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Analysing Food Production and Its Determinants in Nigeria: Insights from an ARDL Analysis

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Abstract **Original Research Article**

This study explores both the long-term and short-term relationships between staple crop prices, macroeconomic variables, climatic conditions, and food production in Nigeria using the Autoregressive Distributed Lag (ARDL) model. It relies on annual data spanning from 1980 to 2025. The results indicate a stable long-run equilibrium connection among food production, staple crop prices (maize, rice, and cowpea), exchange rate, inflation, and climatic factors such as rainfall and temperature. In the long run, maize and rice prices exert significant negative effects on food production, while exchange rate positively influences domestic production. Rainfall has a positive yet statistically insignificant impact, while both temperature and inflation also show no significant effects. The error correction term is negative and statistically significant, indicating a stable adjustment mechanism. Short-run results indicate that rainfall positively affect food production, while rice prices negatively affect output. The study concludes that both price dynamics and climate variability are critical determinants of food production in Nigeria and recommends policies aimed at stabilizing food prices, improving climate resilience, and strengthening domestic agricultural production.

Keywords: Food production in Nigeria, staple crop prices, ARDL model, climate variability, macroeconomic determinants.

1.0 Introduction

Food production continues to be a vital driver of economic development and food security in Nigeria, as a substantial proportion of the population depends on agriculture for their livelihoods and sustenance. The agricultural sector also makes a significant contribution to job creation and income generation (F.A.O., 2022; World Bank, 2023). The sector continues to face major challenges, including staple food price volatility, macroeconomic instability, and climate variability, all of which have implications for food availability and food security.

Staple crops such as maize, rice, and cowpea constitute a major share of household consumption in Nigeria and are central to the country’s food system. In recent years, the prices of these commodities have fluctuated considerably due to inflationary pressures, exchange rate depreciation, rising production costs, and inefficiencies in agricultural markets. These fluctuations create uncertainty for both producers and consumers. According to Ghosh (2014), food commodity prices often exhibit volatility clustering, which disrupts market stability and affects production planning. Recent evidence further shows that price volatility in agricultural commodities remains a major concern for food security in Nigeria, as it affects both supply decisions and consumption patterns (Edoja *et. al.*, 2026).

Macroeconomic factors also play a significant role in shaping agricultural production outcomes. Exchange rate movements influence the cost of imported agricultural inputs such as fertilizers, machinery, and improved seeds (World Bank, 2020; IMF, 2019). Currency depreciation increases production costs but may simultaneously encourage domestic production by reducing reliance on imports. Empirical studies using the ARDL framework have confirmed that exchange rate dynamics significantly affect agricultural output in Nigeria. For example, recent studies suggest that exchange rate fluctuations can affect agricultural productivity over both the short and long term (Muhammed, 2024). Likewise, inflation has been found to adversely impact agricultural production by raising input costs and diminishing farmers' purchasing power (Ibrahim et. al., 2025).

Climate-related factors remain equally important determinants of agricultural productivity in Nigeria. The sector is predominantly rain-fed, making it highly vulnerable to changes in rainfall patterns and temperature (Intergovernmental Panel on Climate Change, 2022). Adequate rainfall enhances crop yields, while erratic rainfall and rising temperatures can reduce agricultural productivity (Omokoro,2025). Recent studies have emphasized that climate variability continues to shape agricultural output, with rainfall playing a crucial role in determining crop performance in Nigeria (Ibrahim & Adeyemi, 2024). Furthermore, contemporary research highlights that despite climate-related challenges such as irregular rainfall and flooding, Nigerian farmers have demonstrated resilience through adaptation strategies and improved farming practices (NAERLS, 2025).

In addition to macroeconomic and climatic factors, structural issues such as access to finance, infrastructure, and technological innovation also influence agricultural productivity. Recent empirical studies using ARDL techniques have shown that agricultural financing and technological advancement significantly affect food production and productivity in Nigeria (Yinka et. al., 2024) These findings suggest that improving access to credit and adopting modern technologies are essential for enhancing agricultural output and ensuring food security.

Despite the growing body of literature, most existing studies examine the effects of food prices, macroeconomic variables, and climate factors in isolation. There is limited empirical evidence that integrates these variables into a unified analytical framework to assess their combined impact on food production in Nigeria. Moreover, while recent studies have applied ARDL models to examine agricultural productivity, few have focused specifically on the interaction between staple crop prices and food production within the same framework.

To fill this gap, the study applies the Autoregressive Distributed Lag (ARDL) approach developed by Pesaran *et. al. (*2001) to investigate both the long-run equilibrium and short-run dynamics among staple crop prices, macroeconomic variables, climatic factors, and food production in Nigeria.

The ARDL approach is especially appropriate as it can handle variables with different orders of integration and delivers reliable estimates of both short-term and long-term relationships (Pesaran *et. al.*, 2001).

The aim of this study is to examine the impact of fluctuations in the prices of key staple crops—maize, rice, and cowpea—together with exchange rate, inflation, rainfall, and temperature, on food production in Nigeria. By combining price movements, macroeconomic indicators, and climatic factors within a unified empirical framework, the study adds to the existing literature and offers policy-relevant insights to enhance food security and agricultural productivity in the country.

2.0 Theoretical Framework and Literature Review

2.1 Theoretical Framework

This study is grounded in three interrelated theoretical frameworks: the Cobweb Theory, the Theory of Agricultural Supply Response, and the Market Equilibrium Framework.

2.1.1 Cobweb Theory of Price Fluctuation

The Cobweb Theory explains cyclical price movements in agricultural markets due to production lags. Farmers make production decisions based on previous prices rather than current market conditions. As a result, high prices in one period led to increased production in the next, which subsequently causes oversupply and price decline.

In the context of this study, rising prices of maize and rice may initially stimulate production; however, persistent price increases could also reflect structural supply constraints. This corresponds with the negative long-term relationship between staple crop prices and food production identified in this study, indicating that rising prices do not necessarily lead to increased output because of higher costs and inefficiencies.

2.1.2 Agricultural Supply Response Theory

The Agricultural Supply Response Theory posits that farmers adjust production levels in response to changes in prices and other economic incentives. According to this theory, higher output prices are expected to stimulate production by increasing expected profits (Siegle *et. al.,* 2024).

However, in developing economies like Nigeria, supply response may be constrained by: Limited access to inputs, Poor infrastructure and Market imperfections. This explains why maize and rice prices exhibit negative long-run effects on food production in this study, as rising prices may reflect increased production costs rather than improved profitability.

2.1.3 Market Equilibrium Theory

The Market Equilibrium Theory emphasizes the interaction between demand and supply in determining prices and output levels. In equilibrium, prices adjust to balance supply and demand.

In Nigeria's agricultural sector, factors such as inflation, exchange rate fluctuations, and climate variability disrupt this equilibrium. The positive effect of exchange rate on food production observed in this study suggests that currency depreciation may shift demand toward locally produced goods, thereby stimulating domestic production.

2.2 Empirical Literature Review

Empirical studies on food price dynamics and agricultural production have widely applied time series econometric techniques, particularly ARDL and GARCH Models. Studies by Ghosh (2014) employed GARCH models to examine volatility spillovers in food commodity prices and found that food prices exhibit significant persistence and clustering of volatility. This supports the observed instability in cowpea prices in Nigeria.

Likewise, Yong Wang et al. (2013) examined global rice price volatility and found that international market shocks have a significant impact on domestic price movements, particularly in economies reliant on imports. This aligns with the negative long-term effect of rice prices on food production in Nigeria observed in the present study. In the Nigerian context, Agbatogun *et. al.* (2024) found that agricultural pricing incentives significantly affect output growth, reinforcing the importance of price signals in determining production outcomes. Additionally, Eneji et al. (2024) investigated the link between climate change and food price inflation in Nigeria, finding that increasing food prices adversely impact agricultural productivity and the availability of food.

Applying the ARDL framework, Ibrahim et al. (2025) identified a stable long-term relationship between agricultural output, inflation, and exchange rates in Nigeria. Their results support the findings of this study, especially regarding the influence of macroeconomic factors on food production.

Regarding climate factors, Omokoro (2025) found that temperature has varying effects on crop production because of regional climatic differences and farmers' adaptive measures, which accounts for the insignificance of temperature observed in this study. Moreover, Ibrahim Adeyemi (2024) reported that rainfall significantly affects crop yields in Nigeria, supporting the short-run positive effect of rainfall on food production identified in this study.

Several empirical studies have utilized the ARDL approach to examine the relationship between staple crop prices and agricultural production. For example, Ogunmola et al. (2023) investigated the determinants of food commodity prices in Nigeria using annual data from 1981 to 2018 within an ARDL framework. Their results showed that macroeconomic factors, including exchange rate fluctuations, agricultural output, and imports, significantly affect maize and rice prices in both the short and long term. Additionally, the study found that lagged prices of maize and rice have a strong influence on current prices, highlighting the persistence of prices in Nigeria's staple food markets. The authors concluded that effective exchange rate management and policies promoting domestic production are essential for stabilizing food prices in the country.

Likewise, Binuomote and Olawuyi (2016) explored the relationship between food commodity prices and food security in Nigeria using the ARDL cointegration framework. They analyzed long-term interactions among variables such as per capita income, exchange rate, and retail prices of key food commodities, including rice and maize. Their findings indicated long-run cointegration between food commodity prices and food security measures, suggesting that fluctuations in staple food prices have a significant impact on food availability and access. The study also showed that short-run adjustments occur through an error correction mechanism, gradually restoring equilibrium when deviations arise.

In a related study, Muhammad (2022) investigated the determinants of food utilization in Nigeria using the ARDL bounds testing approach. The results highlighted that factors such as education, food exports, and population structure significantly affect food security indicators in both the short and long term. Specifically, higher educational attainment and a growing urban population were found to positively influence food utilization, whereas food exports had a negative effect on food availability.

In addition to food security studies, ARDL models have also been applied to analyse the determinants of agricultural output and cereal production. For example, a study examining the impact of capital inflows and exchange rate on agricultural output in Nigeria employed the ARDL bounds testing technique using data from 1981 to 2016, finding that private and public capital inflows positively influence agricultural output in both the short and long run, while exchange rate depreciation has a negative effect on production (Ikpesu & Okpe, 2019).

More recent studies have extended the application of ARDL models to examine cereal production and agricultural productivity dynamics. For example, a study investigating cereal production in Nigeria applied a dynamic ARDL simulation approach to examine the long-run relationship between cereal output, fertilizer use, farm labour, and cropland area using time-series data from 1980 to 2021, and found that expansion of cropland and increases in rural population significantly raise cereal production in the long run (Abdullahi et al., 2024). The Study also confirmed the existence of cointegration among the variables, indicating that agricultural inputs and land utilization play critical roles in determining cereal production levels.

Additionally, ARDL modeling has been employed to assess the effects of agricultural policies on rice production in Nigeria. A recent study examining policy interventions from 1991 to 2024 applied the ARDL approach to explore the relationship between rice output and policy-related factors such as agricultural credit, government budgetary allocations, and agrochemical usage. The findings revealed that these policy variables significantly affect rice production in both the short and long term, highlighting the crucial role of government interventions in boosting domestic rice output and enhancing food security (Jude & Agbu, 2026).

Overall, the empirical literature demonstrates that ARDL modelling has become one of the most widely used econometric techniques in agricultural economics and food security analysis (Hossain et. al. 2022). The ARDL approach delivers reliable estimates of both long-term equilibrium relationships and short-term dynamics among variables. Applied to staple food crops like maize, rice, and cowpea, it allows researchers to pinpoint the main drivers of price movements and evaluate how macroeconomic factors, climatic conditions, and policy measures affect agricultural production and food security (Darboe & Manneh, 2025). As a result, the ARDL framework serves as a comprehensive tool for analysing the behavior of staple crop prices and their impact on food availability and food security in developing countries such as Nigeria.

3.0 Methodology

3.1 The Study Area

Nigeria is located in western Africa along the Gulf of Guinea, between latitudes 4° N and 14° N and longitudes 2° and 15° E, and covers about 923,768 km², sharing land borders with Benin, Niger, Chad, and Cameroon (Wikipedia, 2024). The country's population continues to grow at over 2 % annually, with life expectancy around the mid-50s (Britannica, 2026; World Bank, 2024).

Nigeria has diverse vegetation capable of supporting large livestock populations and an estimated surface water volume of about 267.7 billion m³ and underground water of about 57.9 billion m³, along with a variety of ecological zones including Sudan/Sahel, Guinea and Derived Savanna, and Forest/Mangrove zones, where ecological conditions and precipitation patterns influence farming systems and resource use (Erragheore,2011).

Nigeria's principal cash crops include cocoa, oil palm, and rubber, while key staple foods include rice, cassava, yams, maize, sorghum, and millet. Livestock production—such as goats, sheep, cattle, and poultry—and artisanal fisheries are also important agricultural activities in the country (Hussfarm, 2024).

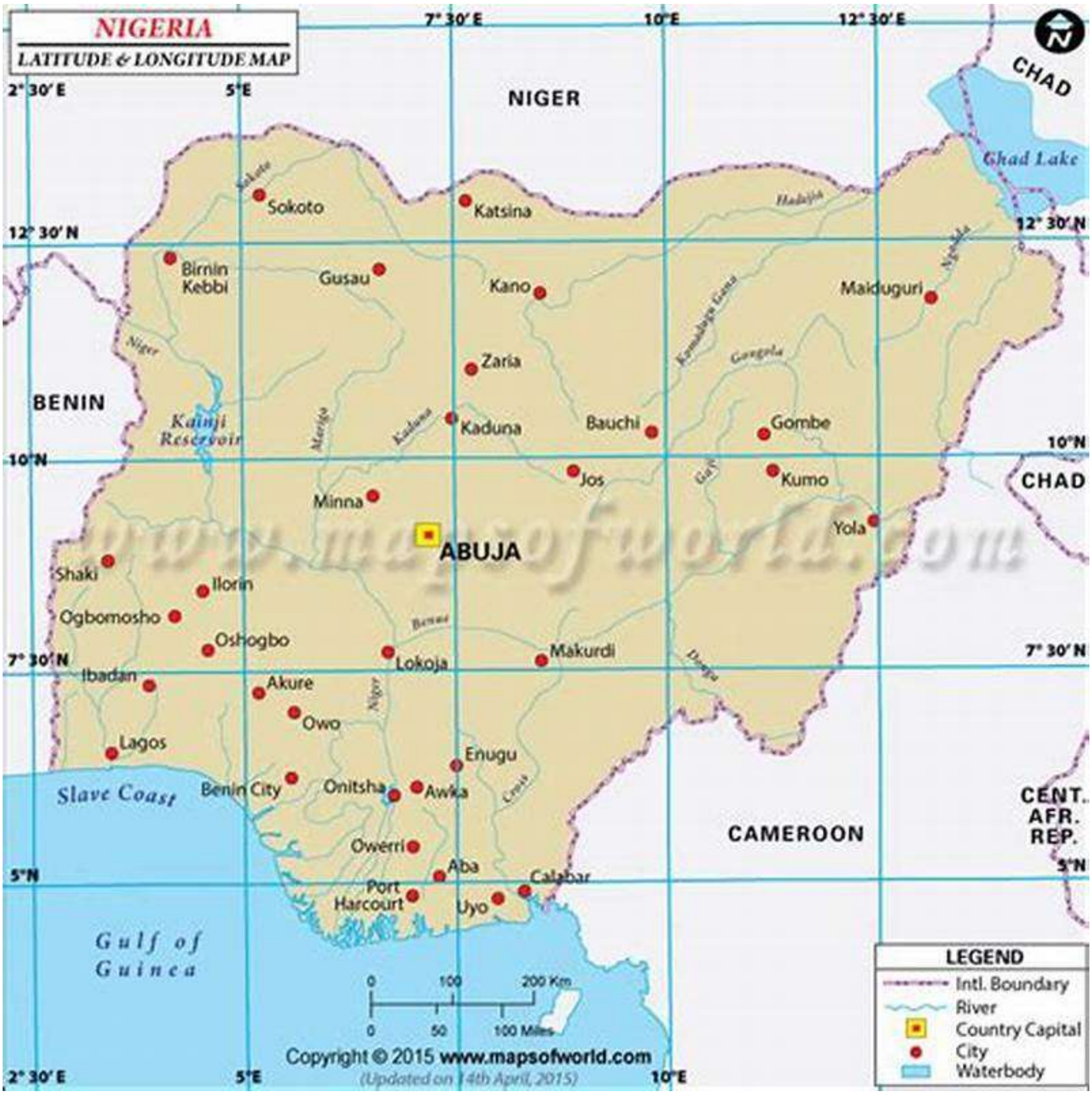

Figure 1: MAP of Nigeria. Source: Vectormap.net

3.2 Data Sources

The study utilized secondary data, specifically time series data collected from multiple sources including the Central Bank of Nigeria (CBN) Statistical Bulletin (2019, 2020, and 2022), NIMET, and the World Bank. The dataset spanned the period from 1981 to 2022.

3.3 Method of Data Analysis

The secondary data for this study were analysed using the Autoregressive Distributed Lag (ARDL) approach including ARDL cointegration as well as long-run and short-run specifications following stationarity testing with the Augmented Dickey-Fuller (ADF) unit root tests.

3.4 Model Specification/Estimation Techniques

3.4.1 Stationarity Test

Most time series data require preliminary analysis to determine the order of integration before modelling; this is done to avoid spurious relationship (Gujarati & Porter, 2021). Consequently, the Augumented Dickey Fuller (ADF) test for the presence of unit root was employed.

The ADF test is based on the following regression given in equation 3.1.

$\Delta Y_t = \beta_1 + \beta_2 t + \delta Y_{t-1} \sum_{i=0}^{n} \lambda i \, \Delta Y_{t-1} + \varepsilon_t$ …. (3.1)

Where:

$\Delta Y_{t-1} = (Y_{t-1} - Y_{t-2})$ represent the difference of the variable at time t.

Y = coefficient of the lagged level of the variable

$\beta_{1=}$ coefficient on the time trend (indicating how series changeover time).

δ = coefficient on the lagged difference of the series

ε_t = pure white noise error term and

The number of lagged difference terms to include is often determined empirically. The ADF test that the series is not stationary is shown by the null hypothesis (Ho: β = 0) whereas the alternative hypothesis (H_1: β < 0) shows that the series is stationary. The rule is that if the computed ADF statistics is greater than the critical at the specified level of significance, then the hull hypothesis of unit root is accepted otherwise it is rejected (Dickey & Fuller, 1979; Gujarati & Porter, 2021).

3.4.2 Model Specification for the ARDL Approach

To accomplish the objective of this study—examining the long-run equilibrium, short-run dynamics, and adjustment mechanisms of staple food prices and their determinants in Nigeria—the Autoregressive Distributed Lag (ARDL) model developed by Pesaran et al. (2001) was employed.

3.4.3 Functional Model Specification

Based on the study objective of examining the effect of staple crop price changes on food availability in Nigeria, the functional relationship is specified as:

$$FPI = f(PM, PR, PC, EXRT, INF, AR, AAT)$$

Where:

- FPI = Food Production Index (proxy for food availability)
- PM = Price of maize
- PR = Price of rice
- PC = Price of cowpea
- EXRT = Exchange rate
- INF = Inflation rate
- AR = Annual rainfall
- AAT = Average annual temperature

3.4.4 Econometric Model Specification

The econometric model is formulated as follows:

$$\text{LN}FPI_t = \beta_0 + \beta_1 LNPM_t + \beta_2 LNPR_t + \beta_3 LNPC_t + \beta_4 LNEXRT_t + \beta_5 LNINF_t + \beta_6 LNARAIN_t + \beta_7 LNAAT_t + \varepsilon_t$$

Where:

- β_0 = Intercept
- β_1–β_7 = Parameters to be estimated
- ε_t = Error term

3.4.5 ARDL Model Formulation

Following the ARDL framework, the dynamic model is expressed as:

$$\Delta FPI_t = \alpha_0 + \sum_{i=1}^{p} \alpha_1 \, \Delta \mathrm{LN}FPI_{t-i} + \sum_{i=0}^{p} \alpha_2 \, \Delta \mathrm{LN}PM_{t-i} + \sum_{i=0}^{p} \alpha_3 \, \Delta \mathrm{LN}PR_{t-i} + \sum_{i=0}^{p} \alpha_4 \, \Delta \mathrm{LN}PC_{t-i}$$
$$+ \sum_{i=0}^{p} \alpha_5 \, \Delta \mathrm{LN}EXRT_{t-i} + \sum_{i=0}^{p} \alpha_6 \, \Delta \mathrm{LN}INF_{t-i} + \sum_{i=0}^{p} \alpha_7 \, \Delta \mathrm{LN}AR_{t-i} + \sum_{i=0}^{p} \alpha_8 \, \Delta \mathrm{LN}AAT_{t-i} + \lambda_1 LNFPI_{t-1}$$
$$+ \lambda_2 LNPM_{t-1} + \lambda_3 LNPR_{t-1} + \lambda_4 LNPC_{t-1} + \lambda_5 LNEXRT_{t-1} + \lambda_6 LNINF_{t-1}$$
$$+ \lambda_7 LNAR_{t-1} + \lambda_8 LNAAT_{t-1} + \varepsilon_t$$

Where:

- Δ represents the first difference operator
- p represents optimal lag length
- λ_1–λ_8 capture the long-run relationship
- α_1–α_8 capture short-run dynamics

3.4.6 ARDL Bounds Testing for Cointegration

To determine whether a long-run relationship exists among the variables, the bound's testing procedure was applied.

The hypotheses are:

Null Hypothesis $H_0: \lambda_1 = \lambda_2 = \ldots = \lambda_8 = 0$ (No long-run relationship)

Alternative Hypothesis $H_1: \lambda_1 \neq 0$ (Long-run relationship exists)

The calculated F-statistic is compared with the critical bounds provided by Pesaran *et. al*. (2001):

- If F-statistic > Upper Bound → Cointegration exists
- If F-statistic < Lower Bound → No cointegration
- If F-statistic lies between bounds → Inconclusive

3.4.7 Long-Run ARDL Model

Once cointegration is confirmed, the long-run ARDL model was estimated as:

$$FPI_t = \theta_0 + \theta_1 LNPR_t + \theta_2 LNPR_t + \theta_3 LNPC_t + \theta_4 LNEXRT_t + \theta_5 LNINF_t + \theta_6 LNAR_t + \theta_7 LNAAT_t + \mu_t$$

Where:

- θ_1–θ_7 represent long-run elasticities.

3.4.7 Error Correction Model (ECM)

The short-run dynamics are estimated using the error correction representation:

$$\Delta \text{LN}FPI_t = \beta_0 + \sum_{i=1}^{p} \beta_1 \, \Delta \text{LN}FPI_{t-i} + \sum_{i=0}^{p} \beta_2 \, \Delta \text{LN}PM_{t-i} + \sum_{i=0}^{p} \beta_3 \, \Delta \text{LN}PR_{t-i} + \sum_{i=0}^{p} \beta_4 \, \Delta \text{LN}PC_{t-i} + \sum_{i=0}^{p} \beta_5 \, \Delta \text{LN}EXRT_{t-i} + \sum_{i=0}^{p} \beta_6 \, \Delta \text{LN}INF_{t-i} + \sum_{i=0}^{p} \beta_7 \, \Delta \text{LN}AR_{t-i} + \sum_{i=0}^{p} \beta_8 \, \Delta \text{LN}AAT_{t-i} + \phi ECM_{t-1} + \varepsilon_t$$

Where:

- ECM_{t−1} is the error correction term derived from the long-run equation
- φ represents the speed of adjustment back to equilibrium
- φ must be negative and statistically significant to confirm long-run stability.

4.0 Results and Discussions

4.1 Stationarity Test Result – Yearly variables data.

The stationarity test result for annual data used for the ADRL is presented in Table 1. it shows that at 5% level of significance; the variables became stationary. For instance, Price of Cowpea (PC), Price of Maize (PM), Price of Rice (PR), Exchange rate (EXR) and Average annual Temperature (AAT) became stationary at first difference I (1). While Food Production Index (FPI), Annual rainfall (AR) and Inflation Rate (INF) became stationary at level I (0).

Given that the variables were integrated of mixed order I (1) and I (0), satisfies the condition for the adoption of ARDL model as buttressed in the works of Pesaran & Shin (1999); Pesaran, Shin, & Smith, (2001). Consequently, prior, to the conduct of ARDL, there is the need to obtain the numbers of lag suitable for ARDL model which further lends the need to conduct the VAR lag selection criteria.

Table 1: Augmented Dickey-Fuller Unit Root Test Result for Stationarity-Yearly Variables Data (1980-2025)

Variable	Order of stationarity	ADF Calculated	ADF Critical Value	Prob	Order of integration	Decision
FPI	Level	-6.736395	-2.928142	0.0000	I (0)	S
PC	Level	2.707962	-2866857	1.0000	I (0)	NS
	1st Dif.	-7.716595	-2.866733	0.0000	I (1)	S
PM	Level	-0.484020	-2.866614	0.9861	I (0)	NS
	1st Dif.	-13.44885	-2.866614	0.0000	I (1)	S
PR	Level	1.101221	-2.866723	0.9975	I (0)	NS
	1st Dif.	-7.282796	-2.866723	0.0000	I (1)	S
EXR	Level	3.873999	-2.931404	1.0000	I (0)	NS
	1st Dif.	-6.731195	-2.903566	0.0000	I (1)	S
INF	Level	-3.240382	-2.928142	0.0240	I (0)	S
AR	Level	-3.269062	-2.602225	0.0224	I (0)	S
AAT	Level	-1.236066	-2.931404	0.6501	I (0)	NS
	1st Dif.	-9.193515	-2.931404	0.0000	I (1)	S

Source: Output from (E-views 10)

4.2 Model /Lag Selection Criteria

The lag selection was done automatically by EViews. For model selection the Akaike Information Criterion (AIC) was selected - ADRL (1,0,1,0,10,10). This implies- One lag of dependent Variable (LNFPI), Mixed lag structure across regressors and optimal balance between fit and parsimony. The R^2= 0.795 suggests that approximately 79.5% of the variation in Food Production Index (FPI) is explained by the included variables. Durbin-Watson approximately 2.06 indicates absence of serial correlation.

4.3 Bounds Test for Long-Run Relationship (cointegration test)

The ARDL bounds test was conducted to determine whether a long-run equilibrium relationship exists between food production and the explanatory variables. The result of bound test presented in table 3 below, reveals that computed F-statistic of 4.5966 exceeds the upper and lower bound critical value of 2.17 and 3.21 at the 5% significance level respectively, indicating rejection of the null hypothesis of no cointegration. This implies that food production, staple crop prices, climatic variables, exchange rate and inflation move together in the long run.

The presence of cointegration indicates that despite short-term fluctuations, the variables sustain a stable long-run equilibrium relationship. This result aligns with existing empirical evidence showing that agricultural production and macroeconomic variables are dynamically interconnected in Nigeria. For example, a recent ARDL study on inflation and agricultural output in Nigeria found a stable long-run relationship between agricultural productivity and macroeconomic factors such as inflation, exchange rate, and government expenditure (Ibrahim et al., 2025).

Table 3: ARDL Bounds Test for Co-integration (Model Estimation Results)

Model		**F-Statistic** = 4.596566
F (AO, ACGSL, GCEA, GREA, LIR, RI and POPG)		K= 6
Critical Values	Lower Bound	Upper Bound
5%	2.17	3.21

Source: Output from (E-views 10)

4.4 Long-Run Determinants of Staple Crop Prices

Maize Price (LNMP)

The estimated coefficient for maize price is −0.0135 and is statistically significant at the 1% level, implying that a 1% rise in maize prices leads to an approximate 0.0135% decline in the Food Production Index in the long run. This inverse relationship suggests that sustained increases in maize prices can hinder food production. Elevated maize prices often signal supply constraints, higher input costs, and market inefficiencies, all of which can weaken farmers' incentives to produce and disrupt livestock feed supply chains. Given that maize is a key staple and major feed grain in Nigeria, persistent price increases may reflect underlying structural challenges in production. This finding is consistent with Agbatogun et al. (2024), who reported that pricing incentives and market conditions play a significant role in shaping agricultural productivity and output growth in Nigeria using an ARDL approach.

Rice Price (LNRP)

The coefficient of rice price is −0.1276 and statistically significant at the 5% level. This implies that a 1% increase in rice price leads to a 0.13% decrease in food production in the long run. This finding indicates that rice price increases may reflect supply constraints and import dependency that negatively influence domestic food production capacity. Rice has become one of the most consumed staples in Nigeria; therefore, price increases may reduce production efficiency through higher production costs and market instability.

The result aligns with studies by Eneji *et. al.*, (2024) on climate Change and food price inflation in Nigeria, reported that show agricultural commodity prices influence output levels and food availability in developing economies. Price volatility and rising food costs are known to determine the agricultural supply chain and overall food production dynamics in Nigeria.

Cowpea Price (LNCP)

The coefficient of cowpea price is 0.0487, but it is statistically insignificant. This suggests that cowpea price fluctuations do not exert a significant long-run influence on overall food production in Nigeria. One possible explanation is that cowpea production is relatively resilient and widely cultivated across different agro-ecological zones in Nigeria. Consequently, price changes may not significantly alter aggregate food production.

Average Annual Temperature (AAT)

The coefficient of average annual temperature is 1.4187, although it is statistically insignificant. The positive sign suggests that increases in temperature may potentially support agricultural production, but the effect is not strong enough to be statistically significant.

The insignificant relationship may be explained by farmers' adaptation strategies such as crop diversification, irrigation practices and changes in planting seasons. Empirical studies on climate and agriculture in Nigeria have reported mixed effects of temperature on crop production due to regional climatic heterogeneity.

For instance, a study on climate variability and crop production in Nigeria found that temperature variations exert different effects across time periods and regions, indicating that agricultural systems often adapt to moderate temperature changes (Omokoro, 2025).

Annual Rainfall (AR)

The coefficient of rainfall is 0.5433, indicating that rainfall has a positive effect on food production, although it is statistically insignificant at the 5% level. The positive relationship implies that increased rainfall tends to improve crop yields and agricultural productivity. Nigeria's agricultural sector is predominantly rain-fed; therefore, rainfall availability remains a crucial determinant of crop production. This result is consistent with empirical findings that rainfall significantly affects crop output and agricultural productivity in Nigeria. Studies examining climate change and agricultural production have shown that rainfall variability plays a key role in determining crop yields and overall food supply in the country (Ibrahim & Adeyemi, 2024).

Exchange Rate

The coefficient of exchange rate is 0.1260 and statistically significant at the 1% level. This implies that a 1% depreciation of the domestic currency increases food production by approximately 0.126% in the long run. The positive relationship suggests that currency depreciation may encourage domestic agricultural production by making imported food products more expensive, thereby increasing the competitiveness of locally produced crops.

Inflation

The coefficient of inflation is negative but not statistically significant, suggesting that overall price increases do not have a direct and significant effect on food production when other macroeconomic and climatic factors are considered. However, inflation may still exert an indirect influence by raising production costs and weakening farmers' purchasing power. This result is consistent with Ibrahim et al. (2025), who found that high inflation in Nigeria tends to reduce agricultural output due to increased input costs and financial constraints faced by farmers.

Table 4: Estimated Long-run of the ARDL model

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNMP	-0.013478	0.003668	3.674898	0.0003
LNRP	-0.127568	0.043858	-2.908623	0.0067
LNCP	0.048711	0.132124	0.368679	0.7149
LNAAT	1.418737	2.474524	0.573337	0.5706
LNAR	0.543331	0.341407	1.591447	0.1217
LNEXR	0.126006	0.035652	3.534301	0.0013
LNIFR	-0.009959	0.032239	-0.308921	0.7594
C	-2.140924	3.728017	-0.574280	0.5699

Source: Output from (E-views 10)

4.5 Error Correction Mechanism

The error correction coefficient CointEq (−1) = −0.3857 is negative and highly significant. This confirms the existence of a stable long-run equilibrium relationship among the variables. The magnitude of −0.3857 implies that approximately 38.6% of short-run disequilibrium is corrected each year, meaning that deviations from long-run equilibrium are gradually adjusted over time. This moderate adjustment speed suggests that shocks to food production caused by price fluctuations or climatic conditions will converge back to equilibrium within a few years.

4.6 Short-Run Dynamics

The short-run dynamics show that:

- Maize price changes positively affect food production in the short run
- Rice price changes negatively affect food production
- Rainfall significantly increases food production in the short run

These findings highlight the immediate role of climatic conditions and price signals in influencing farmers' production decisions. The results overall implication for Food Security, indicate that food production in Nigeria is influenced by both market dynamics and climatic factors. While rainfall enhances agricultural productivity, rising staple crop prices particularly rice and maize can reduce food production in the long run. Exchange rate movements also play a significant role by affecting domestic production incentives.

These findings emphasize the need for policies aimed at stabilizing staple crop prices, improving climate resilience in agriculture, and strengthening domestic food production systems.

Table 5: Estimated short-run of the error correction version of the ARDL model

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LNMP)	0.139397	0.065541	2.126857	0.0415
D(LNRP)	-0.091581	0.030327	-3.019784	0.0050
D(LNCP)	-0.032647	0.049069	-0.665328	0.5108
D(LNAAT)	-0.457172	0.537629	-0.850349	0.4017
D(LNAR)	0.237764	0.066756	3.561684	0.0012
D(LNEXR)	-0.008613	0.019932	-0.432133	0.6686
D(LNIFR)	0.003312	0.010336	0.320468	0.7508
CointEq (-1)	-0.385657	0.053039	-7.271215	0.0000

Source: Output from (E-views 10)

4.7 Diagnostics and Stability Test, Serial Correlation of Squared Residuals

The study performed a post diagnostic test for the residuals and a stability test of the coefficients to verify the dependability and stability of the results obtained from the ARDL and Bounds cointegration models. Specifically, diagnostic tests like heteroscedastic tests, and Serial Correlation and serial correlation of squared residuals tests were carried out to establish the validity of the earlier estimated results. The results of the post diagnostic test are presented in Table 6. The Ramsey Reset test was also utilized in the study to check for model misspecification and coefficient stability.

Since the P-values obtained for the heteroscedastic tests, and Serial Correlation, serial correlation sun of squared residuals test statistics was all greater than 0.05, it demonstrated that the model is free from serial or autocorrelation and heteroscedasticity. Also, the residual term for the model is demonstrated by the normality test to be regularly distributed. A P-value of larger than 0.05 is also reported by the Ramsay RESET results, indicating that the functional form of the models is accurately described and that the coefficients are stable over time. Since the ARDL model estimates pass all of these diagnostic tests, this indicates that they are dependable and acceptable.

Table 6: Diagnostic Tests

	F- Stat	**Probability**
Heteroskedasticity Test (Breusch-Pagan-Godfrey)	0.9723	0.1158
Stability Test (Ramsey Reset)	0.3111	0.3111

Source: Output from (E-views 10)

5.0 Summary, Conclusion and Policy Recommendations

5.1 Summary of Findings

This study examined the long-run and short-run dynamics between staple crop prices (maize, rice, and cowpea), macroeconomic variables (exchange rate and inflation), climatic factors (rainfall and temperature), and food production in Nigeria using the Autoregressive Distributed Lag (ARDL) framework.

The unit root test results revealed a mixed order of integration among the variables, justifying the suitability of the ARDL approach. The bounds testing procedure confirmed the existence of a long-run equilibrium relationship among food production and its determinants.

The long-run results showed that maize and rice prices exert statistically significant negative effects on food production, indicating that persistent increases in staple food prices constrain agricultural output. Exchange rate was found to have a positive and significant impact, suggesting that currency depreciation encourages domestic production by making imports more expensive. Rainfall exhibited a positive but statistically insignificant relationship, while temperature and inflation were found to be insignificant in the long run. Cowpea price also showed no significant influence on aggregate food production.

The error correction term was negative and statistically significant, indicating a stable adjustment process toward long-run equilibrium, with approximately 38.6% of disequilibrium corrected annually.

In the short run, rainfall had a significant positive effect on food production, highlighting the importance of climatic conditions in agricultural output. Maize prices positively influenced production, suggesting short-term supply response to price incentives, while rice prices maintained a negative impact. Other variables were statistically insignificant in the short run.

Diagnostic tests confirmed that the model is stable, correctly specified, and free from serial correlation and heteroskedasticity, thereby validating the robustness of the findings.

5.2 Conclusion

This study concludes that food production in Nigeria is jointly influenced by staple crop price dynamics, macroeconomic conditions, and climatic factors. While price increases may provide short-term production incentives, persistent increases in staple crop prices—particularly maize and rice—have adverse long-run effects on food production.

The findings further reveal that macroeconomic factors, especially exchange rate movements, play a crucial role in shaping domestic agricultural production, while climatic variables such as rainfall remain essential drivers of agricultural productivity in the short run.

Overall, the study establishes that achieving sustainable food production and food security in Nigeria requires a balanced approach that addresses both market distortions and environmental challenges.

5.3 Policy Recommendations

Based on the findings, the following policy recommendations are proposed:

1. **Stabilization of Staple Food Prices**
Government should implement price stabilization mechanisms such as buffer stock programs and market interventions to reduce excessive volatility in maize and rice prices.

2. **Promotion of Domestic Agricultural Production**
Policies that encourage local production, including subsidies on inputs such as fertilizers, improved seeds, and mechanization, should be strengthened to enhance productivity.

3. **Exchange Rate Management**
Authorities should maintain a stable and competitive exchange rate to support domestic agricultural producers and reduce reliance on food imports.

4. **Investment in Climate-Resilient Agriculture**
Given the significant role of rainfall, there is a need to invest in irrigation systems, climate-smart agriculture, and early warning systems to mitigate the effects of climate variability.

5. **Improvement of Agricultural Infrastructure**
Development of storage facilities, transportation networks, and market access will reduce post-harvest losses and improve efficiency in the food supply chain.

6. **Control of Inflationary Pressures**
Macroeconomic policies aimed at controlling inflation should be strengthened to reduce production costs and improve farmers' purchasing power.

7. **Strengthening Agricultural Extension Services**
Farmers should be supported with timely information on weather conditions, market prices, and improved farming techniques to enhance productivity and resilience.

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