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# Effect of climate change on agricultural product in Nigeria

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ABSTRACT

This study uses the Autoregressive Distributed Lag (ARDL) approach to empirically investigate the impact of climate change on agricultural production in Nigeria between 1986 and 2024. The inflation rate, food production, annual rainfall, and carbon emissions are the model's primary explanatory variables. Long-term findings show that food production, rainfall, and carbon emissions all have a significant positive impact on agricultural output, while inflation has a negligible negative impact. In the short term, carbon emissions remain a significant determinant, while rainfall and food production have mixed and largely insignificant effects. The findings support the existence of a long-run relationship between the variables, emphasising the importance of climate change dynamics in shaping agricultural productivity in Nigeria. Although climate variability poses a threat to agricultural stability, the study concludes that targeted adaptation strategies can mitigate negative consequences while also promoting food security. It promotes climate-friendly agricultural practices, emission-reduction policies, farmer assistance programs, and a comprehensive climate-agriculture policy framework.



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## 1. INTRODUCTION

The climate in Nigeria is changing, as evidenced by rising temperatures, variable rainfall, rising sea levels and flooding, drought and desertification, land degradation, more frequent extreme weather events, depleted freshwater resources, and biodiversity loss. Rainfall durations and intensities have increased, causing widespread runoff and flooding in Nigeria (Haider, 2022). Rainfall variability is expected to continue to increase. Precipitation in the south is expected to increase, while rising sea levels are expected to exacerbate coastal flooding and submergence. Droughts have also become a regular occurrence in Nigeria, and they are expected to continue in Northern Nigeria as precipitation decreases and temperatures rise. Lake Chad and other lakes in the country are drying up and on the verge of extinction. Temperatures have risen sharply since the 1980s. Temperatures are expected to rise significantly in all ecological zones over the next few decades, according to climate projections. This study aims to conduct empirical research into the impact of climate change on agricultural production. Agriculture employs nearly two-thirds of the Nigerian workforce and contributes significantly to the country's GDP. However, the sector's reliance on rain-fed farming renders it extremely vulnerable to climate change. With Nigeria's population expected to exceed 400 million by 2050, demand for food is rising, putting enormous strain on the country's agricultural systems. Unfortunately, climate change is undermining these efforts, resulting in lower productivity and greater food insecurity (Eke & Onafalujo, 2023). The country's average temperatures have risen significantly in recent years, with forecasts predicting further increases across all ecological zones. Crop yields suffer as temperatures rise, particularly for temperature-sensitive crops such as maize and cassava. While some crops, such as millet, may be less resistant to rising temperatures in northern regions, the overall impact of heat stress remains negative (Onyeneke, Ejike, Osuji, & Chidiebere-Mark, 2024).

Because of the potential impact on economic activity, researchers are interested in investigating the link between climate change and agricultural products. Several studies, such as Mbonu (2025), Chandio et al. (2024), and Ehi et al. (2024), Kigbu (2025), Utuk et al. (2024), Shah et al. (2014), and Oyeneke et al. (2024), investigated their relationship using various methods such as the ex-post factor method, fully modified ordinary least squares (FMOLS) method, ARDL method, Panel fixed effect approach, and others. Climate change's impact on agricultural productivity is still being debated in the literature. While some authors, such as Mbonu (2025), Chandio et al. (2024), and Ehi et al. (2024), contend that climate change has a negative impact on agricultural products, others, such as Kigbu (2025) and Utuk et al. (2024) Shah et al. (2014) and Oyeneke et al. (2024) both stated that climate change has a positive impact on agricultural products. Based on this context, this paper employs auto-regressive distributed techniques to examine the relationship between climate change and agricultural products in Nigeria using newly updated annual data from 1986 to 2024. To achieve the aforementioned objectives, the paper is divided into five sections. Following a review of the literature in Section 2, Section 3 discusses methodology. Section four contains the findings and discussions, while Section five includes some conclusions and recommendations.

## 2. LITERETURE REVIEW

### 2.1 Overview of Climate and Climate Change Experience in Nigeria

Nigeria has a tropical climate with two distinct seasons, wet and dry. The lengths of the rainy and dry seasons differ depending on location. For example, the southern part of Nigeria has a longer rainy season (March to November) than the north (May to September). The northern dry season is distinguished by high temperatures that can reach an average monthly value of 38 degrees Celsius, while the mean temperature in southern Nigeria ranges between 32 and 33 degrees Celsius. Nigeria, like other countries around the world, has suffered from climate change disasters, such as the one that occurred 25 years ago in the northeastern region now occupied by Borno and Yobe states, and the southern part of Lake Chad, which is part of Nigerian territory, dried up. The Lake used to cover more than 40,000 square kilometres, but it now only covers 1,300. While the negative trend continues, rising temperatures cause the Sahara Desert to rapidly expand southward, leaving farmlands and surrounding villages barren and swallowed up by advancing desertification, resulting in a massive migration of people from the north east to the greener plateau and middle belt regions in search of more fertile land. Furthermore, rising desertification forced thousands of Fulani herders to relocate to the south and middle belt, sparking clashes with crop farmers and killing hundreds, according to residents and activists. Several studies have looked at the relationship between climate change, inflation, and agricultural output in both developed and developing countries, including Nigeria (Mbonu, 2025; Chandio et al., 2024; Kigbu, 2025; Utuk et al., 2024; Shah et al., 2014; and Oyeneke et al., 2024, among others).

Chandio et al. (2024) studied how climate change-induced temperature changes and the use of renewable energy sources affect agricultural productivity in emerging Asian economies including China, India, Japan, Malaysia, Indonesia, Bangladesh, Nepal, Pakistan, Sri Lanka, the Philippines, Thailand, and Vietnam. This study used the FMOLS and DOLS methods to analyse data from Asian developing economies from 1990 to 2018. Long-term projections show that renewable energy increases agricultural output while climate change reduces it. Furthermore, input factors such as agricultural land, fertiliser use, and rural labour force all contribute significantly to increased agricultural productivity. Furthermore, the causality tests reveal that all of the variables examined had a significant impact on agricultural production in the Asian-12 economies. Finally, these findings have several implications for Asian economies, particularly in terms of sustainable agricultural production and improved environmental quality.

Shah et al. (2024) investigated the impact of climate change and production technology heterogeneity on China's agricultural total factor productivity and efficiency. They used the DEA-Malmquist Productivity Index to assess total factor productivity change (TFPC) in 31 Chinese provinces and administrative units from 2000 to 2021. The meta-frontier analysis determines the technological gap in agricultural production across nine Chinese regions. The findings suggested that climate factors could overestimate China's average total factor agricultural productivity during the study period. Climate factors influenced eight of China's nine regions;

however, agricultural TFPC in the Qinghai Tibet Plateau and surrounding regions performed the best, ranking first in China with an average TFPC growth rate of 22.3%. After dissecting the TFPC into efficiency and technological change, the study discovered that climate has a greater impact on technological change than efficiency change. According to Ehi et al. (2024), climate change poses a negative and significant threat to food security in Sub-Saharan Africa. The findings also revealed that the region relies heavily on rain-fed agriculture and has limited adaptability.

Mbonu (2025) Used ex-post facto research design, and linear regression with an Error Correction Model (ECM) for the annual time series data from 2000 to 2023 to investigate the effects of climate change on agricultural productivity in Nigeria. The findings showed that climate change had a negative impact on agricultural output in Nigeria during the study period. Based on these findings, the study concludes that climate change's negative effects on Nigeria's agricultural sector highlight the need for immediate adaptation strategies. Adoption of climate resilient crop varieties, improved irrigation systems, and sustainable farming practices are critical for building resilience and ensuring food security in the face of current environmental challenges.

Kigbu (2025) investigated the effects of climate change on agricultural productivity in Nigeria. The study analysed annual frequency data from 1990 to 2020. The static and dynamic models were estimated using the Autoregressive Distributed Lag (ARDL) estimator. Furthermore, the study examined the stability of the series using the KPSS method, and co integration was tested by means of the bound test. Growth in CO2 emissions does not threaten agricultural productivity by lowering output levels; rather, it has a positive and significant impact, increasing productivity by up to 0.5359 percent in the long run. The study found that agricultural land use and average rainfall increased agricultural productivity, but only to a limited extent. In the long run, fertiliser consumption was discovered to have a negative and significant impact on agricultural productivity. Although CO2 emissions have fluctuated over time.

Utuk et al. (2024) investigated the effects of climate change on Nigerian agriculture production using fully modified ordinary least squares (FMOLS) on annual time series data from 2000 to 2022. The findings indicate that temperature (LNTEMP) has a significant positive impact on the agricultural sector, whereas rainfall has a negative and significant impact. More so, methane emissions (LNMETH) exhibited an inverse relationship with agriculture sector. Carbon dioxide emission (LNCO2) shows a positive but insignificant relationship with agriculture sector

Onyeneke et al. (2024) investigated the impact of climate change on six major crops in Nigeria using the autoregressive distributed lag method for annual time-series data over 39 years. The findings revealed that all six ARDL models were structurally stable and exhibited both short-run and long-run relationships between climate change, production factors, and crop output. Land, in particular, showed long-term positive relationships with all crop outputs except millet. In the long run, temperature had a negative impact on crop outputs of yam, cassava, millet, rice, and sorghum, whereas rainfall significantly increased rice and maize production while decreasing yam, cassava, millet, and sorghum production. Credit significantly increased cassava, maize, and rice production in the long run, whereas fertilisers had mixed effects on yam, cassava, rice, and sorghum production in the long run.

Overall, the existing body of literature appears to be lacking in studies investigating the impact of climate change on agricultural products in developed countries and Nigeria. Furthermore, only a few empirical studies have been published to investigate the relationship using new data from the most recent economic downturn and the country's removal of oil subsidies, as well as the implementation of a flexible exchange rate, which gripped Nigeria from 2023-2024.

## 3. METHODOLOGY

### 3.1 Data Source

The study analysed annual time series data from 1986 to 2024. All data were gathered online from the Central Bank of Nigeria's website (www.cbn.gov.ng) and World Development Indicators. This time period was chosen to account for the independent effects of annual rainfall, inflation rate, food production, and carbon emissions on agricultural products in the context of exchange rate liberalisation, global economic crises, post-global economic crises, the country's August 2016 recession, and the elimination of oil subsidies in 2024.

### 3.2 Model Specification

The model expressing the functional relationship between food inflation/ Core Inflation and their determinants is given as:

$LAGP = f$ (INFR, LFODP, LARNF, $LCO_2$) ............................................... (3.1)

The Econometrics model is stated as:

$LAGP_t = \beta_o + \beta_1 INFR_t + \beta_2 LFODP_t + \beta_3 LARNF_t + \beta_4 LCO_2 + \mu_t$.................... (3.3)

Where;

LASP = Log of Agricultural Product

INFR = Inflation Rate

LFODP = Log of Food production

LARNF= Log of Annual rainfall

$LCO_2$= Log of Carbon Emission

$\beta_0$, is constant while, $\beta_1$, to, $\beta_4$, are Parameters of the variables captured in the model,

μ= Error Term and t represents Time Trend

The study adopts Autoregressive Distributed Lag (ARDL) approach developed by Pesaran et al (2001) to estimate equation (3.2). The choice of the ARDL is based on the following reasons: first, the model can be applied irrespective of whether the series under investigation are stationary at I (0) or I(1) or mixture of both. Second, it provides robust and high quality result even if sample size is small or large. Finally, it takes into account the error correction model. The analysis of error correction and auto regressive lags fully covers both long-run and short-run relationships of the variable under study (Pesaran et al; 2001 and Villavicencio and Bara; 2008). Following the work of Pesaran et al (2001), the ARDL model of equation (3.3) is given as:

$$\Delta LAGP_t = \beta_0 + \sum_{i=1}^{m} \beta_1 \Delta INFR_{t-i} + \sum_{i=1}^{m} \beta_2 \Delta LFODP_{t-1} + \sum_{i=1}^{m} \beta_3 \Delta LARNF_{t-i} + \sum_{i=1}^{m} \beta_4 \Delta LCO2_{t-i}\, \alpha_1 INFR_{t-1} + \alpha_2 LFODP_{t-1} + \alpha_3 L\,ARNF_{t-1} + \alpha_4 LCO2_{t-1} + \mu_t \ldots\ldots\ldots\ldots (3.3)$$

Where m is the optimum lag length will be determine using Akaike Information Criteria (AIC) and Schwartz Information Criteria (SIC), Δ is difference operator, while $\beta_1$ to $\beta_3$are vectors of the coefficient of the first difference lagged values of the variables captured in the model

Thus the short run equation and error correction model is expressed as follows:

$$\Delta LAGP_t = \theta_0 + \sum_{i=1}^{m} \theta_1 \Delta\, INFR_{t-i} \sum_{i=1}^{m} \theta_2 \Delta LFODP_{t-1} + \sum_{i=1}^{m} \theta_3 \Delta LARNF_{t-i} + \theta_4 \Delta LCO2_{t-i} \theta_5 + ECM_{t-1} + \mu_t \ldots\ldots\ldots\ldots (3.4)$$

Where, $\theta_0$ is the coefficient of constant term, $\theta_1$ to$\theta_5$ is the coefficient of short run variables, ECM is the Error correction model of one period lag estimated from equation.

The ARDL model's first part ($\beta_1$ to $\beta_4$) represents short-run dynamics, while coefficients ($\alpha_1$ to $\alpha_3$) represent long-run dynamics. The null hypothesis ($H_o$: $\alpha_1 = \alpha_2 = \alpha_4 = 0$) implies no long-run relationship among variables, so rejecting $H_o$ indicates evidence of a long-run relationship. The study will begin by conducting co-integration test of a bound testing approach for finding the evidence of long run relationship. To do that, the calculated F-statistics would be compared with two critical values (lower and upper bound); the null hypothesis of no relationship would be rejected if the calculated F- statistics is greater than the upper bound critical value, whereas if it falls below the lower critical values, the null hypothesis of no relationship cannot be rejected. The dependent variable in this study is agricultural product (AGP). The model includes the following control variables and their expected linkages:

1. Inflation Rate (INFR): High inflation reduces farmers' purchasing power, raises the cost of inputs (fertilisers, machinery, seeds), and lowers profits. This may lower agricultural productivity. However, the study discovered that inflation is insignificantly related in the long run, despite being positive in some short-run lags, owing to Nigeria's price rigidities and policy interventions.
2. Food Production (FODP): Higher food output is directly related to agricultural performance and contributes to GDP. It also accounts for productivity gains from technological advancements, land use, and input efficiency. The results demonstrated a strong long-term positive impact, confirming its central role.
3. Annual Rainfall (ARNF): Because Nigeria relies heavily on rain-fed farming, rainfall is an important factor influencing yields. Rainfall that is adequate and evenly distributed increases output, whereas variability and extremes (droughts or floods) reduce productivity. Rainfall, according to the model, improves agricultural performance significantly over time.
4. Carbon Emissions ($CO_2$): While commonly viewed as a pollutant, moderate $CO_2$ can improve photosynthesis and plant growth, leading to increased yields. This study found that $CO_2$ has a strong positive relationship with agricultural output in both the short and long run. However, policymakers should consider the long-term environmental risks.

## 4. RESULTS AND DISCUSSION

**Table 1**. Descriptive Statistics result

| | LAGP | LFODP | INFR | LARNF | LCO2 |
|---|---|---|---|---|---|
| Mean | 6118965. | 73.56629 | 18.15298 | 51.60058 | 0.264303 |
| Median | 694447.2 | 75.10000 | 15.90097 | 48.67319 | 0.160600 |
| Maximum | 30790171 | 117.3300 | 27.37879 | 70.12522 | 1.270100 |
| Minimum | 0.000000 | 29.85000 | 9.063329 | 44.16834 | 0.031400 |
| Std. Dev. | 9044488. | 24.46972 | 6.199814 | 8.109666 | 0.266498 |
| Skewness | 1.357413 | 0.110914 | 0.019318 | 0.753627 | 1.962303 |
| Kurtosis | 3.553666 | 2.120339 | 1.330161 | 2.316612 | 7.093969 |
| Jarque-Bera | 11.19537 | 1.200224 | 4.068538 | 3.994130 | 46.90453 |
| Probability | 0.003706 | 0.548750 | 0.130776 | 0.135733 | 0.000000 |
| Sum | 2.14E+08 | 2574.820 | 635.3544 | 1806.020 | 9.250600 |
| Sum Sq. Dev. | 2.78E+15 | 20358.08 | 1306.881 | 2236.067 | 2.414724 |
| Observations | 35 | 35 | 35 | 35 | 35 |

*Source: Authors' Computation with Eviews Version 10 (2025)*

Table 1 demonstrates that agricultural Product (AGP) appears to have higher mean, and, maximum values, it also have the higher standard deviation than the other variables. This is because the agricultural sector's performance is measured in millions, and then followed by FODP. Furthermore, the positive skewness of all variables indicates that the distribution has a long right tail, implying that the distribution is rightward skewed in the variable distributions. Furthermore, only AGP and $CO_2$ display kurtosis values greater than 3, indicate that distributions of AGP, and $CO_2$ are more peaked than the normal distribution. The Jarque-Bera test results show that only AGP, and $CO_2$ series are not normally distributed, implying that they are significant at the 1% probability level, thereby rejecting the null hypothesis for the distribution of only AGP, and $CO_2$. As a result, the variables cannot be described as being normally distributed.

### 4.1 Result of Unit root test

**Table 2:** Unit Root Test (Augmented Dickey-fuller and Philip-Perron Unit Root Test)

| Variables | Augmented Dickey-fuller | | Philip-Perron | | Integration Order of Variables |
|---|---|---|---|---|---|
| | Level 1 (0) | First diff 1 (1) | Level 1 (0) | First diff 1 (1) | |
| | Trend and Intercept | | Trend and Intercept | | |
| LAGP | -4.510** | ----------------- | -9.490*** | ------------- | I (0) I(0) |
| INFR | ------------- | -4.859** | ---------------- | -4.860** | I (1) I(1) |
| LFODP | ------------- | -4.011** | -3.963** | ------------ | I (1) I (0) |
| LARNF | ------------- | -5.581 | ---------------- | -5.581*** | I (1) I (1) |
| $LCO_2$ | ------------- | -4.118** | -4.219*** | ------------- | I (1) I (0) |

****, **, and * denote significance at the 1, 5, and 10% levels, respectively.*
*Source: Authors' Computation with Eviews Version 10 (2025)*

The consistent Augmented Dickey-Fuller and PP unit root test results in Table 4.2 show that all variables are integrated at order I (0) and I (1) (i.e., stationary at levels and first differences). Meanwhile no variable is integrated at order two (I (2)), satisfying the requirement of ARDL bound test.

**Table 3:** Presents the ARDL Bound test result

| Test statistics | Value | K | Significance level | I (0) Lower Bound | I (1) Upper Bound |
|---|---|---|---|---|---|
| F- statistics | 3.53 | 4 | 10% | 2.2 | 3.09 |
| | | | 5% | 2.56 | 3.49 |
| | | | 1% | 3.29 | 4.37 |

*Source: Authors Computation Using Eviews Version 10 (2025)*

Table 3 demonstrates that the calculated F statistic of 3. 53 exceeds both the lower and upper critical values at the (5% and 10%) significance level, respectively. This means that in the long run, all of the variables are co integrated.

**Table 4:** Result of Long Run Coefficients of ARDL

| Dependent Variable: LASP | | | |
|---|---|---|---|
| Variables | Coefficient | t- statistic | P- Value |
| LAGP (-1) | -1.746120 | -3.334 | 0.015** |
| FODP | 698351.9 | 0.000 | 0.000*** |
| ARNF | 1063277 | 0.000 | 0.000*** |
| INFR | -1016046. | -1.676 | 0.144 |
| $CO_2$ | 1063277. | 0.000 | 0.000*** |
| C | -69398183 | 0.000 | 0.000*** |

*Note: ***, ** &* indicate significance at 1, 5 and 10 percent level respectively.*
*Source: Authors Computation Using Eviews output Version 10 (2025)*

The results in Table 4 above show that there is a positive and significant long-run relationship food production (FODP) and agricultural product in Nigeria at the 1% probability level over the study period, implying that a 1% increase in food production would increase agricultural product by approximately (698351.9%), similarly there is significant positive relationship between annual rainfall (ARNF) and agricultural product at 1% probability level over the study period, showing that a 1% increase in annual rainfall would increase agricultural product by approximately (1063277%) respectively, the finding supported that of Kigbu, 2025, Shah et al, 2024, Utuk et al, 2024 & Ajiboye and Olanrewaju, 2024 whose found positive effect in china and Nigeria, but contradict Mbonu, 2025, Chandio et al 2024, and Ehi et al, 2024 whose found negative relationship between Climate change and agricultural product in Asian economies, Africa and Nigeria. On the other hand, the coefficient of inflation rate shows insignificant negative correlation with agricultural product. Carbon Emission ($CO_2$) has significant positive relationship with agricultural product at 1% probability level; an increase in $CO_2$ by 1 will lead to a (1063277%) increase in agricultural product

**Table 5:** Short Run Coefficients of ARDL and Error Correction Mechanism result

| Variables | Coefficient | t- statistic | P- Value |
|---|---|---|---|
| Δ(FODP) | 253806.0 | 1.276 | 0.249 |
| ΔFODP(-1) | -240768.4 | -0.918 | 0.394 |
| ΔFODP(-2) | -134640.5 | -0.459 | 0.662 |
| ΔFODP(-3) | -836691.3 | -4.034 | 0.006* |
| Δ(INFR) | 2335219. | 3.979 | 0.007* |
| Δ INFR(-1) | 436305.3 | 0.664 | 0.532 |
| Δ INFR(-2) | 1659957. | 2.531 | 0.045** |
| Δ INFR(-3) | -523242.8 | -1.049 | 0.335 |
| Δ (ARNF) | 415851.9 | 0.927 | 0.389 |
| Δ ARNF(-1) | 335921.5 | 0.711 | 0.504 |
| Δ ARNF(-2) | -443571.6 | -0.799 | 0.455 |
| Δ ARNF(-3) | -611911.1 | -1.542 | 0.174 |
| Δ(_CO2_) | 10941057 | 0.000 | 0.000*** |
| Δ(_CO2_(-1) | 59634095 | 0.000 | 0.000*** |
| Δ(_CO2_(-2) | 24996925 | 0.000 | 0.000*** |
| Δ(_CO2_(-3) | 40211162 | 0.000 | 0.000*** |
| ECM (-1) | -1.746 | -6.236 | 0.000*** |
| $R^2$ = 0.93, Adj $R^2$ = 0.83, D.W = 2.72, F statistic= 7.60 (0.000)***, | | | |

*Note: ***, ** &* indicate significance at 1, 5 and 10 percent level respectively.*
*Source: Authors Computation Using Eviews output Version 10 (2025)*

The short run estimates presented in Table 5 show insignificant positive relationship with food production and agricultural product, implying that a 1% increase in exchange rate resulted in an increase in agricultural product by roughly (253806.0), but food production is not the major determinant of agricultural sector as indicate by insignificant p-value of (0.249), similarly lag 1 and 2 of food production also shows insignificant positive relationship with agricultural sector. In contrast only lag 3 of food production shows significant negative relationship with agricultural product at 10% significance level, inflation rate also shows long run significant positive relationship with agricultural sector at 10% probability level, a 1% increase in inflation rate will lead to an increase in agricultural sector by (2335219) also lag 1 of inflation shows insignificant positive effect on agricultural sector but lag 2 shows significant effect at 5% level, on the other hand lag 3 of inflation shows insignificant negative relationship with agricultural sector. The coefficient of annual rainfall shows insignificant positive correlation with agricultural sector even at lag 1 while at lag 2 and 3 it has insignificant negative correlation with agricultural sector. Furthermore the coefficient of Carbon emission ($CO_2$) have a significant positive correlation with agricultural product at the (1%) probability level, implying that a 1% increase (decrease) in ($CO_2$) will result in an increase in agricultural product by (10941057) In similar way lag 1, 2 and lag 3 of ($CO_2$) have shown a significant positive relationship with Agricultural sector at 1% probability level. The error correction term, as expected, is less than one with a negative sign (-1.746) and statistically significant at one percent (0.000). This indicates that in the case of any downswing in the agricultural product, the system may correct itself in 12 months at the monthly speed of adjustment of approximately 74% for the food production, inflation rate, annual rainfall, and carbon emission

**Table 6:** Diagnostic test Result

| Test | LM version | F. Statistics |
|---|---|---|
| Normality (Jarque Bera Test Statistics) | JQ= 0.909 [0.635] | Not applicable |
| Serial Correlation (Breusch Godfrey LM Test) | CHSQ (2) = 10.657 [0.004] | F(2,4) = 1.162[0.400] |
| Heteroscedasticity (Breusch pagan Godfrey) | CHSQ (22) =23.850 [0.356] | F (20,131) = 1.263 [ 0.414] |

*Source: Authors Computation Using Eviews Version 10 (2025)*
*Note: values in parenthesis are p-values*

The series were discovered to be not normally distributed, as JQ demonstrated statistical insignificance. As a result, we accept the null hypothesis of series' frequency distributions are not normal distributed. The Breusch-Godfrey serial correlation test revealed that the F statistic is insignificant, while LM versions is significant, indicating that the series are not serially correlated. This also implies that the error terms are independent, which means that the error term in one period is unaffected by the error term in another. As a result, we can conclude that there is no autocorrelation at the 5% level. The Breusch - Pagan - Godfrey test is a Lagrange multiplier that checks the null hypothesis of no heteroscedasticity. The heteroscedasticity test result produced a high p-value, indicating that it is statistically insignificant. This implies that we accept the null hypothesis and conclude that the residual variance is constant (homoscedasticity). To check the structural break, a stability analysis was carried out using graphs depicting the cumulative sum of recursive residuals and the cumulative sum of squared residuals (see figures 1 and 2 below).

***Figure 1***

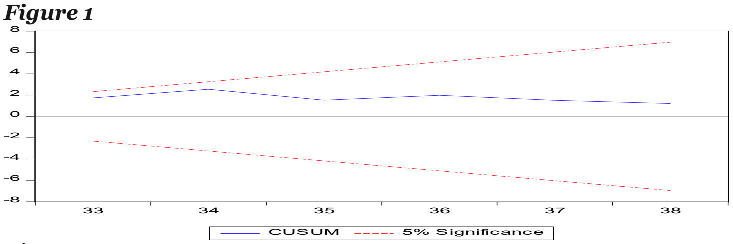
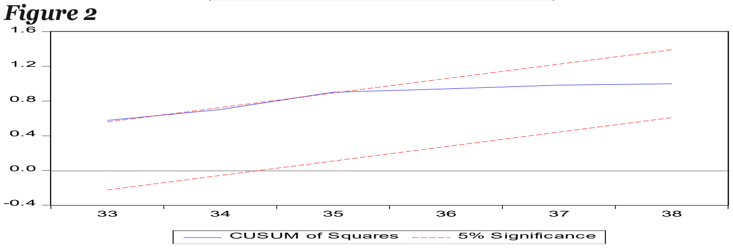



***Figure 2***




The CUSUM and CUSUMQ test graph shows that the model is still stable, with the lines staying within the (5%) critical boundaries represented by the blue lines. Indicating that both the two are stable within the period under review

## 5. CONCLUSSION AND RECOMMENDATION

This study used annual data from 1986 to 2024 within an ARDL framework to investigate the impact of climate change on Nigeria's agricultural sector. According to the findings, food production, annual rainfall, and carbon emissions all have a significant positive long-term impact on agricultural performance, while inflation has an insignificant negative effect. However, food production and rainfall were largely insignificant in the short run, whereas carbon emissions had a significant positive impact on sectoral performance. These findings highlight the nuanced relationship between climate variables and agricultural productivity in Nigeria. Overall, the findings confirm that, while climate change poses significant risks, it can also have mixed effects depending on the variable, timeframe, and agricultural subsector examined. Importantly, the findings highlight the importance of effective adaptation and mitigation strategies for improving agricultural resilience in Nigeria, given the sector's importance for food security and economic growth.

### 5.1 Recommendations

- Adoption of Climate-Resilient Technologies: Farmers should be encouraged to use climate-smart agricultural practices like drought-tolerant seeds, irrigation, and water harvesting techniques.
- Policy Interventions on Emissions: Although this study found a positive correlation between $CO_2$ and agricultural output, unchecked emissions could have negative long-term consequences. Policies that encourage renewable energy and sustainable agriculture should be prioritised.
- Improving Early Warning Systems: The government should invest in climate monitoring and forecasting systems to assist farmers in preparing for rainfall variability and extreme weather.
- Subsidies and Credit Assistance: Smallholder farmers need access to low-cost credit and subsidies in order to adopt modern farming technologies that can mitigate the negative effects of climate change as well as Integrated Climate and Agricultural Policy: Building long-term resilience requires a coherent national policy framework that links climate action to food security strategies.

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