynamics. Identifying patterns in seasonal transitions can provide valuable insights into the influence of climate variability on regional agricultural systems.

The observed variations in the growing season parameters underscore the significant impact of climate variability on agricultural practices and ecosystem dynamics. Factors such as temperature, precipitation patterns, and climatic anomalies likely play a crucial role in shaping the timing and duration of the growing season. Understanding these relationships is essential for developing adaptive strategies to mitigate risks associated with climate change and optimize agricultural productivity. The insights gleaned from the analysis of growing season dynamics have direct implications for agricultural planning and management. Farmers and policymakers can utilize this information to tailor planting and harvesting schedules, optimize resource allocation, and enhance resilience to climate variability.

By aligning agricultural practices with the prevailing seasonal patterns, stakeholders can mitigate risks and capitalize on opportunities for sustainable agricultural development. In conclusion, the presented results offer valuable insights into the spatiotemporal dynamics of the growing season and its implications for agricultural systems and ecosystems. Further research is warranted to explore the underlying mechanisms driving seasonal variability and to develop targeted strategies for climate-smart agriculture and natural resource management.

Figure 3:

Trend of onset date in the study area from 1992-2022



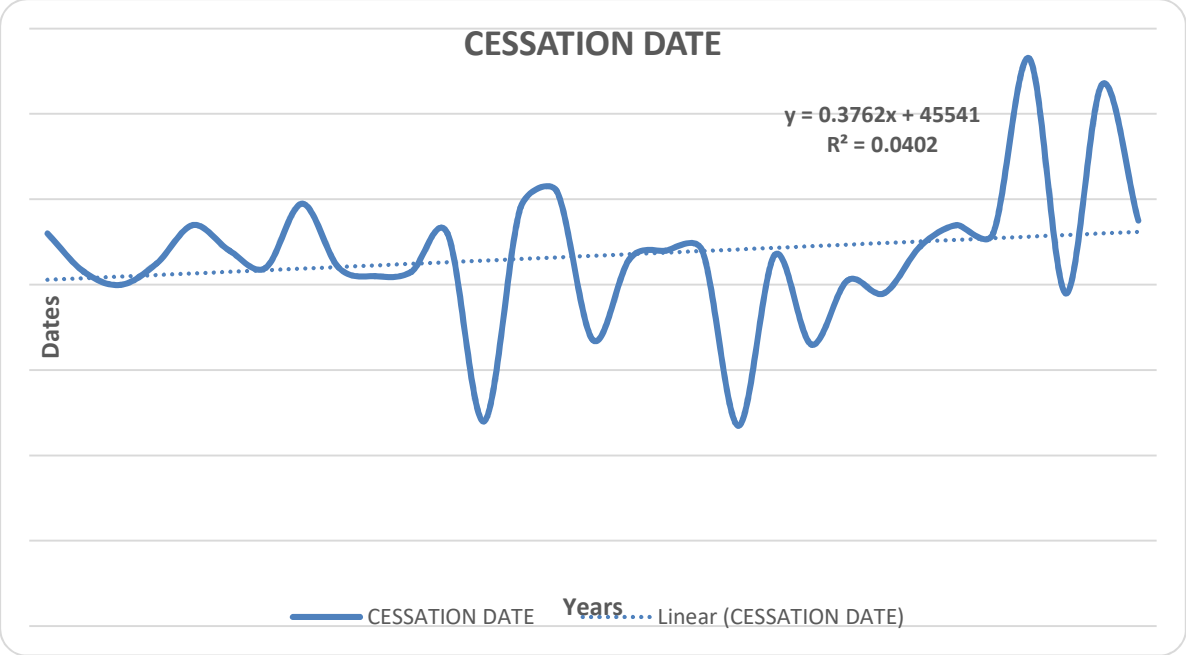
Source: Authors Analysis, 2023

The analysis of the onset dates of the rainy season reveals a significant trend, as evidenced by the best fit line equation y = -0.4464x + 45473. This equation indicates a negative slope, indicating a decreasing trend in the onset dates of the rainy season over time. With an R-squared value of 0.0972, approximately 9.72% of the variability in the onset dates of the rainy season can be explained by the linear relationship with time. While the R-squared value is relatively low, it still suggests a discernible trend in the data. The negative slope of the trend line indicates that, on average, the rainy season has been starting earlier in recent years in the study area. This shift in onset dates can have significant implications for agriculture, water resource management, and socio-economic activities that rely on seasonal rainfall patterns.

Various factors may contribute to the observed trend, including climate change, land use changes, and natural climate variability. Climate change, in particular, can alter precipitation patterns, leading to shifts in the timing and duration of the rainy season. Land use changes, such as deforestation or urbanization, can also influence local climate patterns and impact the onset of the rainy season. While the linear model provides valuable insights, it's essential to acknowledge the complexity of climate systems and the limitations of linear regression in capturing all relevant factors. Future research may involve more sophisticated modeling techniques, incorporating additional variables, and conducting detailed spatial and temporal analyses to better understand the drivers behind the observed trend. In conclusion, the decreasing trend in the onset dates of the rainy season underscores the dynamic nature of climate patterns and emphasizes the importance of adaptive strategies to address potential impacts. By enhancing resilience and implementing proactive measures, stakeholders can better cope with changing rainfall patterns and ensure sustainable development in the study area.

Figure 4:

Trend of Cessation date in the study area



Source: Authors Analysis, 2023

The analysis of the cessation dates of the rainy season reveals a notable trend, as indicated by the best fit line equation y = 0.3762x + 45541. This equation demonstrates a positive slope, suggesting an increasing trend in the cessation dates of the rainy season over time. With an R-squared value of 0.0402, approximately 4.02% of the variability in the cessation dates of the rainy season can be explained by the linear relationship with time.

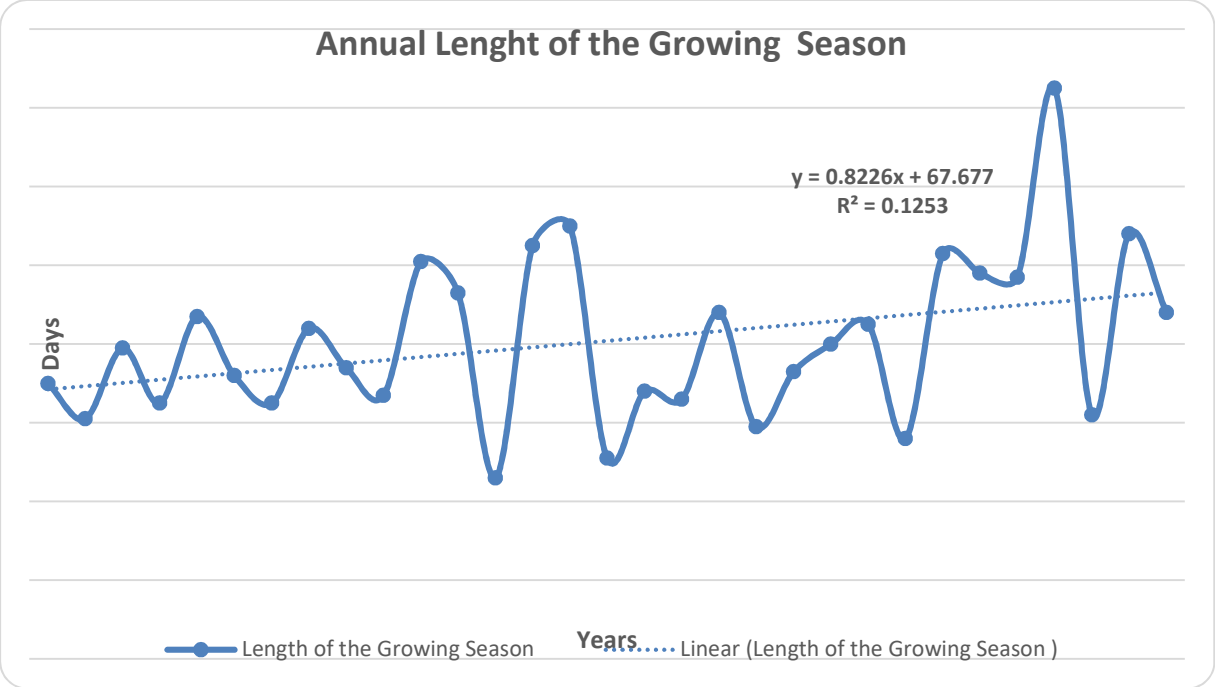
Although the R-squared value is relatively low, it still indicates a discernible trend in the data. The positive slope of the trend line implies that, on average, the rainy season has been ending later in recent years in the study area. This shift in cessation dates can have significant implications for agricultural practices, water resource management, and ecological processes dependent on seasonal rainfall patterns.

Multiple factors may contribute to the observed trend, including climate change, land use changes, and natural climate variability. Climate change can alter precipitation patterns, leading to shifts in the timing and duration of the rainy season. Changes in land use, such as deforestation or urbanization, can also affect local climate patterns and influence the cessation of the rainy season. While the linear model provides valuable insights, it's essential to recognize the complexity of climate systems and the limitations of linear regression in capturing all relevant factors. Future research may involve employing more advanced modeling techniques, integrating additional variables, and conducting detailed spatial and temporal analyses to better understand the drivers behind the observed trend.

In conclusion, the increasing trend in the cessation dates of the rainy season underscores the dynamic nature of climate patterns and emphasizes the importance of adaptive strategies to address potential impacts. By enhancing resilience and implementing proactive measures, stakeholders can better adapt to changing rainfall patterns and ensure sustainable development in the study area.

Figure 5:

Trend of length of the growing season in the study area from 1992-2022



Source: Authors Analysis, 2023

The analysis of the length of the rainy season indicates a discernible trend, as evidenced by the best fit line equation y = 0.8226x + 67.677. This equation demonstrates a positive slope, suggesting an increasing trend in the length of the rainy season over time. With an R-squared value of 0.01253, approximately 1.25% of the variability in the length of the rainy season can be explained by the linear relationship with time. While the R-squared value is relatively low, it still suggests a noticeable trend in the data. The positive slope of the trend line implies that, on average, the rainy season has been lengthening in recent years in the study area. This extension in the duration of the rainy season can have significant implications for various sectors, including agriculture, water resource management, and ecosystem dynamics.

Several factors may contribute to the observed trend, including climate change, land use changes, and natural climate variability. Climate change can influence precipitation patterns, leading to changes in the timing and duration of the rainy season. Land use changes, such as deforestation or urbanization, can also impact local climate patterns and affect the length of the rainy season. While the linear model provides valuable insights, it's essential to acknowledge the complexity of climate systems and the limitations of linear regression in capturing all relevant factors. Future research may involve employing more advanced modeling techniques, integrating additional variables, and conducting detailed spatial and temporal analyses to better understand the drivers behind the observed trend.

In conclusion, the increasing trend in the length of the rainy season underscores the dynamic nature of climate patterns and highlights the importance of adaptive strategies to address potential impacts. By enhancing resilience and implementing proactive measures, stakeholders can better adapt to changing rainfall patterns and ensure sustainable development in the study area.

Conclusion and Recommendation

The study concludes that, result of the study reveals that the pattern of the rainfall in the study area is late onset, early cessation and shortened the length of growing season, which indicate that there is variation in the pattern of rainy season in the

study area and this it leads to affect crop production and farming activities in general.

The study therefore recommended that the Farmers should change/shift their planting period to appropriate time since the onset date has changed in order to avoid crop damage at the early stage. Government should provide the farmers with improved seeds. Government should provide Agricultural extension workers to rural areas to train farmers on how to improve their farming activities. Mitigation/Adaptation measures are necessary and urgent action and coping strategies to cope with the effect of rainfall variability.

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