

Research Article

Analysis of Onset, Cessation, and Length of the Growing Season and Its Implication for Agricultural Production in Uromi, Edo State

Perpetua Nkeiruka Oby Iyere-Usiahon^{1,*} , Onyilo Desmond Onyilo²¹Federal Department of Agriculture, Federal Ministry of Agriculture and Food Security, Abuja, Nigeria²Applied Meteorological Services Department, Nigerian Meteorological Agency, Abuja, Nigeria

Abstract

Irregular rainfall limits adequate crop production within the Uromi in south – south agroecological zone of Nigeria. This study was carried out to analyse the rainfall pattern, onset and cessation of rainy season including the length of growing season for agricultural production in Uromi, Edo state. Secondary data collected from NiMET maproom for the period 1991 – 2024 were used. The result revealed a variation in rainfall pattern in the area which led to variation in onset and cessation of rainfall including length of growing season. A very high variability in the onset of rain was observed with a CV of 95%, cessation has a CV of 30.67% indicating a high variability while length of growing season has a low variability with a CV of 3.88%. The trend analysis shows that onset of the rainy season has a negative trend of $y = -0.1329x + 9.8556$ with an R-squared value of 0.0304. A positive trend was observed for cessation of rain with a best fit line equation $y = 0.1134x + 13.369$ and a low R^2 of 0.0605 which is discernible trend in the data. The length of growing season has a positive slope ($y = 0.2527x + 217.7$) and an R^2 of 0.0853. The observed trend in the area may have been triggered off by intrinsic and extrinsic factors. This information is very important to farmers in Uromi in deciding on crop types to be cultivated and on planning sowing dates as a function of observed onset dates. 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.

Keywords

Length of Rainy Season, Onset and Cessation Dates, Rainfall, Rainy Season, Uromi

1. Introduction

Global ecosystems are experiencing changes in rainfall amount, intensity, and temporal distributions [6] and this poses great challenge to agricultural production [7]. Rainfall is undoubtedly the most critical hydroclimatic variable that

has profound effect on agricultural production and water resources management [15]. Given the trend of climate change, whereby global temperature has been increasing in the past decades [31], the rainfall characteristics—including total

*Correspondence: Perpetua Nkeiruka Oby Iyere-Usiahon (perhon2011@yahoo.com)

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amount, intensity, frequency, onset, and cessation are very important to determining agricultural productivity in tropical regions [10, 23].

The gravity of the changes noticed in rainfall is its effect on the actual planting dates which has serious implication for farmers' decision since the onset date of rain has become unpredictable over the years [26]. The implication of this scenario is the issue of a dry spell that is capable of causing crop failures and waste of resources [4, 17]. The dry spell is the first occurrence of unsustainable rainfall that deceives farmers into planting [8].

One of the climate indicators frequently requested by farmers for their planning is the onset of rain [37]. Onset of rainy in season mean different things to different professionals but to a farmer, it simply means the rainy season by the day after which they can expect a continuity of wet days, indicating that water availability will meet crop water requirements [18]. The Nigerian Meteorological Agency define Onset date as the point when the amount of water that plant can access in the soil reaches 50% of the soil's total water holding capacity measured cumulatively from the start of the rainy season [24]. A day is considered to be rainy at least 1 mm observed accumulated to 20 mm over 5 days with at least 3 rain days and dry spell not exceeding 7 days in the next 21 days. This definition is in line with Food and Agricultural Organization [16] definition that refers onset in the context of agriculture and climatology dates as when moisture supply from precipitation and soil storage equals or exceeds half the potential evapotranspiration.

On the other hand, cessation date does not refer to the last day of rainfall rather when the amount of rainfall can no longer guarantee effective crop production. Cessation of rainfall has been referred to as any day there are 21 or more consecutive days of rainfall that is less than 50% of the decadal crop requirement from September 1st [30]. The date of onset and cessation often determines the length of the growing season, which is key for high crop yields [37]. The length of the growing season is referred to as the number of days when plant growth takes place and it is determined by the onset and cessation dates of the rains. It naturally exhibits spatial and temporal variation due to shifts in onset and cessation dates [18].

In Nigeria, the challenge of feeding a rapidly growing population is already significant. Widespread poverty, urbanization, insecurity and demographic pressures have strained agricultural productivity and food supply systems [22]. These challenges pose the mismatch between food demand and domestic production, with many households facing rising food prices and nutritional insecurity. Climate change is currently increasing this precarious situation [1, 5] by distorting traditional farming calendars, decrease in crop yields, and threats to the stability of food systems thus leading to crisis in the national food system. This challenge calls for a critical analysis of the onset and cessation dates including the length of the growing season to enable proper planning activities in the season.

Since rainfall is a very important climatic factor for crop production, crop yields may be affected by either a late onset or early cessation of the growing season as well as high rate of dry spells within the growing season. Agricultural planning activities for sustainable food production is dependent on rainfall, therefore the knowledge of rainfall onset and cessation variation as well as length of the growing season is of great importance [21].

There have been studies on onset and cessation of rain in Nigeria but mostly in the Northern part of the country [21, 36, 38]. A few studies were conducted in the south [19]. Available search showed that in Edo state, there was a study on the Effects of Rainy Season Onset, Cessation, and Length on Food Security and Sustainable Crop Production in Edo State, Nigeria [14] but non in Uromi, Esan North East, a place noted by [12] as an agrarian area. The goal of this study therefore is to determine the patterns of changes of onset and cessation of rainfall as well as the length of growing season in Uromi. This information could contribute to successful planning for crop production; selection of the crop type and variety, timing of sowing, short-term seed storage and harvesting. The specific objectives of the study are to:

- 1) determine the trends onset and cessation dates as well as length of the growing season for the period of 1991 to 2024
- 2) the variation in onset and cessation dates as well as length of the growing season for the period of 1991 to 2024

2. Study Area and Methodology

2.1. Location and Data Collections

The study area consisted of rural and urban communities in Uromi, headquarter of Esan North East Local Government Area of Edo state. The area lies within Latitudes 6.7140° N and Longitudes 6.3279° E. The 2006 National census put Uromi population at 119,346 people but it is estimated to be 180,200 people as at 2024 [33] with a land area of about 255.399 Kilometer square and an estimated population of 195,757 (National Population Commission, 2022). The area has about 22 villages which include Amedokhian, Arue, Awo, Efandion, Egbele, Eguare-Uromi, Eko-Ibadin, Eror, Ewoyi, Idumoza, Ivue, Obeidu, Onewa, Ubierumu Ne- Oke, Ubierumu Ne- Uwa, Ukoni, Unuwazi, Utako and Uwalo.

Uromi which is located in Edo central has a tropical climate with an annual rainfall averaging 1540 mm, mean temperature of 31°C and mean annual relative humidity ranging from 30.50 to 94.00% [35]. The village of Ivue is located at the highest point in Esan with about 1,490 feet above the sea level.

The area stands topmost on the plateau sitting at about 1000 feet above sea level, with the village of Ivue occupying the highest point on the Esan plateau with about 1,490 feet above sea level [3]. The seasonal pattern is characterised by rain from April to October and dry season from early November to March.

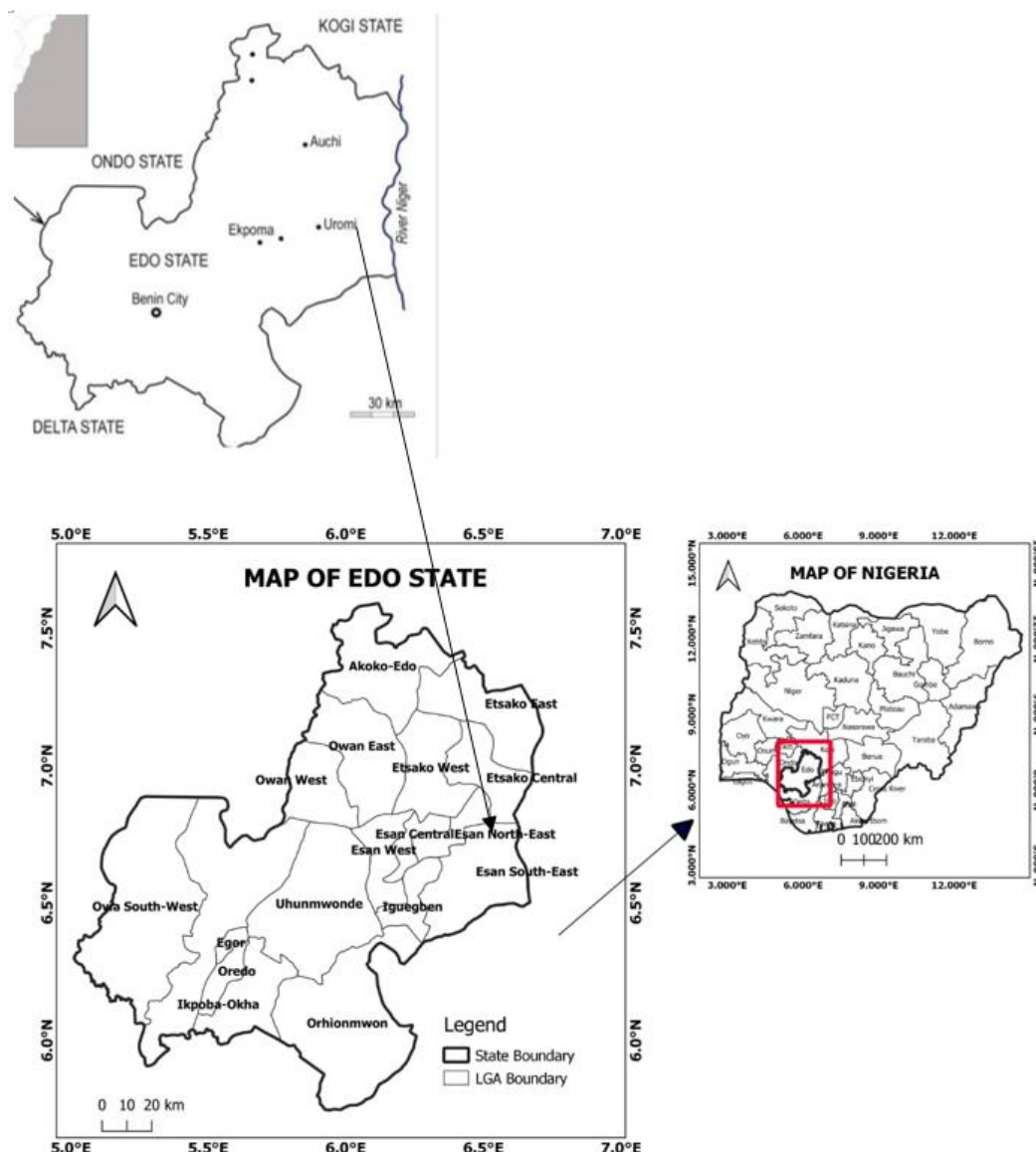


Figure 1. Map of Edo state indicating the location of Uromi.

2.2. Methodology

2.2.1. Source of Data

The data for this research is strictly secondary data. The rainfall data; mean monthly rainfall from 1991-2020 and onset and cessation data from 1991 to 2024 were extracted from NiMET maproom. In addition, other materials like journals, textbooks, maps, and any related note were consulted.

2.2.2. Data Analysis

The onset and cessation dates was determined using the Walters formulation as modified by [28].

$$\text{Onset/End} = \frac{DM}{TM} = (51 - AP)$$

Where;

DM = Days of onset in a month

TM = Total rainfall that exceeds 51 mm in a month.

AP = accumulated rainfall of previous months just before the month in reference.

51 mm = the threshold of rainfall for both Onset/End month. where such onset date was followed by rainfall amount less than 51 mm, the next rain day date that is up to 51 mm or more will be chosen.

$$SD = \sqrt{\sum(x_i - \bar{x})^2 / n - 1}$$

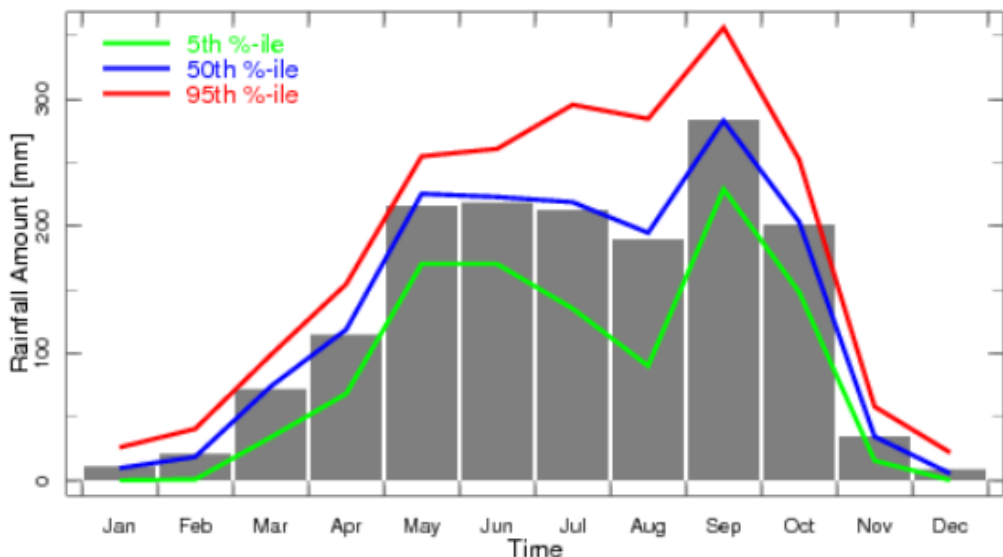
SD = Standard Deviation

\bar{x} = mean value of the observations

n = The number of observations

3. Results and Discussions

3.1. Rainfall Patterns in Uromi



Source: NiMET Maproom (2026)

Figure 2. Monthly Rainfall Pattern in the Study area.

Figure 2 shows the monthly rainfall pattern in Uromi. The mean monthly rainfall climatology of the area between 1991 and 2020 shows an average monthly rainfall ranging from 10mm in December to 280mm/month in September. This is in line with the report of nomadseason (2024) that observed a mean monthly rainfall of 7mm in December and 267mm in Sept between 2017 and 2022 in Uromi, Esan North East. December, January and February with less than 51mm of monthly rainfall can be regarded as the dry months. This is as noted by [11] that any month with less than 51mm average rainfall is dry. However, the months of March to October are wet months having an average rainfall of 67mm in March and 280mm in September. These periods are therefore regarded as having heavy rainfall according to [20] who noted that any rainfall that has about 60mm in a month is termed to be heavy. December, January and February can be actually regarded as dry months, since the recorded average rainfall are less than 51 mm. Rainfall in Uromi is influenced by intrinsic and extrinsic factors. One of them is Intertropical Discontinuity (ITD). The ITD is positioned in the equatorial trough, a continuous low-pressure region that marks the geographic equator, where surface trade winds converge to generate a zone of heightened mean convection, cloudiness, and precipitation; transporting heat and moisture from surface evaporation and sensible heating [9]. It has been noted that, apart from the contribution of ITD to rainfall distribution in Nigeria, other factors controlling rainfall include the ocean-atmosphere interaction, relief, line squall and the local features [2].

3.2. Variations

Table 1 below presents a data set from 1991 – 2024 detailing the planting window (onset) and crop maturity date (cessation date) including length of growing season for each year. A detailed analysis of the data is necessary for understanding the changes in crop during development and its interaction with the environment over time, and its implications for agricultural practices. According to [32], a Coefficient of Variance (CV) is used to classify the degree of variability in the following order; less ($CV < 20\%$), moderate ($20 < CV < 30\%$), high ($CV > 30\%$), very high ($CV > 40\%$) and $CV > 70\%$.

3.2.1. Variation in Onset Dates of Rainfall

The data set in Table 1 is clearly not normally distributed. The mean onset date was 8th of April, with a coefficient variation of 95%, the implication of this is that from one year to the other, onset of rainfall for the growing season is likely to change from the expected by about 95% indicating a very high variability. Standard Deviation of ± 8 days, in other words from one year to the next, onset of rainfall for the growing season is likely to commence 8 days before the expected date, just as much as it is likely to arrive 8 days later than the normally expected onset date. The earliest onset date was 1st of April and 28th of April 2000 was the last onset date within the period of study which indicates yearly variations as observed

by [19] that rainfall onset dates could vary remarkably on annual basis. This finding is similar to that of [34] who observed that rainfall typically commences within April in Uyo, Akwa Ibom state, a state within south -south region of Nigeria just like Uromi in Edo state.

3.2.2. Variation in Rainfall Cessation Dates

The minimum rainfall cessation date observed is 5th November, the highest is 26th November while the average cessation 15th November. The cessation date has a standard deviation of 4.6 (5) and CV of 30.67. The data set shows variability, as evidenced by CV is 30.67 which indicates a relatively high variability. These statistics suggests that the cessation of

rainfall values exhibit significant dispersion around the mean. The findings of this study is in conformity with [25].

3.2.3. Variation in Length of Growing Season

The data in Table 1 indicate both increases and decreases in the length of growing season over the chosen years (1991-2024) with a mean value of 222 days. The standard deviation is 8.62 while the CV is 3.62. Having a standard deviation of 8.62 and a Coefficient of Variation (CV) of 3.62% indicates that the data has low variability relative to the mean, but the absolute dispersion (8.62) is meaningful only in the context of the data's magnitude.

Table 1. Rainfall onset dates, cessation and length of growing season.

Year	planting window Onset Date	crop maturity (Cessation) Date	Length of the growing Season (Days/year)
1991	4th April	14th Nov	224
1992	7th April	13th Nov	220
1993	19th April	15th Nov	210
1994	1st April	16th Nov	229
1995	11th April	17th Nov	220
1996	2nd April	9th Nov	221
1997	1st April	19th Nov	232
1998	18th April	11th Nov	207
1999	20th April	14th Nov	208
2000	4th April	17th Nov	227
2001	7th April	7th Nov	214
2002	4th April	17th Nov	227
2003	28th April	19th Nov	205
2004	2nd April	15th Nov	227
2005	4th April	13th Nov	223
2006	2nd April	14th Nov	226
2007	13th April	15th Nov	216
2008	18th April	5th Nov	210
2009	1st April	17th Nov	230
2010	1st April	19th Nov	232
2011	1st April	15th Nov	228
2012	8th April	18th Nov	224
2013	5th April	16th Nov	225
2014	7th April	19th Nov	226
2015	25th April	14th Nov	203
2016	9th April	14th Nov	219

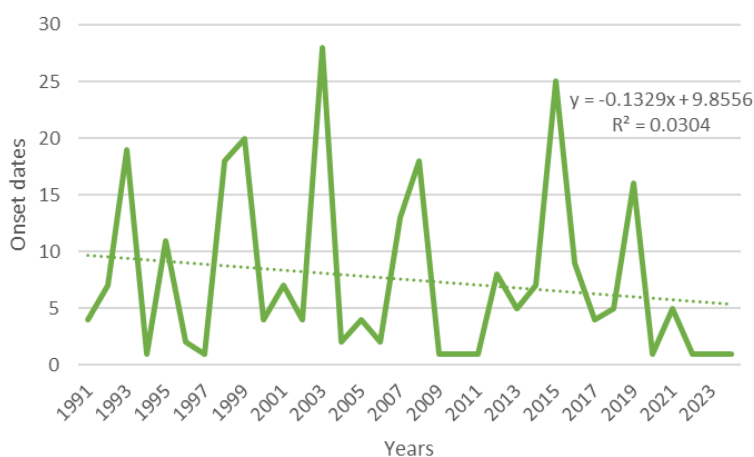
Year	planting window Onset Date	crop maturity (Cessation) Date	Length of the growing Season (Days/year)
2017	4th April	16th Nov	226
2018	5th April	21st Nov	230
2019	16th April	23rd Nov	221
2020	1st April	11th Nov	224
2021	5th April	24th Nov	233
2022	1st April	9th Nov	222
2023	1st April	26 th Nov	239
2024	1st April	10 th Nov	224
Mean	8	15	222.12
STD	7.6	4.6	8.62
CV (%)	95	30.67	3.88

Source: Author’s Analysis, 2026

3.3. Trends in the Onset, Cessation Dates and Length of Growing Season (LOS)

The trend analysis was carried out to identify the direction and magnitude of the relationships in the onset, cessation and Length of growing season (LOS). It showed the existence of a

significant trend in the assessed parameters. The onset of the rainy season has a negative trend of $y = -0.1329x + 9.8556$ (Figure 3). This equation indicates a decreasing trend in the onset dates of the rainy season over time in the study area. With an R-squared value of 0.0304, only 3.04% of variability in the onset dates of rainy season can be explained by the linear relationship with time.

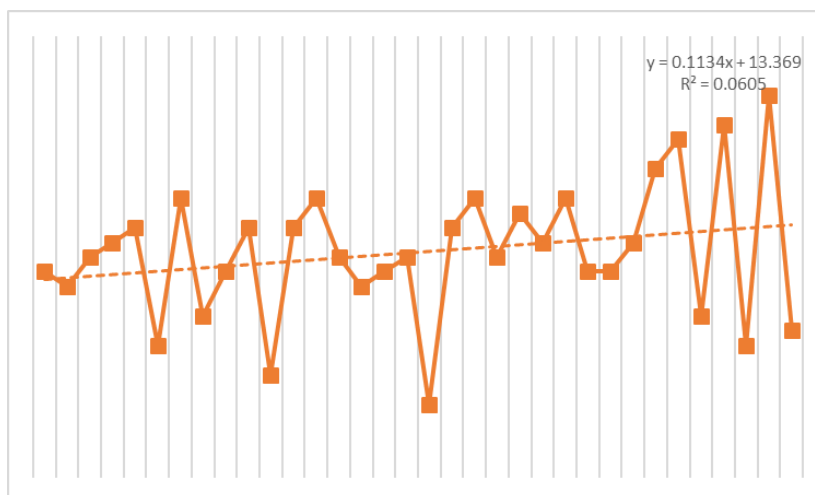


Source: Author’s Analysis 2026

Figure 3. Yearly onset dates of rain in Uromi (1991 – 2024).

The analysis of the cessation dates of the rainy season reveals a notable trend, as indicated by the best fit line equation $y = 0.1134x + 13.369$ (Figure 4). This equation demonstrates a positive slope, suggesting an increasing trend in the cessation dates of the rainy season over time. A positive slope of 0.1134 in a trend analysis indicates a delayed rainfall cessation over time. An (R)-squared value of (0.0605) demonstrates that time accounts for only (6.05%) of the variance in rainy season

end dates, suggesting a weak correlation between the two variables. It also indicates a discernible trend in the data. The positive slope of the trend line implies that, averagely, the rainy season has been ending late, in recent time in the study area. This changes in rainfall cessation dates significantly impact agricultural planning, hydrological resource management, and seasonal ecological processes. This finding is similar to an earlier study by [21].

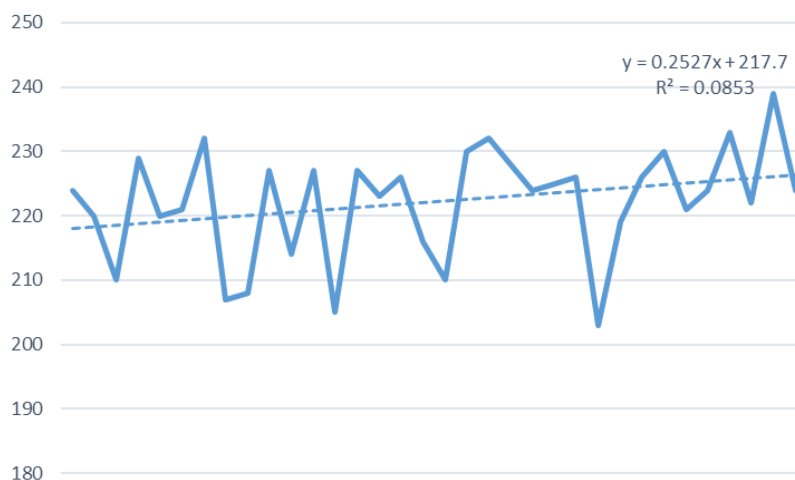


Source: Author's Analysis 2026

Figure 4. Yearly cessation dates of rain in Uromi (1991 – 2024).

The analysis of the length of growing season indicates a discernible trend, as shown in the best fit line equation $y = 0.2527x + 217.7$ of Figure 5. The positive slope denotes an upward trend in the length of the growing season over time. A coefficient of determination R^2 of 0.0853 demonstrates that while temporal changes account for 8.53% of the variance in

rainy season length, the underlying trend remains statistically significant. The positive slope of the trend line implies that, on average, the rainy season has been longer in recent years. This increased duration of the rainy season can have significant implications for various sectors, including agriculture, water resource management, and ecosystem dynamics.



Source: Author's Analysis 2026

Figure 5. Length of growing season in Uromi (1991 – 2024).

4. Discussion

A variability analysis of onset and cessation of rain including length of growing season is of great importance for policy makers in their decision making and farmers in their decision of what to plant and when to plant it as rainfall plays leading role in deciding cropping calendar in red-fed agriculture. It has

been noted that rain-fed agriculture and farmers' income are threatened by highly variable dates of onset and end of the rainy season [13].

In line with this, the Uromi inhabitants, the farmers' income and food production can be boosted via sustainable planning with little supply of irrigation to ensure multiple crops growing seasons annually. This is necessary to avert food scarcity and food insecurity in the study area and beyond. Though the

late end of the rainy season is not a prominent feature of the rainfall regime in Uromi, the years with later dates significantly had longer growing seasons. The observed trend in the area may have been triggered off by some factors, including climate change, land use management, and variability natural climate [27]. Variations in the timing and duration of rainy seasons are heavily influenced by climate change which induces shifts in precipitation. Additionally, changes in land-use pattern specifically deforestation and urbanization—significantly impact local weather patterns and seasonal length.

It has been reported that lack of synergy between rainfall onsets and agronomic decisions such as sowing date is one of the main factors causing low productivity globally [6, 15] implying that Uromi in Edo state is not excluded. Onset of rainy season is very important to crop production, as a few days delay in onset of the rainy season can make drought conditions more imminent. This therefore means that early identification and warning of drought conditions can save lives and livelihoods through informed preparedness.

5. Conclusion

The ability to predict the onset and cessation dates as well as the amount and the distribution of rainfall each year are usually some of the needs of farmers and extension agents to ensure high yield of crops. From this study, climate variability has significant influence on onset and cessation dates of rainfall in the study area. The identified onset and cessation dates and the lengths of the growing season are quite valuable for planning of rain fed agricultural activities which is what is practiced in the study area.

Analysis of onset results indicate that there exists organized progression of rainfall onset within the Uromi indicating that the South west air mass has influence on the rainy season. There is a very high and high variation of onset and cessation of rain in the area within the time (1991 -2024). Only length of growing season was observed to have very low variability. The variability observed may have been caused by El Niño-Southern Oscillation (ENSO) which is a major driver of early or late onsets [29]. El Niño events can disrupt traditional rainfall patterns, causing delays, while La Niña phases often correlate with delayed onset in many regions.

A negative slope was observed for the onset of rain analysis which implies that the date is decreasing with time. The positive slope in cessation of rain and length of growing season had implies that the rainy season starts early in recent times while cessation dates arrive late. Consequently, the length of rainy season is long. This showed that the trend of onset and cessation dates and length of rainy season are characterized by marked variability.

6. Recommendations

In view of the foregoing, it is recommended that Farmers

must adjust their planting schedules to align with shifting rainfall patterns to prevent early-stage crop damage. Additionally, the government should supply improved seeds and deploy agricultural extension workers to rural areas to train farmers on modern techniques. Urgent mitigation and adaptation strategies are critical to building resilience against climate variability.

Abbreviations

CV	Coefficient of Variance
ITD	Intertropical Discontinuity
NIMET	Nigerian Meteorological Agency
SD	Standard Deviation

Author Contributions

Perpetua Nkeiruka Oby Iyere-Usiahon: Conceptualization, Methodology, Writing – review & editing

Onyilo Desmond Onyilo: Writing – review & editing

Conflicts of Interest

The authors declare that there is no conflicts of interests regarding the publication of this paper.

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