HUNGER, INFLATION RATE AND AGRICULTURAL OUTPUT GROWTH IN NIGERIA

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Abstract

Investments in economically inclined agricultural inputs in Nigeria have always been constrained by persistence rise in goods and services across the country, especially during this period of slow economic recovery which has resulted to hunger protests. This study investigates the effect of inflation rate on agricultural output growth in Nigeria, as a panacea to hunger protests. The study systematically explained the short-run and long-run effects of inflation rate on agricultural output growth, using Auto-regressive Distributed Lags (ARDL) approach. Findings revealed that inflation rate has significant short-run and long-run effects on agricultural output growth in Nigeria. Similarly, post estimations analysis via Heteroskedasticity and Autocorrelation tests were adopted to establish the absence of biased estimation in the estimated models as exhibited by the CUSUM Square. The study established short-run and long-run effects of inflation rate on agricultural output growth via system ARDL to provide valuable insights to policymakers. Consequently, the study recommends for the stabilization of general price level through single digit inflationary policy.

Keywords: Inflation, agriculture, hunger, protest, autoregressive distributed lags

Introduction

The dominant roles of agricultural output growth cannot be overemphasized, particularly in tackling major macroeconomic tool such as inflation rate. Advancing agriculture output growth tends to sustain general price levels, hence improving output growth in the long-run (Keji, 2018; Keji & Efuntade, 2020). Nigeria has witnessed different forms of inflationary periods, particularly, from mild to

severe and from crawling to galloping (Olubusoye and Oyaromade, 2008). The recent surge of inflationary trend in Nigeria has drawn varied attention, especially on the need to sustainable agricultural output development, in tackling the current hike of food prices that have intensified continuous hunger protests in the country. This could be attributed to persistence skyrocket inflationary pressure compounding difficult situations that slide the Nigerian economy into recessions in the recent years (Nnoli et al., 2023; Kotur et al., 2024). Therefore, it is pertinent for the country's agricultural output level to stabilize through sustainable price level, by improving the agricultural production and supply chain. Consequently this would curb possible damaging effects that might cause persistence rise in inflationary trend that could disrupt sustainable agricultural output growth in Nigeria. Notably, persistence rise in inflation rate tends to disrupt supply chain through high transportation costs, increasing farm input prices, among others factors (Ondoma, Awuna and Ochigbo, 2022). Invariably, the escalating costs of agricultural inputs due to inflation, which can considerably influence farming profitability, hence slow plough-back investment in agricultural sector.

Despite successive government efforts towards stabilizing the inflation figure at single digit for sustainable output growth in Nigeria, the surge in inflationary figure continue to persist (Kotur et al., 2024; Owoh, 2024). For example, the Nigerian government adopted the "cheap money policy" in 1960 to motivate output growth and this policy was render ineffective, which made inflation an obvious threat since the founding of the country (Bayo, 2005). This policy was aimed at curbing sudden rise in food prices by promoting agricultural sector via agricultural output growth. Then, agricultural sector was the mainstay of the Nigerian economy, hence the cheap money policy became necessary (Olatunji et al., 2010). Notably, the government policies were targeted towards curbing inflation rate and increasing agricultural output growth in the country (Ondoma et al., 2022; Nnoli et al., 2023; Kotur et al., 2024), which include Agricultural Credit Guarantee Scheme (ACGSF), Structural Adjustment Programme (SAP) in 1986 whose main aim was to reform the general output growth with a strong basis for agricultural export production; Agricultural Transformation Agenda (ATA) whose main objective

was to restore sustainable agriculture but only lasted from 2011 to 2015 (Adeniyi, 2016). Other policies of government were Operation Feed the Nation (1976), National Rolling Plan, etc. All of these policies were large scale agricultural projects aimed at boosting agricultural output, hence improving supply chain for sustainable food security in Nigeria . In spite all varied agricultural policies, the implementation effects remained mirage in Nigeria, and this has compound the recent food insecurity in the country.

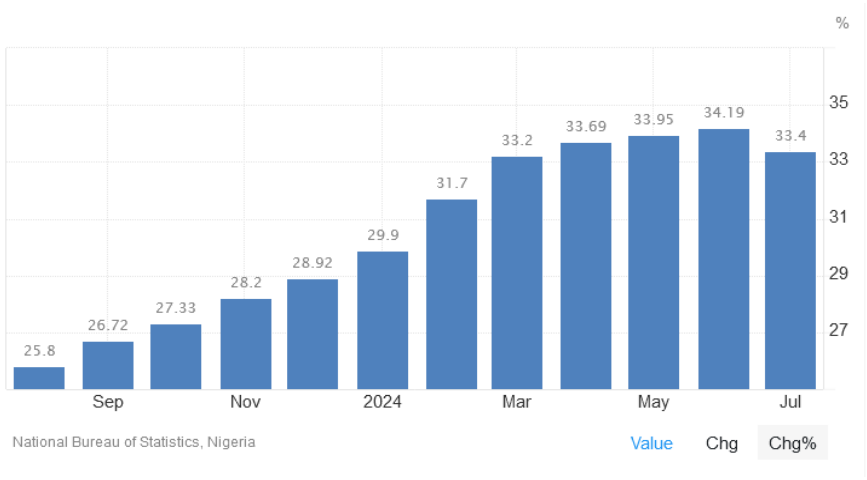
Also, several researchers have come up with varied conclusions on the relationship between inflation rate and agricultural output growth in Nigeria without any consensus. For example, Akinsola, Ayinde, Omotesho and Adewumi (2012), Mbah, Orjime, and Mgbemena (2022) Mustapha, Supo-Orija (2019) and Nwosu 2018 and Kabir (2015) had come up with different assertions without any consensus on the link between agricultural output and inflation rate in Nigeria. In view of this, this study seeks to investigate the symmetric impact of inflation rate on agricultural output growth in Nigeria. This is to address the emerging questions from the study; as to what is the trend of inflation rate and agricultural output growth in Nigeria? What is the symmetric impact of inflation rate on agricultural output growth in Nigeria?

Notably, in recent years, the inflationary pressure persist, as the value of Agriculture output decreased to 3851887.07 NGN Million in the first quarter of 2024, compared to 5685658.24 NGN Million in value in the fourth quarter of 2023 (National Bureau Of Statistics, 2024). Moreover, the Central Bank Statistical Bullettin (2023) revealed the current figures of agriculture sector contribution at 24.17% to the GDP in the fourth quarter of 2022 which was lower than what was recorded in the fourth quarter of 2021.

The average rate of inflation in Nigeria between 1960 and 1969 was found to be 3.49%, rising to 15.81% between 1970 and 1979 and 11.80% between 2010 and 2019. 2021 saw an inflation rate of 15.99% (CBN Bulletin, 2023). The damaging impact of inflation rate become glaring in recent years as the Nigerian headline inflation rate stood at 33.4% in July 2024 and 34.19% in the previous month. This could be attributed to the sudden removal of fuel subsidies and a devaluation of local currency. The alarming effects of the recent hike in inflation rate

was mostly on the Food, especially on consumer goods. Meanwhile, the annual leading inflation rate in the country, which includes other commodities climbed high to 27.47% in July, 2024. The monthly basis figures for June and July were 34.19% and 33.19%, respectively, for consumer prices, as stated in Figure 1 (National Bureau of Statistics, 2024).

The Double Digit Inflationary Trends in Nigeria



Source: National Bureau of Statistics, 2024.

The extreme effect of high rate of inflation erodes the purchasing power of consumers, making it challenging for farmers to sell their products at profitable prices (Nnoli et al., 2023). Consequently, farmers reduce production levels or switch to alternative crops. Also, inflation disrupts the agricultural supply chains and distribution network leading to increased transportation costs and storage expenses (Eleri et al., 2012; Akpan, 2019). The Nigeria inflation rate trended between 5 and 18 percent between 1999 and 2011, with an average of 11.8 percent; the country's core inflation rate averaged 10.16 percent in 2007 (National Bureau of Statistics, 2023). It has been observed that the general output growth nosedived since inflation has impacted on the returns from investments, thereby discouraging savings which pre-hindered the country’s economy from flourishing.

Therefore, there is need to improve the meagre share of agricultural sector to GDP, as it nosedived to about 19.63% in 2023 compared to about 24.90% recorded in the last quarter of 2022 This is pertinent towards developing the nation's major source of food chain. Since the Agricultural sector is an important source of raw materials for agro-allied industrial processing. It also has strong relationships with employment, national income stability, market prospects for industrial output, and significant potentials for reducing poverty and improving health, which make this study pertinent (Ayinde et al., 2017; Ondoma, Awuna,. & Ochigbo, 2022). Notably, the rising cost of food is just one of the many problems that Nigerian agriculture is facing in recent years.

Moreover, study of this nature is pertinent to address and mitigate the current effects of food insecurity in Nigeria which has intensified hunger protests across the country, as the country persistently loss about 40 percent of rice produce annually due to poor storage system (Daily Trust, 2024). In addressing the recent macroeconomic challenges in Nigeria, this study is noteworthy, as it would aid further expansion of agricultural output growth, thereby reducing unemployment in Nigeria. The study will provide necessary guide for policy makers, particularly on the guide towards formulating policies aimed at curbing inflation thereby improving agricultural productivity. The findings in this study will as well contribute to the existing literature, and would be a valuable tool for scholars, institutions and individuals that want to research into inflation rate and agricultural output in Nigeria. It will also serve as a point of reference for further studies. This is because agriculture plays an important role in human life, which cannot be over emphasized, therefore the study explored direct effect of inflation rate on agricultural output growth to contribute to the body of knowledge.

Consequently, this research seeks to further investigate into the direct impact of inflation rate on agricultural output growth in Nigeria, using data spanning the period of 1985-2023, which is a span of 38 years. Also, the study was divided into five sections. The introduction which is the first section, and it exhibited the introduction of the study: problem statement, the objectives of the research, scope of the study, significance. Meanwhile, the section two consist the literature review,

the theoretical and the empirical literature. Section three emphasized on the research methodology and it procedures. While section four encompassed the data analysis and interpretation of the empirical analysis. Lastly, section five disclosed the summary of the study, conclusion and policy recommendations.

Interaction between Inflation and Agricultural Output Growth in Nigeria

The interaction between inflation and agricultural output growth in Nigeria is multifarious and polygonal. According to the extant economic intuition, continuous rise in inflation rates is expected to increase the cost of agricultural inputs such as machines and machinery, seeds, and seedling, among others, thereby decreasing the expected profit margins for farmers. This scenario possibly discourage investment in the agriculture sector, hence reducing general agricultural output growth. This cost-push inflation often leads to a reduction in agricultural productivity and output growth (Ondoma et al., 2022). Inflation upsets farming operations by impelling the cost of agricultural inputs and overall profitability. For instance, higher inflation rates lead to increased prices for imported inputs, as well as domestically produced inputs that rely on imported components or technologies:

Inflation Rate: Lucas (1972) argued that "inflation" implies an increase in an economy's average level of prices for goods and services over time, hence money loses some of its purchasing power. Similarly, Bernanke (2010) posited that an increase in the general level of prices must be continuous and maintained rather than a one-time spike to establish inflation rate. Meanwhile, extant economic theory assumed that inflation rate is the persistence rise in goods and services, which brought about more money chasing few commodities in the market.

Friedman (1917) and Hayek (1960) came close in their different arguments by using money as the bane of inflationary trend in an economy. However, Keynes (1976) suggested otherwise, by concluding that an excess of aggregate demand over available goods and services leads to a general rise in prices, which brought inflation.

Others scholars such as Samuelson [1967], Gordon [1958], Mankiw [2018] , and Yellen [2010] all agree that inflation generally means a sustain increase in general price level which in turn as a direct effect on the value of money. The implication is that each unit of a particular currency in question will buy less commodities than it can previously buy. Inflation refers to a steady increase in the economy's overall price level, which impacts the value of the domestic currency (Fatukasi, 2004).

Agricultural Output: The concept of agricultural output includes the physical and economic measurement of agricultural production, encompassing the quantity of agricultural products generated as well as their market value and contribution to the national economy (Brown, 2008).

According to Rutten (1959), agricultural output is the end result of laborious human efforts and the application of resources like land, labour, and money to the production of agricultural goods and services. According to Solow and Kramer (2010), transforming natural resources into more valuable use can be classified as agricultural output, which pass through the inputs and technicality stages to become tangible agricultural product and services for the purposes of consumption, trade, and other uses. In Thompson (1969)'s view, agricultural output refers to the total physical production of crops and livestock from agricultural activities within a given region or country. According to Gad (1974), he believed that agricultural output is the quantifiable value of agricultural products and services produced and provided by agricultural activities in a specific geographical area. Agricultural output is an offshoot of the agricultural sector and which according to Lockeretz (1997) is a system of producing food, fiber, feed, livestock, and other products by utilizing natural resources, applying knowledge and technologies, and managing the interactions between human activities and the environment. Also according to Borlaus (1984), agricultural output encompasses the science, art and business of cultivating plants and rearing animals for human use with the goal of improving food production and ensuring food security. All of these culminate in the effective management of the agricultural value-chain.

Empirical Review

In this sub-section, previous related works were reviewed in ascertaining the nexus between inflation rate and agricultural output growth in Nigeria.

Enilolobo, Mustapha, and Supo (2020) adopted Fully Modified Ordinary Least square (FMOLS) analysis to investigate the impact of macroeconomic indicator dynamics on agricultural output in Nigeria between 1995 and 2020. The study revealed that macroeconomic indicator such as inflation to be significant on agricultural output in Nigeria. Indicator for inflation align with the economic intuition of negative influence on agricultural growth. In a related study, Mbah, Orjime, and Mgbemena (2022) evaluated agricultural output, food costs and inflation spanning the years 1981 through 2021. The study concluded that higher agricultural productivity causes a positive change in food prices, while higher food prices are ultimately associated with sky-rocket inflation through Structural Vector Auto (SVAR) technique. Meanwhile, .Ene, Onyele and Orji (2022) adopted Autoregressive Distributed Lag (ARDL) technique to investigate factors affecting Nigerian agriculture output between 1981 and 2018. The study revealed that determine factor such as inflation rate affects agricultural output in short-run. Meanwhile, Olatunji, et al., (2012) analyzed the relationship between Nigeria's agricultural output and inflation rate from 1970 to 2006. The study employed the Granger Causality model. The examination of the data revealed a direct causal relationship between agricultural output and inflation rate in Nigeria. The study's conclusion was that an increase in the inventory change of agricultural production from the previous year raises the inflation rate.

Olarinde and Abdullahi (2014) studied how macroeconomic policies affected Nigeria's agricultural output between 1978 and 2011. The study concluded that fluctuations in exchange rates and government spending influence Nigeria's agricultural food output. In a related study, Wasiu and Ndukwe (2018) investigated the potential uneven effects of real exchange rate fluctuations on agricultural output

performance in Nigeria between 1981 and 2016. Agricultural output was positively affected by the ACGSF loan, though not significantly data were gathered from secondary sources. In order to ensure that the agricultural sector's full potential is realized, it is advised that Nigeria's fiscal and monetary authorities cooperate.

Oyakhilomen and Rekwot (2014) studied the correlations between the trajectory of inflation rate and agricultural productivity in Nigeria using Pair wise granger causality test via time series data. The study revealed that agricultural productivity and economic growth were not causally related, while a one-way causal relationship between inflationary trend and agricultural productivity subsisted. Whereas, Abiola (2019) employed a structural vector auto-regression methodology, it was examined how the exchange rate affected Nigerian agriculture output. The study proxy agricultural output and exchange rate indicators as Agricultural labour (AGLAB), Acreage and loan rate (LR), and exchange rate (EXR) were the four factors that were examined. It was disclosed that Acreage and lending rates and exchange rate demonstrated positive relationship. Meaning that higher exchange rate attract higher agricultural loans due to depreciate in the value of currency.

Ondoma, Awuna and Ochigbo (2022) adopted Co-integration and Vector Auto-Regressive (VAR) techniques to investigate the impact of inflation on agricultural goods prices in Nigeria. The study revealed the existence of long run and short-run links between inflation and prices of selected agricultural goods in Nigeria. Meanwhile, Nnoli et al., (2023) examined the effect of inflation and exchange rate on agricultural exports in Nigeria through the Autoregressive Distributed Lag (ARDL) and Granger causality techniques. The study exhibited unidirectional causal effect from indicators of inflation and exchange to indicator of agricultural export. Also, positive long-run effect of inflation and exchange rate on agricultural exports was established in the study.

Owoh (2024) investigated the effect of policy interventions on the advancement of agro-based micro enterprise in Nigeria. The study disclosed mix-impact of policies frameworks on advancement of the Nigerian agro-based micro enterprise. Whereas, Maina (2024) examined the link between food security and nutrition is a critical

issue in low- and middle-income countries. The study disclosed multifaceted impact of food insecurity on the nutritional level in low and middle-income countries. The double burden of malnutrition were disclosed due to food insecurity across low and middle-income countries. Ugwu and Okon (2024) examined the impact of fertilizer production in boosting food security with the implication on the policy frameworks. The study advocated for an improved distribution of fertilizer through domesticated policy frameworks. Also, the authors concluded that proper execution of fertilizer policies becomes a formidable means towards increasing agricultural output growth.

Ayinde et al., (2010) Determinants of Inflation rate in Nigeria using the time series data. The study revealed several factors such as rate of import, interest rate and exchange rate influenced inflation rate in Nigeria. Meanwhile, Oyinbo and Rekwot (2014) examined the nexus between the Nigerian economic growth, inflationary trend and agricultural productivity. The study disclosed series of causal relations from agricultural productivity to economic growth, from inflationary trend to agricultural productivity with no causal link from inflationary trend to economic growth.

Kotur et al., (2024) explored the asymmetric effects of economic policy uncertainty on the Nigerian food security between 1970 and 2021, using Nonlinear Autoregressive Distributed Lag (NARDL) approach. The findings disclosed both positive and negative impact of economic policy uncertainty on the Nigerian food security, which is an implication for investigating the current hunger protest in the country.

Consequently, it is evident that most previous studies duel much on the connections between inflation rate and agriculture output without much emphasis on the hunger aspect and its implications, resulting to recent hunger protest in the country. Also, most of the previous studies such as Muftaudeen and Abdullahi (2014), and Enilolobo, Mustapha and Orija (2019) were in distance years, without much emphasis in addressing the current poor agriculture output causing continuous hunger crisis in Nigeria. This is premised on the recent World Bank report, stating that Nigerians lament hunger, which has trapped about 129m in poverty trap (Punch, 2024). Notably, this calls for urgent attention and this study is meant to provide the needed

answers to the current hunger protest by addressing the current happenings concerning sky-rocket prices of goods and services which have worsen food security in Nigeria. Hence, this study tends to expand the scope of the previous works to disclose the extent of the current state of inflationary trend, hunger and agricultural output growth in Nigeria. In view of the highlighted knowledge gaps in the literature, it necessary to update the body of knowledge by presenting a more nuanced understanding of the link between hunger, inflation rate and agricultural output in Nigeria.

Theoretical Framework

This study reviewed some key theoretical perspective on which these research work was premised on, were as follows:

The Cobweb theory proposed by Nicholas Kaldor in 1934 that sought to explain the regular recurring cycles in the output and prices of agricultural product underpins this study with notable adjustment. Theory is relevant to this study, as it helps to explain how inflation rate can cause an increase in input costs. When this happens, farmers may face reduced profit margins which will invariably influence production decisions. This theory was named Cobweb theory because the pattern traced by the price and output changes resembled that of a cobweb. The theory is generally based on a time lag between supply and demand decisions. This time lags are due to the time required for planting, cultivating, and harvesting crops.

Nicholas Kaldor (1934) used Cobweb theory proposed frequently recurring cycles in the output and prices of agricultural product because the pattern of theory was traced by the price and output changes in resemblance Cobweb. The theory is generally based on a time lag between supply and demand decisions. Consequently, The Cobweb theory anticipates two forms of outcomes with an implication on the Nigerian economy;

- The magnitude of the variations will decrease with each cycle if the supply curve is steeper (less elastic) than the demand curve. It is referred to as the stable state or the convergent situation.

- The variations will be amplified if the supply curve is more elastic than the demand curve, which will cause the market to become more unstable or diverge from equilibrium, which an implications on the current sky-rocket prices of food commodity in Nigeria.

Meanwhile, Cost-Push Theory of Inflation**:** Stuart (1767) argued that costs of production were the primary cause of goods prices, which might orchestrated by the level at which money supply responds to demand. The fiscal implication was premised on increment of salaries without corresponding increase in general output growth, this forms parts of the primary cause of cost-push inflation in current state of Nigeria. Strong unions such as Nigerian Labour Congress put pressure on employers to boost salaries as a result of increases in worker productivity, which in turn raises the cost of producing goods hence rise in market price. This is basically referred to as the wage-cost spiral push, which is caused by the fact that increased prices encourage by labour unions to continue demanding higher pay, despite the fact that higher wages allow employees to buy as much as they did previously. Ahuja (2012) and Kalluhl et al. (2013) concluded that production of agricultural commodities is external dependent environment, in which an increase in labor costs may result in cost-push inflation, and in turn might have an effect on the level of output growth.

Meanwhile, demand-pull theory of inflation as posited by Keynes explained inflation as a situation where aggregate demand exceeds aggregate supply which eventually leads to general rise in price level. The demand-pull theory can be explained from the monetarists view or the Keynesian view. Milton Friedman (1942) was more vocal in explaining demand-pull sources of inflation. Friedman opined demand-pull inflation as monetary phenomena which is caused by a more rapid expansion of money supply than total output growth. This analogy rested on the viewpoint Irving Fisher in 1913, by adopting the exchange equation; MV= PQ Where M=Money supply, V= Velocity of money, P= Price level, Q= Output level.

In this equation V and Q are assumed to be constant why P varies directly with M. This model assumed that there are no idle resources

because the economy is at full employment, which was against by Keynes. This because the model failing to account for likely effect of interest rates and for assuming the independence of M, V, P, and Q, which was not realistic because changes in any one of them might have an impact on the others and inflation. Hence, Keynes further strengthen consequences of demand-pull inflation on output growth via non-monetary tools such as investment which is most determine by interest rate.

In view of the theoretical narratives, the theories reviewed are relevant to this study because their pertinent roles and they explain how inflation rate can cause an increase in input costs, and farmers profit margins reduces which in turn influence production decisions, with drastic implication on house consumption, hence resulting to hunger protest in the country. Also, due to uncertainty caused by inflation in the economy, especially uncertainty about future prices may discourage farmers from making long-term term investments in agriculture, hence compromising agricultural output growth in the long-run.

Research Methodology

This study investigated the link between inflation rate and agricultural output growth in Nigeria.

In this section, the study examined to what extent inflationary trend influence agricultural output growth in Nigeria. Different statistical and econometric tools were adopted through Augmented Dickey Fuller (ADF) and unit root test to ascertain the level of stationarity among the time series indicators. Auto-regressive Distribution Lag ARDL) model and Error Correction Mechanism approach were be used to examine the long-run and short-run the impact of inflation rate on agricultural output growth in Nigeria following outcomes from the ADF tests. Also, pertinent diagnostics tests such as Serial LM Autocorrelation test and Heteroscedascity test were conducted in the study to check whether estimation of the parameters have theoretical backing and statistical validity.

Data Required and Source

Secondary data and annual time series data were sought for this study. The sources of data obtained specifically follow annual time series data on the estimating variables under study from 1985-2023. The data collected are mostly from the CBN statistical bulletin, World Bank Development Indicator and National Bureau of statistics (NBS).

Model Specification

Notably, necessary clues guiding the choice of variables and modeling were adapted from the works of Ewubare and Udo (2017), Musa, Maijama'a, Shaibu, and Muhammad, (2019), Okunlola, Osuma and Omankhanlen, (2019) and Keji and Efuntade (2020) with notable modifications. Hence, the study proceed to conduct econometric modeling of the data employed through model specification:

Consequently, the model implicitly revealed agricultural output growth function through the expansion and justification for estimating variables in equation (1) thus:

AOT = F (ACGS, INF, INTR, LAPR, GCF)…….. (1)

$AOT_t = \beta_0 + \beta_1 ACGS_t + \beta_2 ACGS_t + \beta_3 INT_t + \beta_4 LPR_t + \beta_5 GFC_t + U_t$ ……. (2)

Where;

AOT = Agricultural Output Growth

ACGS=Agricultural credit guarantee scheme fund

INF= Inflation Rate

INTR= Interest Rate

LPR= Labour Participation Rate

GCF= Gross Capital Formation

$U_t$is the stochastic error term.

A PRIORI EXCPECTATIONS

Considering the apriority expectations, we expect β_0, to capture the shift in parameters, and$\beta_1, \beta_2, \beta_4 \beta_5$>0, which implies that INF, LPR and GCF stimulates Agricultural output growth. And β_3,<0, meaning indirect relationship subsists that is, lower INTR is expected to trigger investments in agricultural output which in return brings about improved general growth.

ARDL MODEL

It is pertinent to hypothesize the coefficient estimates as follows;

Hypothesis: $H_0 = \beta_1 j = \beta_2 j = \beta_3 j = \beta 4 j = 0$ {Null hypothesis}

$H_i = \beta_1 j \neq \beta_2 j \neq \beta_3 j \neq \beta 4 j \neq 0$ {Alternate hypothesis}

Where j= (1, 2, 3, 4)

$$AOT_t = \beta_0 + \beta_1 ACGS_t + \beta_2 ACGS_t + \beta_3 INT_t + \beta_4 LPR_t + \beta_5 GFC_t + U_t$$

Therefore, it is important to transform the model (2) into Autoregressive Distributed Lags (ARDL) model in model (3) to conduct econometric analysis (Pesaran et al., 2001; Glenda, 2022; Alshehry & Belloumi, 2023).

$$AOT_t = \beta_{01} + \beta_{11} AOT_{t1}\text{-}i + \beta_{21} ACGS_{t2}\text{-}i + \beta_{31} INT_{t3}\text{-}i + \beta_{41} GFC_{t4}\text{-}i + \sum^{p}_{i=1} \beta_{1j} \Delta AOT_{t1}\text{-}i + \sum^{R2}_{i=1} \beta_{2j} \Delta ACGS_{t2}\text{-}i + \sum^{R3}_{i=1} \beta_{3j} \Delta INT_{t3}\text{-}i + \sum^{R4}_{i=1} \beta_{4j} \Delta GFC_{t4}\text{-}i \ldots\ldots\ldots\ldots\ldots\ldots 3$$

Consequently, the theoretical relationship among the estimated series can as well be econometrically expressed thus:

$$Yt = \gamma_{0j} + \sum^{p}_{i=1} \alpha_j Y_1\text{-}i + \sum^{R}_{i=0} \delta'_j X_1\text{-}i + \mu jt \ldots\ldots\ldots\ldots 4$$

Where $\mathbf{Y}_t$ is a vector and variables in (**X**'t) are allowed to be purely I(0) or I(1) or mixed integrated as indicated under the unit test in Table 1. Notably, α and $\boldsymbol{\delta}$ denoted as coefficients estimates; γ is the constant; j=1, 2, …k; in which **P, R** are optimal lag orders; meanwhile μj_t is signals vector of error terms i.e. unobserved zero mean white vector process (i.e. serially uncorrelated or independent).

Note: the lag length **P, R** may not be necessary the same: **P** Lag is used for dependent variable, while **R** are used for exogenous variables.

Table 1: UNIT ROOT TESTS

UNIT ROOT TEST	ADF T-STATISTICS	ORDER OF INTEGRATION	PROB. VALUE
Agricultural Output Growth (AOT)	-11.0931	I(1)	0.0000
Agricultural credit guarantee scheme fund (ACGS)	-3.4659	I(0)	0.0151
Inflation Rate (INF)	-4.5208	I(1)	0.0014
Interest Rate (INT)	-6.2775	I(1)	0.0000
Labour Participation Rate (LPR)	-5.3881	I(0)	0.0001
Gross Capital Formation (GCF)	-8.9938	I(0)	0.0000

Source: Author's computation, 2024.

AOT-Agricultural Output Growth, ACGS-Agricultural credit guarantee scheme fund, INF-Inflation Rate, INTR-Interest Rate, LPR-Labour Participation Rate and GCF-Gross Capital Formation data through ADF unit root test.Unit root and outcome qualities in the Table 2 represents all the estimates in the model. It showed the mixture of variables at level and at first difference for each of the unit-root test carried out in the model. The null hypothesis states that there is a unit root in individual series, meaning that the variables possessed a unit root at certain point, while the alternate hypothesis stated that some are not. Consequently, the null hypothesis is rejected because the ADF statistic is greater than critical value at various significance levels. The Augmented Dickey Fuller reveals that AOT ACGS INF INT LPR and GCFare integrated of order one and zero i.e. I(1) and I(0). Therefore, the condition for Autoregressive Distributed Lags and Error Correction Mechanism methods is achieved. Going forward, is to test for the Bound testing to establish the manifestation of co-integration in the specified models.

Bound Test

The Bound testing result was expected to check if long run co-integration subsisted in the model. Consequently, based on the unit root test results in table 1 above, the most appropriate co-integration test is the Pesaran Bounds testing. As this would support the extant econometric rule of a priori expectation, since the test allows for combination of slightly integrated variable that possess combined different forms of integration. Hence, the Bounds Cointegration testing result is disclosed as follows:

Table 2: ARDL Bounds Test

Test Statistic	Value	k
F-statistic	5.348744	5
Critical Value Bounds		
Significance	I(0)Bound	I(1)Bound
10%	2.26	3.35
5%	2.62	3.79
2.50%	2.96	4.18
1%	3.41	4.68

Source: Author's computation

The ARDL Bounds testing results in Table 2 displayed that the assumption of weak exogeneity on agricultural output, inflation rate, agricultural credit scheme, interest rate, labour participation rate and gross capital formation. The hypothesis of no long run relationship is hereby rejected across1%, 5%,10% significant levels respectively, as the F-statistic for the model is greater than 1%, 5%,10% of both I (0) and I (1) bounds of 2.7 and 3.73, respectively. Hence, the long-run relationship between agriculture output, inflation rate, interest rate, labour participation rate and gross capital formation subsists.

Lag Length Criteria

Table 4: Lag length selection Outcomes from the model estimation between 1985 and 2022.

VAR Lag Order Selection Criteria

Endogenous variables: AOT ACGS INF INT LPR and GCF

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-720.3813	NA	4.28e+10	41.50750	41.77414	41.59955
1	-664.7843	88.95519	1.44e+10	40.38768	42.25409	41.03196
2	-605.3948	74.66118	4.59e+09	39.05113	42.51733*	40.24766
3	-539.6534	60.10643*	1.47e+09*	37.35162*	42.41761	39.10040*

*Note: * indicates lag order selected by the criterion, LR: sequential modified LR test statistic (each test at 5% level), FPE: Final prediction error, AIC: Akaike information criterion, SC: Schwarz information criterion, HQ: Hannan-Quinn information criterion.*
Source: *Author's computation.*

Table 3 disclosed the lag length selection results from the series "*" which indicate lag order as selected in the criterion rule. Notably, the criterion order was significance at a 5% level on each test. The study compared five alternative methods of lag length selection such as the sequential modified LR test statistic (LR); final prediction error (FPE); Akaike information criterion (AIC); Schwarz information criterion (SC) and Hannan-Quinn information criterion (HQ). The outcomes from this selection criterion revealed that lag length switched between two (2) and (3) of the Schwarz information criterion (SC) and Akaike information criterion (AIC), which is the most appropriate for the estimated ARDL model in the study. Premised on the fact that 37.35162* is the least figure among the suggested information criterion under the lag (2) row.

Autoregressive Distributed Lags Analysis

This aspect of the study discloses the result attained from the Auto-regressive Distributed Lags (ARDL-Model), that is, unrestricted error correction model (ECM) and the ARDL long-run form (static) model are displayed in the Table 3. With this result, the study revealed the short-run relationships between agriculture output, inflation rate,

agricultural credit scheme, interest rate, labour participation rate and gross capital formation subsists.

ARDL MODEL
Table 4

Variables	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.***
AOT(-1)	0.201558	0.191415	1.052990	0.3102
ACGS	0.352780	0.468989	0.752214	0.4644
ACGS (-1)	-0.573549	0.489856	-1.170852	0.2612
ACGS (-2)	-0.453316	0.459172	-0.987247	0.3403
ACGS (-3)	1.183922	0.511429	2.314927	0.0363**
INF	-0.187659	0.075837	-2.474510	0.0268**
INTR	-1.140967	0.695859	-1.639653	0.1233
INTR(-1)	0.537476	0.626627	0.857729	0.4055
INTR(-2)	-1.477056	0.676630	-2.182959	0.0466**
INTR(-3)	0.670810	0.587065	1.142651	0.2723
LPR	0.400308	0.134611	2.973827	0.0101***
LPR(-1)	-0.455411	0.164657	-2.765814	0.0152**
LPR(-2)	0.504982	0.195204	2.586940	0.0215**
LPR(-3)	-0.376502	0.124993	-3.012192	0.0093***
GCF	-0.184764	0.107261	-1.722555	0.1070
GCF(-1)	-0.327567	0.126416	-2.591189	0.0213**
GCF(-2)	-0.476804	0.131577	-3.623759	0.0028***
GCF(-3)	-0.239128	0.092997	-2.571352	0.0222**
C	11.66029	6.509095	1.791384	0.0949
R-squared	0.874696		Mean dependent var	1.769342
Adjusted R-squared	0.835021		S.D. dependent var	5.646598
S.E. of regression	4.052116		Akaike info criterion	5.930420
Sum squared resid	229.8750		Schwarz criterion	6.792046
Log likelihood	-78.85193		Hannan-Quinn criter.	6.220331
F-statistic	2.674356		Durbin-Watson stat	2.060010
Prob(F-statistic)	0.033700			

Source: Author's computation, 2024.

The results obtained from Table 3 shown a positive relationship between agriculture output (AOT), inflation rate (INF), agricultural credit scheme (ACGS), interest rate (INT), labour participation rate (LPR) and gross capital formation (GCF) subsists. The third year lag value of agriculture output was statistically significant to influence

the current year agriculture output in Nigeria, which means the AOT possessed a lag path. While other variables such as three year lag of access to credit scheme, current year inflation rate, two year lag of labour participation rate and a year lag of gross capital formation were statistically significant at 5% level to affect agricultural output, hence agricultural output growth. Meanwhile, variables for ACGS and INTR were not significant across all the three conventional levels in their current years but rather at their respective lag years which were statistically significant at 5% levels. Notably, the current year of labour participation rate significantly influence agricultural output growth at 5% levels. The co-efficient of determination at 0.874696, implies 87.5% of the variation effects of inflation was explained on agricultural output growth in Nigeria. Also, the Durbin-Watson stat of about 2.06 indicated that the models are free from all forms of autocorrelation.

In view of these outcomes, it is pertinent to estimate the speed of adjustment between the short-run and long-run impact of inflation rate on agricultural output in Nigeria, using ECM techniques.

ERROR CORRECTIONCOINTEGRATING MODEL OF ARDL

Table 5	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.***
D(ACGS)	0.352780	0.468989	0.752214	0.4644
D(ACGS(-1))	0.453316	0.459172	0.987247	0.3403
D(ACGS (-2))	-1.183922	0.511429	-2.314927	0.0363**
D(INF)	-0.187659	0.075837	-2.474510	0.0268**
D(INTR)	-1.140967	0.695859	-1.639653	0.1233
D(INTR(-1))	1.477056	0.676630	2.182959	0.0466**
D(INTR(-2))	-0.670810	0.587065	-1.142651	0.2723
D(LPR)	0.400308	0.134611	2.973827	0.0101***
D(LPR(-1))	-0.504982	0.195204	-2.586940	0.0215**
D(LPR(-2))	0.376502	0.124993	3.012192	0.0093***
D(GCF)	-0.184764	0.107261	-1.722555	0.1070
D(GCF(-1))	0.476804	0.131577	3.623759	0.0028***
D(GCF(-2))	0.239128	0.092997	2.571352	0.0222**
CointEq(-1)	-0.798442	0.191415	-4.171252	0.0009***

*Source: Author's computation 2024. Where *, **, and *** indicate 1%, 5% and 10% respectively.*

From the model outcomes in Table 4, it was observed that there were short run and long run relationship between agricultural output and others independent variables such as inflation rate, access to credit, interest rate, labour participation rate and gross capital formation in Nigeria. That is, the standard errors coefficients and t-statistics values reported in Table 4 disclosed the presence of association-ship within the specified models. In the meantime, Cointegrating error term coefficient [CointEq(-1)*] affirmed Cointegration-ship in the model. This was explained by the level of siginificance at 1% and speed of adjustment of the model which was disclosed at 79% high. The percent speed of adjustment disclosed how the Autoregressive Distributed Lags (ARDL) models can respond quickly to shocks at the equilibrium point. Hence, the Error Correction Model (ECM) revealed that ARDL model run at about -0.798442 (79%) speed to temporary shocks and return back to equilibrium quickly at a very high speed. Meaning that the models employed in the study are self-regulating and self-correcting in terms of errors and shocks. Also, the Durbin-Watson (DW) stat of about 2.06 which is approximately 2 implies that the model is free from any incidence of autocorrelation. Meaning the estimating models conformed to the econometric assumption of best least unbiased estimate (BLUE). Next, is to verify the long run relationship among the series thus.

Table 6: LONG-RUN COINTEGRATING MODEL OF ARDL

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
ACGS	0.638540	0.606294	1.053185	0.3101
INF	-0.235032	0.110177	-2.133232	0.0491**
INTR	-1.765609	1.618652	-1.090790	0.2938
LPR	0.091901	0.184084	0.499233	0.6254
GCF	-1.538325	0.611015	-2.517655	0.0246**
C	14.603813	8.257248	1.768605	0.0987

Source: Author's computation 2024.

It can be observed from Table 5 that inflation rate has long-run significant effects on agriculture output, hence general output growth. For example; data for inflation rate and gross capital formation significantly influence at 5% levels of significant in the long-run, respectively, while data for interest rate, access to credit and labour participation rate have long run insignificant effect on the Nigerian agricultural output growth. Notably, data from inflation rate exhibited the expected appriori expectation of negative link with unit of agricultural products. Meanwhile, data for gross capital formation contradicted what the economic intuition postulated, despite being significant to influence agricultural output growth in Nigeria.

Notably, when there is long run nexus, the Engle-Granger Theorem states need for encompassing power of the error correction mechanism over other forms of dynamic specifications. Hence, it pertinent to estimate the Error Correction Mechanism results in the Table 3, as indicated that the estimated ECM in the models adjust at 79% speed. That is, the Error Correction Mechanism calculated speed of adjustment between the short run and long run. It appeared that the estimated models in the study can adjust from short run to long run at a top speed of 0.79 high. The implication of this figure is that the models can quickly re-adjust from unexpected disequilibrium point at some points to readjust to equilibrium point within the shortest possible time. Hence, in view of this outcome, it is worth noting that the estimated models in the study are valid and consistence with the econometric intuitions of BLUE. Next is to further ascertain the validity of the estimated models in the study by carrying diagnostics tests.

Figure1: Normality and Residual Plot

Normality test

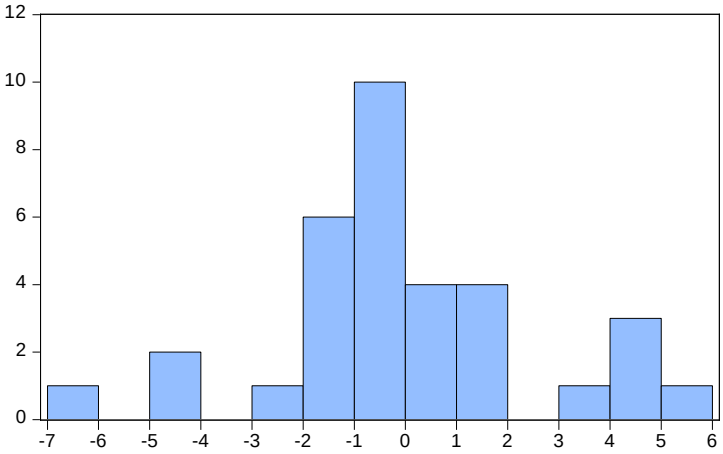
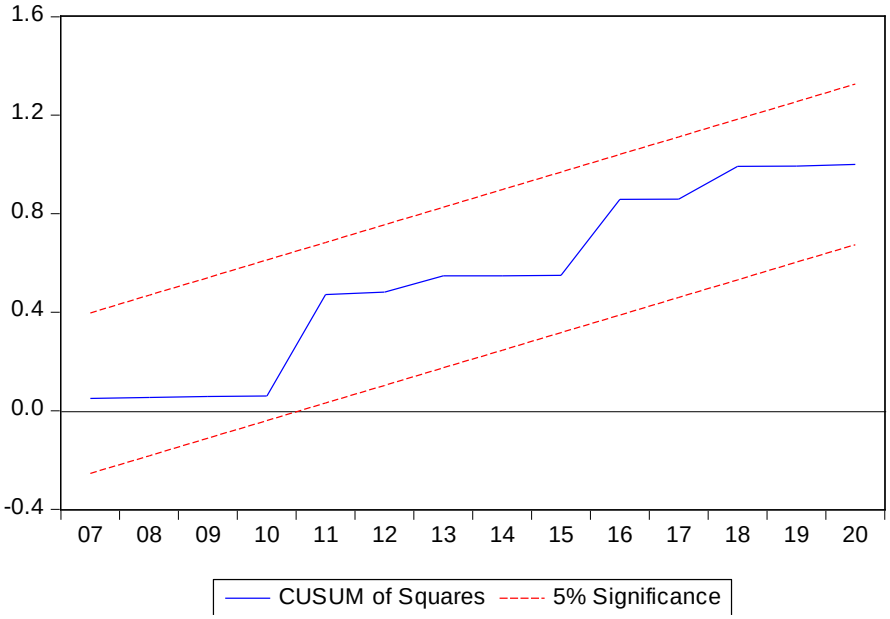


Figure 2: Residual Plot of CUSUM SQUARE



Based on the outcomes from the diagnostics tests, it can be observed that the series employed in the study were normally distributed and stable with respect to time. Similarly, the CUSUM of squares curve affirmed that the model is stable throughout the thirty eight years

under review. Meaning that the model is stable around the mean. This implication is that the model is free from incidence of Heteroskedasticity, as it was disclosed in Table 7. Furthermore, the serial LM autocorrelation test disclosed that was from serial autocorrelation, as it was revealed in Table 6.

Table 7: Breusch-Godfrey Serial Correlation LM Test.

F-statistic	Obs*R-squared	Prob. F(2,7)	Prob. Chi-Square(2)
0.745572	3.647413	0.4952	0.1614

Table 8: Heteroskedasticity Test: Breusch-Pagan-Godfrey Test.

F-statistic	Obs*R-squared	Prob. F(22,9)	Prob. Chi-Square(20)
0.825084	16.98697	0.6547	0.5240

Consequently, the Heteroskedasticity Test and Breusch-Godfrey Serial Correlation (LM) test affirmed that the null hypothesis of autocorrelation can be rejected since the probability value is greater than 5% critical value. Therefore, the models of specification in the study are free from any form of outliers and serial autocorrelation (Keji, 2021; 2023).

Findings and Discussion

The results obtained from the Autoregressive Distributed Lags in the Table 3 elucidated an inverse impact of inflation rate and other independent variables such as interest rate, labour participation rate and gross capital formation on agriculture output growth in Nigeria. The dependent variable for real agriculture output disclosed time path effect on the current agriculture output. That is, the previous year's performance predict the current year performance of agriculture output. The implication of this outcomes, emphasized on the importance of advanced storage facilities in agricultural sector in Nigeria. However, the current crisis of inadequate supply of agricultural goods in the country can be attributed to poor storage facilities in the agricultural sector. That is, previous year's output, in

most cases were wasted and rotten away before the next planting season, hence short supply of agricultural output in the current year. Consequently, artificial scarcity submerged and persist in the market, which in turn lead to persistence rise in prices of agricultural goods.

Also, the Bound test statistics disclosed the presence of long-run effects of inflation rate on agriculture output growth in Nigeria. Since, Bound coefficient F-statistic is greater than the upper bound and the lower bound, which conformed to the overall significance of the ARDL model. The long run and the error correction models disclosed how pertinent the inflation rate can influence agriculture output over the long period of thirty-eight years. While error correction mechanism model explained that the model for Autoregressive Distributed Lag model adjust quickly to shocks and disruption from the equilibrium. The speed of adjustment is so high at 79% at shortest period, specifically from short run to long run. In conclusion, the indicators for inflation rate revealed the impact of disruptions in general external price stability on agriculture output in Nigeria.

The outcome in Figure 1, 2 and 3 explained the normal distribution, residual and CUSUM Square (stability) of the data in the model, while the residual trend disclosed the consistent flow of the series employed in the study along the mean. This implies that the figure within the models are stable and can react quickly to unexpected disequilibrium shocks at point of the equilibrium within the shortest possible time. Hence, it is worth noting that the estimated models in the study are valid and consistence with the economic intuitions. Meaning that the Nigerian inflation rate posed different challenges to agriculture output growth in Nigeria, which is the current manifestation of hunger protest in the country. Hence, this has caused several and predominant challenges that connected with external shocks in which affect cost of input for agricultural output growth performance, despite being able to adjust quickly to any further unexpected shocks.

Further tests revealed the validity of the models adopted in the study. It is pertinent to check the efficient, validity and consistency of the models employed through the necessary statistical rules. For example; from Figure 1; Jarque-Beta test suggest that the residuals for both models are normally distributed since the probability value is

greater than 5% significant level. Hence, the hypothesis of normal distribution for residuals cannot be rejected. The Breusch-Godfrey Serial Correlation (LM) test suggests that the null hypothesis of autocorrelation can be rejected since the probability value is greater than 5% critical value.

Conclusion and Recommendations

In the study, the effect of inflation rate on agriculture output growth in Nigeria, using annual time series data spanning 1985 through 2023. The Autoregressive Distributed Lags (ARDL) and Error Correction Mechanism (ECM) model techniques were adopted in the study. It was exhibited in this study that inflation rate significantly influence agriculture output growth in Nigeria. Furthermore, to address the current foods insecurity in the country, this study recommend appropriate economic policies that can best suggest answers to the observed problems emerging from the study. Discoveries from this research generally resolved that there were short-run and long-run relationships between inflation rate and agriculture output growth in Nigeria. This corroborates the views of Ewubare and Udo (2017), Musa, Maijama'a, Shaibu, and Muhammad, (2019), Okunlola, Osuma and Omankhanlen, (2019), which inferred that inflation rate has negative effect on the Nigerian agriculture output. Also, the coefficient of previous year's agriculture output affect the current year agriculture output, which implies that the agricultural output indicator is time path variable and other control variable such as interest rate, gross capital formation among others showed some levels of resilience throughout periods of analysis. Furthermore, it was established that Bound test established cointegration among the indicators specified in the model. Meaning that there is presence of both short and the long run effects of inflation rate on agriculture output in Nigeria. In view of these outcomes, notable recommendations were suggested accordingly.

Consequently, based on the current food insecurity in the country which has resorted to series of hunger protest, there is need for necessary attention from the policy-maker. Having address the problems emerging from the study through the empirical findings in the previous sections, we hereby recommend policy guides that are

pertinent towards sustaining agricultural output growth in Nigeria. This is to provide necessary answers to the challenges bedeviling improved agricultural production in Nigeria, which in turn would dose tension of the current hunger protest in the country. In view of this, the study recommends the following policies for quick implementation in Nigeria for an improved output growth.

Firstly, government should redesign monetary policy that would support stability in general price levels with necessary tamperproof safety-net against external shocks. This is to address persistence leakages across all the country's currency boarder. By so doing, the local investment in agriculture productivity would rise due to less external shocks.

Secondly, Nigeria government needs to improve storage facility across the real sector of the economic such as agricultural sector. This is to further expand output supply that can address artificial scarcity in the market, hence reducing inflation rate.

Thirdly, there is need to reconfigure the protectionist trade laws in Nigeria. The protectionist should be driven towards export promotion. This corroborates the views of Otalu and Keji (2015) and Keji and Efuntade (2020).

Fourthly, government should promote farmer skills enhancement through agriculture extension workers. This would drastically impact on the labour participation rate leading to high agriculture output growth in Nigeria. Since, countries around the globe are now embracing knowledge based economy as major sources of robust general output yields.

Finally, there is need for improved and remodeled international terms of trade agreements to attract both local and foreign direct investments in agriculture sector via stable general price with a drastic fall in cost of production and ease of doing business. Nigerian government should strive to train its various agencies by updating their skills toward getting better terms of trade transactions treaties that would attract better domestic investment in agricultural sector in Nigeria. Hence, this would guarantee improve exchange rate and reduce inflation rate.

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