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RELATIONSHIP BETWEEN RAINFALL VARIABILITY AND MAIZE YIELD IN APA LOCAL GOVERNMENT AREA OF BENUE STATE, NIGERIA

Elisha Ikpe[1], Omede U. D.[2] and Alhassan Y. J.[3]

1 Department of Geography, Federal College of Education, Odugbo, Benue State, Nigeria
2 Department of Agricultural Education, Federal College of Education, Odugbo, Benue State, Nigeria
3 Department of Agricultural Economics and Extension, Federal University, Wukari, Taraba State, Nigeria
Email : ugbedave@gmail.com

ABSTRACT

This study investigated the relationship between rainfall variability and maize yield in Apa Local Government Area of Benue State. The specific objectives were to analyse the trend in rainfall distribution and its impact on maize yield and to provide recommendations to improve maize productivity in the study area. Rainfall data was sourced from the archives of the Nigerian Meteorological station, Oshodi, Lagos; the maize yield data was collected from the archives of Benue State Agricultural and Rural Development Agency (BNARDA). The rainfall and maize yield data for 33 years (1988-2021) were used to characterise the maize yield response to rainfall pattern (increase or decrease). Trend-line equation was used to show the trend of rainfall, while Pearson's Correlation Coefficient (r) showed the degree of relationship between rainfall and maize yield. The results of the trend-line regressions showed an increase in total annual rainfall (y = 7.1873x + 1106.4) and an increase in maize yield (y = 0.0319x + 2.3239). The correlational trend chart showed a positive relationship between total annual rainfall and maize yield (r = 0.19), indicating that rainfall positively influenced yield. The study recommended that early warning weather information and climate-resilient varieties are needed to improve maize productivity. Extension services should also be provided to enhance farmers' knowledge on rainfall variability and its effects on maize yield.

Keywords *:* adaptation strategies, farmers, maize yield, rainfall variability and yield

INTRODUCTION

Rainfall variability has become a topical concern largely because of its impacts on natural and human systems. Labiru (2016) noted that the most often cited areas that are affected by rainfall variability include, crop production, fisheries, hydrology and forestry. Agriculture which is one of the major areas of socioeconomic as well as National Gross Domestic Product (GDP) in most countries in Africa is more vulnerable to rainfall variability. Despite the recent technological advancement, weather and climate are imperative determinants in agricultural production. The long-term crisis between farmers and herders mostly in the north-central part of the country is primarily attributed to change in climate and the variability of rainfall. Farmers need to expand on their farm size to maximize higher yield due to the danger posed by rainfall variability (Iornongo, 2021).

Rainfall variability is the fluctuations of rainfall occurrence annually or seasonally above or below a long-term normal value. Every year, the rainfall of a location can be different in a specific period, either above or below normal (Intergovernmental Panel on Climate Change [IPCC], 2022). Rainfall values in last decade reduced drastically and affected crop yields across Nigeria (Iornongo, 2021). These posed threats to food security in many developing nations including Nigeria because of the climate-dependent nature of agricultural systems and lack of viable Smart Climate Agricultural Practices (Bello et al. 2012; Opeyemi et al. 2021).

Despite enough rain, its irregularity can affect yields adversely if rains fail to arrive during the actual growing stage of crops (Iornongo, 2021). Odewumi (2013) reported that the availability of water to crops is by far the most important climatic factors which influence the pattern and productivity of rain-fed agriculture in Nigeria. Based on rainfall distribution, certain crops are found at a geographical location. Ariko et al. (2024) reported that the pattern of rainfall intensity and distribution explains why drought resistant crops such as millet and sorghum are grown largely in the northern part while more moisture-demanding crops such as rice, maize, soybeans and cassava are grown in the north central and southern areas of Nigeria extensively. To date, much of the effort to analyse rainfall patterns in Nigeria as related to agriculture, has generally focused on the exploitation of the seasonal rainfall (Yamusa et al., 2013). However, the season distribution of rainfall and its subsequent effects on crop productivity has received less attention.

Given the negative impacts of rainfall variability on economic livelihoods and food security in much of the developing world, helping farmers better adapt to this variability is a central concern of development and it is the best way to promote food security. This is because most farmers and governments can more readily perceive and understand the threat of variability (Ariko et al. 2024). Rainfall can be a challenging factor to maize production and can affect the productivity and sustainability of soils to maize yield (National Agricultural Extension Liaison Service, [NAERLS], 2009).

Maize production in Nigeria mainly depends on climatic conditions and its yield depends on rainfall availability in terms of amount and distribution (Okeowo et al. 2015). Maize is grown under divergent physical condition. The variability of rainfall pattern in Nigeria is responsible for the gradual changing of the planting date of maize. According to International Institute for Tropical Agriculture (IITA, 2018), maize requires considerable amount of moisture of about 500-750 mm of well-distributed rainfall conducive for proper growth. Maize requires more moisture during reproductive period and less moisture when developing towards maturity (Ikpe, 2021). Its area of cultivation has extended into the drier zones of Nigeria because of the introduction of drought resistant early maturing varieties (NAERLS, 2009).

Maize is one of the important grains in Nigeria. It is a multipurpose crop in which every part of it has great economic value. The grain, leaves, stalk, tassel and cob can all be used to produce a large variety of food products. Studies by Badu-Apraku et al. (2012) on maize production in different parts of Nigeria has shown an increasing importance of the crop amidst growing utilization by food processing industries and livestock feed mills in Nigeria. The demand for maize is increasing daily, because it is a major staple food for human and animals. Despite the economic importance of maize, it has not been produced in such quantity that could meet food and industrial needs of the country, and this could be attributed to low productivity due to lack of improved technologies for maize production (Iornongo, 2021). One of the major limitations to maize production in Nigeria is the rainfall variability which is exacerbated by climate change (Okeowo et al. 2015). In view of the demand for maize, Nigeria and international bodies such as Food and Agriculture Organization (FAO, 2016) have developed interest in promoting maize production for households food security and poverty alleviation.

Benue State is proudly referred to as the 'food basket of the nation' since the rich nutrients deposits of alluvial soils that support bumper harvest have helped farmers in producing crops on large scale. However, with the climate change and rainfall pattern, rainfall has become a critical issue in recent years. Therefore, rainfall variability and its attendant weather events have become what farmers will have to cope with, since it is fast becoming unpredictable to give accurate account of crop yields on farms (Opeyemi et al. 2021). Therefore, information is needed on the relationship between rainfall variability and the yield of maize in Apa Local Government Area (LGA) of Benue State. The need for such information constitutes the problem of the research interest. This is the gap the study intends to fill. This study therefore intends to address the following research questions;

i. What is the rainfall trend between 1988 – 2021 in the area?

ii. What is the trend in the yield of maize in the area?

iii. What is the relationship between rainfall variability and maize yield in the area?

OBJECTIVES

The aim of the study is to show the relationship between rainfall variability and in the yield of maize in the study area. The aim of the study was achieved through the following set objectives which were, to:

(a) Characterise the rainfall pattern of the study area between 1988 - 2021;

(b) Show the trend of maize yield in the area;

(c) Determine the relationship between rainfall variability and the yield of maize in the area.

METHODOLOGY

Apa LGA is in North-Western part of Benue State. The LGA is located on Latitude 7°20′ North to 7° 50′ North of the Equator and Longitude 7° 40′ East to 8° 10′ East of the Greenwich Meridian. It is bounded to the North by Agatu LGA, Otukpo LGA to the south, Gwer-West LGA to the East and Olamaboro LGA of Kogi State to the West (Jande and Amonjenu, 2018). The LGA has its headquarters at Ugbokpo and it consists of 11 council wards. The LGA has a population of about 146,138 people (projected to 2023) and a land area of about 995 Km^2 (National Population Commission, 2009).

Climatically, the State belongs to the Koppen's Aw climate group and experiences seasonal wet and dry seasons. The rain falls for seven months from April to October with total annual amount ranging between 12,000-20,000mm while dry season sets in November and ends in March (Ikpe et al. 2013). Temperatures are constantly high averaging between 28-32°C and sometimes rising to 37°C. The vegetation still possesses relics of the guinea savanna with coarse grasses

and numerous species of scattered trees. Dense forests are very few and far apart in the State and exist either as gallery forest, village forest or forest reserves (Terwase and Terese, 2013). Agriculture forms the backbone of the LGA economy, engaging more than 70% of the population. The LGA has an advantage of being located across both the forest zone where tree crops are grown and the savanna where mainly grains are cultivated.

Apa LGA is called "the green land" of Benue State because of its huge agricultural potential. The area is endowed with rich fertile lands, which encourage variety of arable crops such as yam, rice, cassava, guinea corn, maize, groundnuts, beniseed, pepper, cowpea, e.tc. Crops such as vegetables are produced on smaller scale during the dry season (Jande and Amonjenu, 2018).

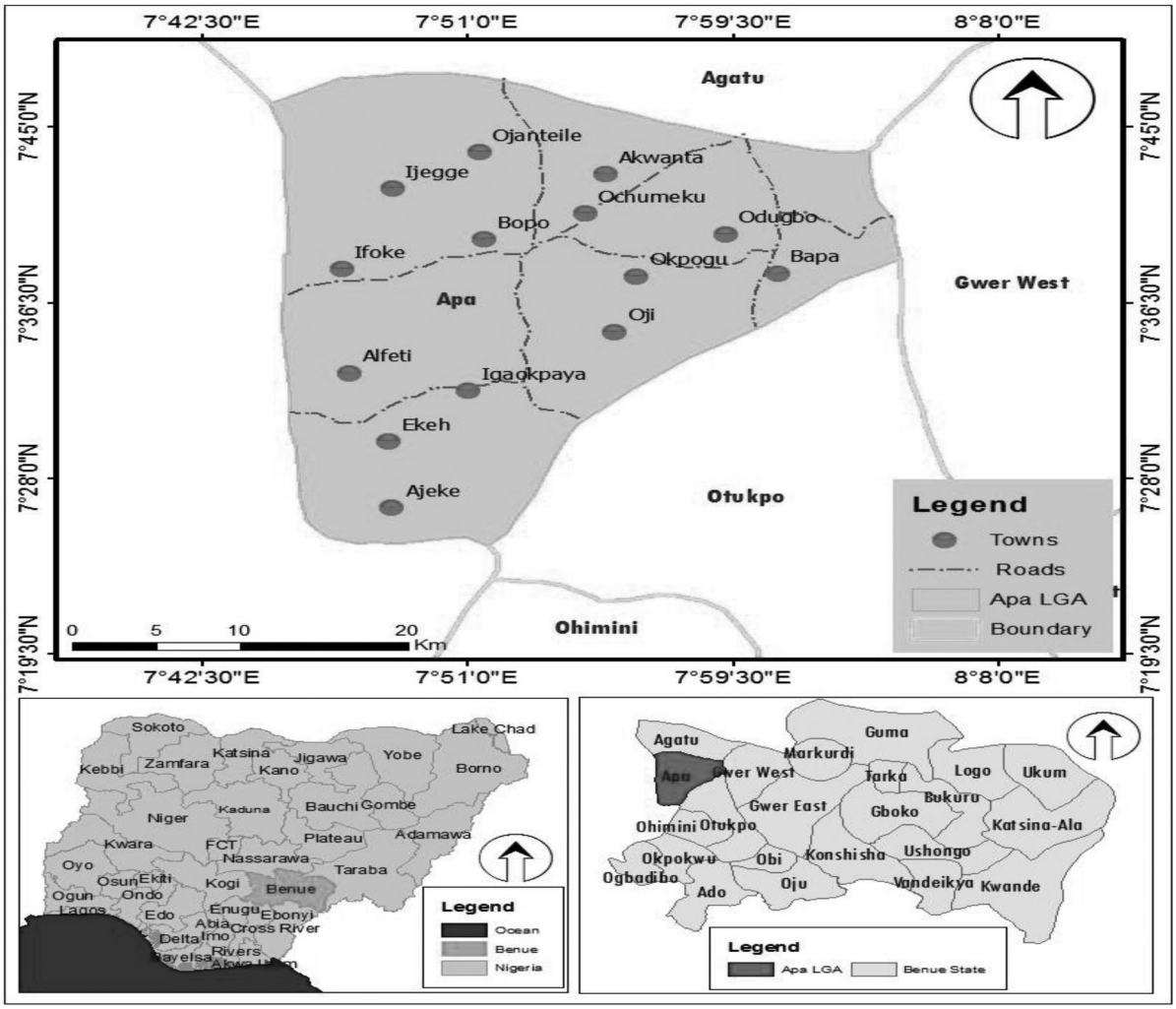

Fig. 1: Map of the study Area in Benue State, Nigeria

Source: Field Survey 2024

Rainfall and maize yield data for 33 years (1988 - 2021) were obtained and used for the study. The choice of using thirty-three (33) years data was because of the unavailability of maize yield data for the area before 1988. The Rainfall data was sourced from the archives of the Nigerian Meteorological station, Oshodi, Lagos, while the maize yield data was collected from the archives of Benue State Agricultural and Rural Development Agency (BNARDA).

The rainfall and maize yield data were used to characterise the maize yield response to rainfall pattern (increase or decrease). Trend-line equation was used to show the trend of rainfall, while Pearson's Correlation Coefficient (r) showed the degree of relationship between rainfall and maize yield. The analysed results were presented using charts and tables.

RESULTS AND DISCUSSION

Rainfall trend of the study area

Trend in the Total Annual Rainfall (TAR) of the study area for the period of study is presented in Figure 2.

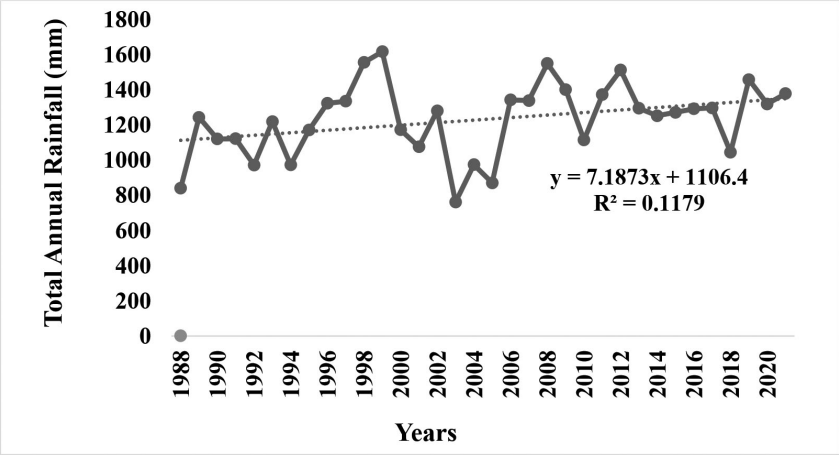

Figure 2: Trend in Total Annual Rainfall (1988 – 2021)

The trendline show a fluctuating, oscillating pattern in the TAR for the 33 years reviewed. Although, the best fit trend-line shows a positive equation (y = 7.1873x + 1106.4) which implies that TAR is on the increase. The upward and downward movement of the trendline represents the variability of the rainfall. Within the period of study, 2003 experienced the lowest TAR (761 mm) while 1999 experienced the highest amount of rainfall (1618 mm). That the TAR is increasing in the study area agrees with the findings of Adamgbe and Ujoh (2013), which reported that rainfall amount is on the increase in Gboko LGA of Benue State. According to Akinola, et al. (2019), farmers' in Benue State perceived an increasing trend in annual rainfall, while the observed variability showed increasing trend in all the rainfall variables.

According to Ayoade (2004), rainfall has more significant effect on inter-annual changes in crop yield in a tropical environment as it determines the supplies of water to plants. Moreover, rainfall is the most variable of all climatic elements and determines the growing season in developing countries like Nigeria where agriculture is predominantly rain-fed. Almost every farmer is interested in what the expected rainfall would be, more than any other climatic elements as it determines the success or failure of crops. Timely and accurate weather forecasting is crucial to improving farming activities. This would require developing human capacity and appropriate infrastructure for weather forecasting and information sharing (Ikpe et al. 2016).

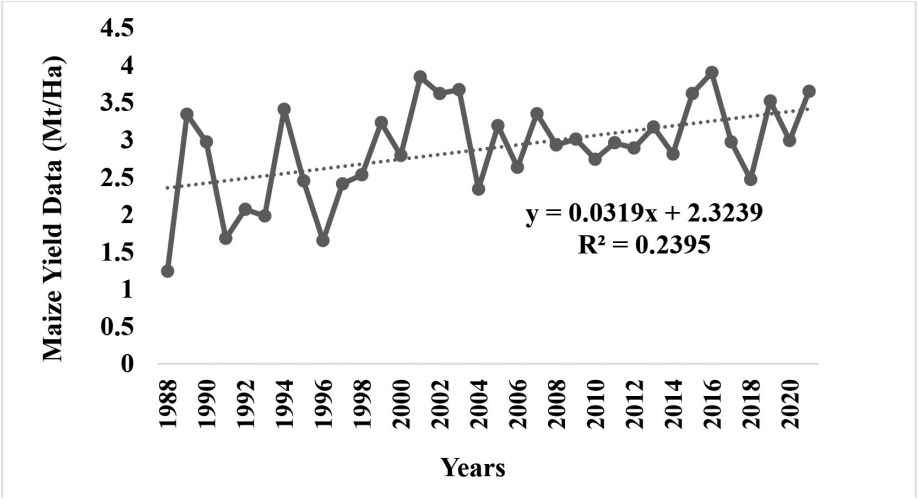

Figure 3: Trend in the yield of maize (1988 – 2021)

Figure 3 indicates an increasing trend in maize yield in the study area with the trend-line equation y = 0.0319x + 2.3239. The highest yield was recorded in 2001 (3.84 tons/ha), the lowest yield was recorded in 1988 (1.24 tons/ha) and 2.88 tons/ha was the average yield obtained within the period reviewed. Adamgbe and Ujoh (2013) reported that most households in Nigeria cultivate maize more than any other grain crop. Maize is an important source of carbohydrate, protein, iron, vitamin B and minerals. It is a staple food for the masses and provides dry season feed for farm animals. That maize yield is increasing in the study area disagrees with the findings of Adamgbe and Ujoh (2013) who reported low yield of maize crop in Benue State, Nigeria. The result further disagrees with the findings of Emeghara (2015) which reported a negative trend line results in the yield of maize in Sokoto State. The reason for the increase in the yield of maize in Apa LGA of Benue State may not be wholly attributed to increase in rainfall amount, other factors such as increase in knowledge and adoption of viable adaptation strategies (improved seed varieties, application of organic and inorganic manure; mixed cropping etc) could be a factor for the increase in the yield of maize.

The correlational trend chart for rainfall and maize yield are presented in Figure 3. The results show that rainfall amount influences the yield of maize in the area. The results show that as rainfall increases or decreases, it pulls or push the yield of maize.

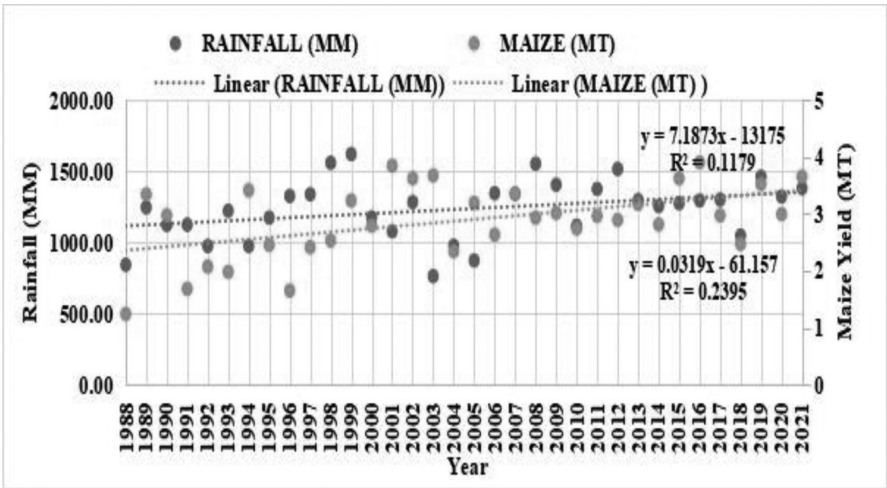

Figure 3: Interactive trend chart for rainfall (mm) and maize yield (Mt)

The analysis of correlation between rainfall and maize in Apa LGA of Benue State **(**1988 – 2021) is presented in Table 1.

Table 1: Correlation between Rainfall and Maize in the study area

Variable	Results
Pearson's Correlation Coefficient (r)	0.19
No. of observations (n)	33

Source: Author's computation

The correlational trend (Table 1) show a positive relationship between TAR and maize yield (r =0.19), indicating that rainfall positively influenced yield. The positive correlation coefficient between rainfall and maize yield shows increase in the yield of maize. This implies that the TAR in the study area is sufficient for maize production considering other weather parameters and suitability.

NAERLS (2009) reported that maize is the most widely cultivated grain in the country. Apart from having some industrial uses, it is one of the staple food crops in the country. Its area of cultivation has extended into the drier zones of the country because of the introduction of drought resistant early maturing varieties. Given the effects of variability and dry spells on the early planted crop, the problems of access to fertilizers and the area planted up with maize mostly by small holder farmers was estimated as 4,862,620ha which represents an increase of about 4.2% compared with 4,668,780 ha in 2008.

CONCLUSION

This study analysed the relationship between rainfall variability and the yield of maize in Apa LGA of Benue State, Nigeria. The results established that as TAR increases in the area, so do yield in maize also increases which implies that relationship exist between TAR and maize yield in the study area.

RECOMMENDATIONS

Based on the findings of the study, the study therefore recommends the following:

(1) early warning weather information by the Nigerian Meteorological station and climate-resilient varieties are needed by the farmers to improve maize productivity;

(2) extension services should also be provided by non-governmental organisation, government agencies and stakeholders to enhance farmers' knowledge on rainfall variability and its effects on maize yield.

CONFLICT OF INTEREST

The authors declare no conflict of interest

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