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Effect of Agricultural Mechanization on the Growth of the Nigerian Economy

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Abstract
This study examined the impact of agricultural mechanization on the growth of the Nigerian economy by employing an ex-post facto research design. Secondary data spanning 1981 to 2023 were obtained from the Central Bank of Nigeria Statistical Bulletin and World Bank Development Indicators. The autoregressive distributed lag (ARDL) model was used to analyse the relationship between real gross domestic product (RGDP) and the explanatory variables. The empirical results indicate that capital investment in agriculture and labour force in agriculture have statistically insignificant effects on RGDP, implying that capital investment and labour force contributions to agricultural output may be undermined by structural inefficiencies or inadequate mechanization. In contrast agricultural credit guarantee scheme and gross fixed capital formation significantly and positively impact RGDP, indicating that credit access and investments in fixed capital play pivotal roles in enhancing economic growth through agricultural mechanization. The study finds that while credit and fixed capital investments are instrumental in driving economic growth, capital investments and labour force contributions in agriculture need to be optimized. Inefficiencies in the agricultural sector, such as insufficient mechanization, may limit the potential of these variables to contribute effectively to economic growth. It is recommended that policymakers intensify efforts to promote agricultural mechanization through targeted funding, infrastructure development, and favourable credit policies.

Keywords: Agricultural Mechanization, Economic Growth, Innovations, Agricultural Productivity, ARDL.

1.0 Introduction

Agricultural mechanization plays a critical driver of productivity and economic growth in many developing economies. In Nigeria, agriculture plays a vital role in the nation's economic development, contributing significantly to employment, food security, and rural development. According to the National Bureau of Statistics (NBS, 2023), agriculture contributes approximately 24% to Nigeria's Gross Domestic Product (GDP) and employs over 60% of the labour force, particularly in rural areas. Nevertheless, the sector's productivity has been constrained by reliance on traditional farming methods, limited access to technology, and inadequate infrastructure. Thus, the adoption of agricultural mechanization plays a vital strategy for improving productivity and fostering economic growth (Wang, Chen, Kopittke and Zhao (2019). Agricultural mechanization entails the use of machinery and equipment to enhance farming operations, reduce manual labor, and increase efficiency across the agricultural value chain

(Olaniyi & Oyelami, 2021). Mechanization encompasses a wide range of activities, including land preparation, planting, irrigation, harvesting, and post-harvest processing. Studies have demonstrated that mechanized farming can lead to higher crop yields, reduced post-harvest losses, and improved food security.

Despite its potential benefits, the level of mechanization in Nigeria remains low. The Food and Agriculture Organization (FAO, 2022) reports that Nigeria has one of the lowest tractor densities in sub-Saharan Africa, with less than one tractor per 1,000 hectares of arable land. Factors such as high costs of machinery, limited access to finance, and poor infrastructure have impeded the widespread adoption of mechanization. Furthermore, smallholder farmers, who constitute the majority of agricultural producers in Nigeria, often insufficiency resources and technical capacity to invest in mechanized farming (Jaleta, Baudron, Krivokapic-Skoko and Erenstein, 2019).

Efforts by the Nigerian government to promote agricultural mechanization have included policies such as the Agricultural Transformation Agenda (ATA) and the Agricultural Promotion Policy (APP), which aim to enhance access to credit, subsidize equipment, and develop rural infrastructure (Federal Ministry of Agriculture and Rural Development, 2023). Nevertheless, the impact of these initiatives has been mixed, with many farmers still facing significant barriers to mechanization. Private sector involvement and public-private partnerships have also been explored as potential solutions to address the mechanization gap. Although, agriculture remains the cornerstone of Nigeria's economy, contributing significantly to employment, food security, and national income. Nevertheless, the sector's potential has been limited by reliance on subsistence farming practices characterized by low productivity and inefficiency. In Nigeria, where the population exceeds 200 million, the need for a vibrant agricultural sector is critical for sustaining economic growth and reducing poverty. Despite various policy interventions, agricultural productivity has not met expectations, largely due to inadequate mechanization.

The underperformance of Nigeria's agricultural sector has been a longstanding concern for policymakers and stakeholders. Low productivity, inefficiencies in the value chain, and high post-harvest losses persist to undermine the sector's potential to drive economic growth and ensure food security. One of the critical challenges facing the sector is the limited adoption of mechanized farming practices. Traditional farming methods, characterized by the use of basic tools and reliance on manual labor, dominate agricultural production in Nigeria. These practices are labor-intensive, time-consuming, and often yield suboptimal results (Leo, 2019).

The impact of low mechanization extends beyond productivity to affect the broader economy. Agriculture is a key sector for economic diversification in Nigeria, particularly in the context of fluctuating oil prices and the need for non-oil revenue sources. The insufficiency of mechanization limits the sector's ability to contribute meaningfully to economic growth, export earnings, and job creation. In addition, food insecurity and rising import bills for agricultural products highlight the need for increased domestic production and competitiveness (Ndubuisi, 2019). Several studies have highlighted the positive relationship between agricultural mechanization and economic growth. For instance, Ogundele and Ojo (2023) found that mechanized farming significantly boosts agricultural output and reduces rural poverty in Nigeria. Nevertheless, the insufficiency of comprehensive and coordinated efforts to scale up mechanization remains a major bottleneck. The high cost of machinery, inadequate financing options, and poor maintenance culture are some of the factors impeding progress. Additionally, infrastructural deficits, such as poor road networks and limited access to electricity, further constrain mechanization efforts.

Given the importance of agriculture to Nigeria's economy and the pressing need to enhance productivity, understanding the impact of agricultural mechanization on economic growth is crucial. This study seeks to explore the effect of mechanization on agricultural output, employment generation, and overall economic performance. By examining the challenges and opportunities associated with mechanization, the study aims to provide insights and recommendations for policymakers, stakeholders, and investors interested in promoting sustainable agricultural development in Nigeria by determining the relationship between capital investment in agriculture and economic growth in Nigeria and to examine the relationship between labour force in agriculture and economic growth in Nigeria. The study also evaluates the relationship between agricultural credit guarantee scheme fund and economic growth in Nigeria and determine the relationship between gross fixed capital formation on agriculture and economic growth in Nigeria.

2.0 Literature Review

Mechanization spans various stages of agriculture, including land preparation, planting, cultivation, harvesting, and post-harvest processing, and is a critical driver of agricultural productivity, rural development, and economic growth. This framework emphasizes mechanization as an integrative process that enhances efficiency, reduces drudgery, and fosters sustainability within agricultural systems (Bako, Jacob, Bitrus and Yakubu, 2018).

Mechanization includes the use of tractors for ploughing, seed drills for planting, irrigation systems for water management, and harvesters for efficient crop collection. Post-harvest mechanization, involving milling, threshing, and storage technologies, is equally important for reducing losses and enhancing value addition. Mechanization is also increasingly incorporating renewable energy sources, such as solar-powered irrigation systems and biogas-powered equipment, reflecting a growing emphasis on sustainability (Sims, Kienzle, & Hilmi, 2022).

The low mechanization intensity in Nigeria is a critical concern. The country has fewer than 1.5 tractors per 1,000 hectares of arable land, far below the Food and Agriculture Organization's recommended minimum of 4 tractors per 1,000 hectares (FAO, 2022). This lack of mechanization is a key factor in the low productivity levels experienced by Nigerian farmers, with crop yields often significantly below global averages. For example, maize yields in Nigeria are about 1.8 tons per hectare, compared to a global average of 5.5 tons (Olukoya et al., 2022).

The relevance of mechanization to Nigeria's agricultural and economic development is multifaceted. Mechanization has the potential to address labour shortages caused by rural-urban migration, improve productivity, and reduce the drudgery associated with manual farming. Furthermore, it enhances the timeliness and precision of agricultural operations, enabling farmers to cultivate larger areas and achieve higher yields. Mechanization also supports the development of agro-industries by providing a steady supply of raw materials and reducing post-harvest losses. This contributes to value addition and the creation of employment opportunities in related sectors such as machinery manufacturing, repair, and logistics.

With Nigeria's population projected to exceed 250 million by 2050, mechanization is essential for meeting the rising food demand and reducing the reliance on food imports (Zhai et al., 2022). The adoption of mechanization also promotes rural development by increasing farm incomes, reducing poverty, and encouraging investment in rural infrastructure. Mechanized farms are more likely to attract investments in roads, storage facilities, and markets, further stimulating economic activities in rural areas.

To address these issues, the Nigerian government has implemented initiatives such as the National Agricultural Mechanization Program (NAMP) and partnerships with private sector entities to establish tractor leasing centres. These programs aim to increase the availability and affordability of machinery for smallholder farmers. Additionally, international collaborations, such as those with China and India, have facilitated the importation of low-cost machinery suitable for Nigeria's farming conditions.

Agricultural mechanization in Nigeria also highlights the importance of capacity building. Many farmers lack the technical skills needed to operate and maintain modern equipment. Extension services and training programs are therefore critical for ensuring the effective use of mechanized tools and promoting their widespread adoption. Agricultural mechanization is a vital component of Nigeria's strategy for transforming its agricultural sector and achieving sustainable economic growth. While significant progress has been made in recognizing its importance, the full potential of mechanization remains unrealized due to persistent challenges. Addressing these challenges requires a holistic approach that combines policy support, infrastructure development, financial incentives, and capacity building.

2.2 Theoretical Framework

The primary theory underpinning this research is the Solow–Swan growth model due to its emphasis on technological progress, capital accumulation, and long-run equilibrium analysis, all of which align closely with the research objectives. The Solow–Swan Growth (SSG) model, formulated by Robert Solow and Trevor Swan during the 1950s and 1960s, stands as a fundamental concept in economic theory. It extends the Harrod–Domar model by incorporating labour as a factor of production and allowing for variable capital-output ratios. The model aims to elucidate the factors driving long-term economic growth, emphasizing the contributions of capital accumulation and technological progress (Solow 1956). At its core, the SSG model posits that economic growth is a function of increases in capital (both physical and human) and technological advancements. Mathematically, this can be expressed as follows:

$Y = f(K, H, A, L)$

where Y represents output or GDP, K denotes the stock of physical capital, H represents the stock of human capital, A signifies technological progress or total factor productivity (TFP), and L denotes the labour force. In the absence of technological breakthroughs, the model predicts that economies will eventually reach a steady state where further accumulation of capital ceases to significantly impact growth. Mathematically, this steady state can be represented by the following condition:

$sY = (n + \delta)K$

where s denotes the savings rate, n represents the rate of population growth, and δ signifies the depreciation rate of capital.

Technological progress, considered an external force, becomes imperative for breaking out of this equilibrium and achieving sustained economic growth (Frey 2017). Endogenous growth theory further extends the Solow model by emphasizing the role of knowledge and human capital (Romer 1990). It posits that technological advancements are endogenously determined by factors such as research and development (R&D) investments, and human capital is considered a critical driver of growth.

The relevance of this model to the study of technological innovation's impact on agricultural productivity in Nigeria lies in its recognition of the transformative potential of technological progress. While initial investments in capital, such as modern machinery and infrastructure, may yield short-term gains in agricultural productivity, the model suggests that the sustained impact comes from exogenous technological innovation (Olayide et al. 2016; Tabe-Ojong et al. 2023). This implies that for long-term and sustained growth in the agricultural sector in Nigeria, the adoption of cutting-edge technologies like precision farming, genetic modifications, and data-driven decision-making is paramount.

In summary, the SSG model offers a solid theoretical foundation for understanding the interplay between technological progress, capital accumulation, and economic growth. Applied to agriculture, it highlights the crucial role of technological innovation in enhancing productivity and achieving sustainable agricultural practices, making it a pertinent guide for examining the impact of technological innovation on agricultural productivity in Nigeria.

2.3 Empirical Literatures

Edwin (2024) examined accelerating Nigeria's Economy in the 21st Century Through Mechanized Production: A Thematic Approach. The research adopted secondary sources of data collection such as text books, journals, government documents etc and subsequently analyzed the data through the use of descriptive method of analysis also known as content analysis. The paper found out that farming systems currently practised in some parts of Nigeria do not encourage mechanized production. Majority of roads especially in the South Eastern part of Nigeria are not accessible. The paper recommends among others that Nigerian government should give utmost priority to road reconstruction in other to make them accessible to agricultural machines. The study concludes by asserting that if Nigeria fails to enhance her economy through mechanized, perhaps, she is announcing her economic doom.

Joel, Adel, Dominic et al, (2024) investigate technological Innovation and Agricultural Productivity in Nigeria Amidst Oil Transition: ARDL Analysis. Using the ARDL estimation technique, our findings reveal a significant negative influence of immediate lagged agricultural productivity (AGTFP(−1)), indicating technological constraints. Technological innovation, proxied by TFP, shows a substantial impact on agricultural productivity, with a negative long-term effect (−90.71) but a positive, though insignificant, impact on agricultural output (0.0034). The comparative analysis underscores that the agricultural sector tends to benefit more from technological innovation than the oil sector. This highlights the critical need to prioritize technological advancements in agriculture to drive sustainable growth and economic resilience in Nigeria.

Similarly, Agbaje and Hassan (2023) analyzed the macroeconomic impact of mechanization on Nigeria's GDP using an error correction model (ECM). Their results demonstrated a significant positive relationship between the number of tractors per hectare and agricultural GDP, underscoring the importance of mechanized tools in enhancing agricultural efficiency and contributing to national economic growth. The study recommended increased investment in subsidized mechanization programs to boost smallholder farmers' access to machinery.

Olukoya et al. (2022) investigated the relationship between mechanized farming and crop yields in Nigeria using time-series data from 1990 to 2020. Their findings revealed that farms utilizing mechanized tools achieved a 35% higher output compared to those reliant on traditional methods.

The study concluded that mechanization is critical for closing Nigeria's yield gap, particularly in staple crops like maize and rice.

However, challenges persist. Omotayo and Bolarinwa (2022) noted that the high cost of machinery, coupled with limited access to credit and fragmented land holdings, has constrained the widespread adoption of mechanization in Nigeria. Their findings emphasized the need for policies that support cooperative farming and provide financial incentives to lower the cost of mechanized tools for smallholder farmers.

Kehinde, Oyetola, Oladunni. and A. T. (2022) analyzed the effect of Agricultural Mechanization on Production and Farmers Economy in Nigeria: A Case Study of Lagos State. The investigative research approach method was employed to retrieve information from farmers through a structured questionnaire. A five-rating scale questionnaire was utilized for the respondents to show their level of agreement or disagreement. The percentage was used to analyze the respondents' bio-data. At the same time, the mean was employed to answer the research questions. The null hypotheses were tested using Chi-square statistics at 0.05 significant levels. The results revealed that agricultural mechanization increased the cultivated land, crop yields, and farmers' income. The study showed that agricultural mechanization had a significant influence on crop production and farmers' income. Therefore, there is a need to improve the available technologies and formulate and implement policies to make agricultural mechanization accessible and sustainable.

In another study, Olorunfemi and Adekunle (2021) explored the impact of post-harvest mechanization on Nigeria's food security and agro-industrial development. The researchers found that mechanized processing and storage facilities significantly reduced post-harvest losses by up to 40%, thereby increasing the availability of raw materials for agro-industries. The study highlighted the indirect benefits of mechanization in stimulating agro-industrial growth and creating employment opportunities in rural areas.

Hiroyuki, Patrick and Hyacinth (2020) explore the effects of agricultural mechanization on economies of scope in crop production in Nigeria. Using panel data from farm households and crop-specific production costs in Nigeria, we estimate how the adoptions of animal traction or tractors affect the economies of scope (EOS) for rice, non-rice grains, and legumes/seeds, which are the crop groups that are most widely grown with animal traction or tractors in Nigeria, with respect to other non-rice crops. The inverse-probability-weighting method is used to address the potential endogeneity of mechanization adoption and is combined with primal- and dual-models of EOS estimation. The results show that the adoption of these mechanization technologies is associated with greater EOS between rice and non-rice crops but lower EOS among non-rice crops (i.e., between non-rice grains, legumes/seeds, and other non-rice crops). Mechanical technologies may raise EOS between crops that are grown in more heterogeneous environments, even though it may lower EOS between crops that are grown under relatively similar agroecological conditions. To the best of our knowledge, this is the first paper that shows the effects of mechanical technologies on EOS in agriculture in developing countries

These empirical literatures thus emphasize the transformative potential of agricultural mechanization for Nigeria's economy, while also highlighting the structural challenges that must be addressed to maximize its benefits.

2.4 Literature Gap

Agricultural mechanization has been widely studied as a driver of economic growth, with research focusing on its role in improving productivity, reducing labour intensity, and enhancing the efficiency of agricultural operations. However, existing studies often exhibit several limitations that this research aims to address.

First, many studies on agricultural mechanization in Nigeria tend to focus primarily on its direct impact on agricultural productivity without adequately exploring its broader economic implications, such as its influence on GDP growth, employment generation, and rural-urban migration. This study diverges by investigating not just the productivity gains but also the macroeconomic ripple effects of mechanization on Nigeria's economic growth. This study also introduces a regionally disaggregated approach, providing a nuanced understanding of how mechanization impacts growth differently across Nigeria's geopolitical zones.

Finally, prior research often relies on older data sets or employs outdated methodologies that may not reflect recent advancements in agricultural technology or policy changes. This study uses updated data (1981–2023) and advanced econometric models to capture contemporary trends and provide more reliable insights into the relationship between agricultural mechanization and economic growth in Nigeria.

3.0 Methodology

The study utilized secondary data, which was obtained from Central Bank of Nigeria Statistical bulletin over a period of 43 years from 1981 to 2023. The study applied ex-post facto research design. The study used the Autoregressive Distributed Lag (ARDL) model. The ARDL model is supported by descriptive statistics, stationarity test and cointegration test for long run.

Model Specification

Following the review of literatures and particularly the Solow Swan Growth model, which serves as a vehicle for economic growth of any country. The model of this study was stated:

$$RGDP_t = f(CIA_t, LFA_t, ACGS_t, GFCF_t) \qquad (3.1)$$

The econometric form of the model is expressed as:

$$RGDP_t = \beta_0 + \beta_1 CIA_t + \beta_2 LFA_t + \beta_3 ACGS_t + \beta_4 GFCF_t + \mu_t \qquad (3.2)$$

Where;

RGDP is Real Gross Domestic Product proxy as economic growth; CIA is Capital investment in Agriculture; LFA is Labour force in Agriculture; ACGS is Agricultural credit guarantee scheme and GFCF is Gross Fixed Capital Formation. β_0 is Constant term; β_{1-4} is the Parameters and μ_t is the error term.

4.0 Results and Discussion of Findings

Descriptive Analysis

The descriptive statistic technique on the data was conducted using measures of central tendency, measures of dispersion, and data normality measure. The results obtained from the descriptive analysis are presented in Table 4.1.

Table 4.1 Descriptive Statistics for the data

	RGDP	CIA	LFA	ACGS	GFCF
Mean	39902.54	22.89659	47218889	3208744.	8743.094
Maximum	77936.10	36.96508	75721345	12061412	15789.67
Minimum	16211.49	12.24041	32844703	9853.900	5668.870
Std. Dev.	21651.62	4.480943	13370148	3756299.	1992.304
Observations	43	43	43	43	43

Source: Author's own computation using E view 10.

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The descriptive statistics provide an overview of the data used in the study, summarizing the central tendency, dispersion, and range of values for each variable. The real gross domestic product (RGDP) has a mean value of 39,902.54, reflecting the average economic output over the observed period. The standard deviation of 21,651.62 indicates considerable variability in economic output across the period, with values ranging from a minimum of 16,211.49 to a maximum of 77,936.10. Capital investment in agricultural outputs (CIA) has an average value of 22.90, reflecting a moderate level of financial input into agricultural activities. The standard deviation of 4.48 demonstrates some variability, indicating that investment levels were not consistent throughout the period.

The labour force in agriculture (LFA) has a mean of 47,218,889, representing the average number of individuals engaged in agricultural activities. The standard deviation of 13,370,148 reveals significant variability, suggesting substantial differences in labour force size over time.

The agricultural credit guarantee scheme (ACGS) records an average of 3,208,744, which highlights the mean level of guaranteed credit to support agricultural activities. With a standard deviation of 3,756,299, there is noticeable fluctuation, reflecting differences in the scheme's application across the period.

Gross fixed capital formation (GFCF), representing infrastructure investment, has a mean of 8,743.09. The standard deviation of 1,992.30 indicates moderate variability, suggesting that investment levels were relatively stable compared to other variables.

Correlation Matrix for Multicolinearity

The essence of the correlation matrix is to test the presence of multicollinearity in the model. The result is presented in table 4.2

Table 4.2 Correlation Matrix

	CIA	LFA	ACGS	GFCF
CIA	1.000000			
LFA	0.132807	1.000000		
ACGS	-0.009014	0.221848	1.000000	
GFCF	-0.353972	0.461247	0.376666	1.000000

Source: Author’s own computation using E view 10.

The correlation matrix reveals the relationships among the independent variables, helping to assess the presence of multicollinearity. Capital investment in agricultural outputs (CIA) shows weak correlations with the other variables, with values of 0.13 for labour force in agriculture (LFA), -0.009 for the agricultural credit guarantee scheme (ACGS), and -0.35 for gross fixed capital formation (GFCF). Similarly, LFA exhibits weak to moderate positive correlations with ACGS (0.22) and GFCF (0.46). ACGS and GFCF show a moderate positive correlation of 0.38. Overall, the correlations are below 0.8, indicating the absence of significant multicollinearity among the variables.

Test of stationarity using ADF unit root test

Table 4.3: Unit Root Test using ADF

ADF @ Level					
Variables	ADF test Statistics	Critical value @ 5%	Prob.	I (0)	Decision

Log(RGDP)	-1.500608	-3.526609	0.8128	I (0)	Non-Stationary
Log(CIA)	-2.807484	-3.526609	0.2031	I (0)	Non-Stationary
Log(LFA)	-3.359733	-3.526609	0.0718	I (0)	Non-Stationary
Log(ACGS)	-1.511085	-3.526609	0.8095	I (0)	Non-Stationary
Log(GFCF)	-5.883203	-3.523623	0.0001	I (1)	Stationary

ADF @ 1st Difference					
Variables	ADF test Statistics	Critical value @ 5%	Prob.	I (0)	Decision
Log(RGDP)	-4.010653	-3.523623	0.0160	I (1)	Stationary
Log(CIA)	-6.959123	-3.523623	0.0000	I (1)	Stationary
Log(LFA)	-4.082763	-3.523623	0.0134	I (1)	Stationary
Log(ACGS)	-4.237968	-3.523623	0.0090	I (1)	Stationary
Log(GFCF)	-	-	-	I (1)	Stationary

Source: Author's own computation using E view 10.

The ADF test in table 1 and 2 clearly revealed that, all the variables were not stationarity at 1(0) except gross fixed capital formation which was stationary a level. However, they became stationarity at their first difference 1(1). Hence, the study used of Autoregressive Distributed Lag (ARDL) model and Bound test to test for the long run relationship between the independent and dependent variable.

Cointegration Analysis

The cointegration test was conducted to determine the existence of a long-run relationship among the variables in each of the models earlier specified. The summaries of the results from the tests are presented in Table 4.3.

Table 4.4: Bound test of long run relationship

F-Bounds Test		Null Hypothesis: No levels relationship		
Test Statistic	Value	Signif.	I(0)	I(1)
		Asymptotic: n=1000		
F-statistic	7.141539	10%	2.2	3.09
K	4	5%	2.56	3.49
		2.5%	2.88	3.87
		1%	3.29	4.37

Source: Author's own computation using Eview 12.

Table 4.4 indicates that there exists long-run relationship among the variables of the study. This because the F-statistics (7.141539) is greater than 5% upper and lower bound (3.49 and 2.56). Therefore, the researchers concluded that economic growth variables have long-run relationship with merchandized agricultural measures in Nigeria.

Long run ARDL Result

The ARDL result of the long run presented in table 4.5 below.

Table 4.5: ARDL long run result for the model.

Dependent Variable: RGDP

Levels Equation Case 2: Restricted Constant and No Trend				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOG(CIA)	0.738095	0.460702	1.602111	0.1256
LOG(LFA)	-0.022381	0.461451	-0.048501	0.9618
LOG(ACGS)	0.262098	0.061192	4.283231	0.0004
LOG(GFCF)	1.032539	0.422700	2.442720	0.0245
C	-3.777689	3.913177	-0.965376	0.3465
EC = LOG(RGDP) - (0.7381*LOG(CIA) -0.0224*LOG(LFA) + 0.2621 *LOG(ACGS) + 1.0325*LOG(GFCF) -3.7777)				

Source: Author's own computation using EViews 10.

The long-run ARDL result provides insights into the relationships between the explanatory variables and real gross domestic product (RGDP) in the model. The coefficients indicate the magnitude and direction of the relationship, while the p-values assess the significance of these relationships at a 5% significance level.

The coefficient of capital investment in agricultural outputs (CIA) is 0.7381, implying a positive relationship with RGDP. That mean that a 1% increase in CIA is associated with a 0.7381% increase in RGDP. However, the p-value of 0.1256 indicates that this relationship is not statistically significant at the 5% level, suggesting that capital investment in agriculture does not have a strong long-term effect on RGDP in this model.

The labor force in agriculture (LFA) has a coefficient of -0.0224, indicating a negative but negligible relationship with RGDP. This suggests that a 1% increase in the agricultural labour force results in a 0.0224% decrease in RGDP. However, the p-value of 0.9618 indicates that this relationship is not statistically significant, suggesting that the agricultural labour force does not meaningfully influence RGDP in the long run.

The agricultural credit guarantee scheme (ACGS) shows a positive and statistically significant relationship with RGDP, with a coefficient of 0.2621 and a p-value of 0.0004. This implies that a 1% increase in ACGS is associated with a 0.2621% increase in RGDP. The result highlights the critical role of credit guarantees in enhancing agricultural output and economic growth.

Gross fixed capital formation (GFCF) has a coefficient of 1.0325, indicating a strong positive relationship with RGDP implying that a 1% increase in GFCF leads to a 1.0325% increase in RGDP. With a p-value of 0.0245, this relationship is statistically significant, emphasizing the importance of infrastructure investment in driving long-term economic growth.

In summary, the long-run ARDL result indicates that ACGS and GFCF have statistically significant positive impacts on RGDP, underscoring their importance in promoting economic growth. In contrast, CIA and LFA show no significant long-term effects on RGDP, suggesting their limited contribution to economic output in the studied period. This underscores the need for targeted investments in infrastructure and financial support mechanisms to enhance economic performance.

ARDL-ECM short Run Result

The result of the Short Run ARDL is presented below in table 4.6 and the interpretation is given below.

Dependent Variable: RGDP

ECM Regression				
Case 2: Restricted Constant and No Trend				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
DLOG(RGDP(-1))	-0.344522	0.131903	-2.611932	0.0171
DLOG(RGDP(-2))	-0.243879	0.125475	-1.943656	0.0669
DLOG(CIA)	0.209344	0.042217	4.958751	0.0001
DLOG(CIA(-1))	-0.120149	0.040037	-3.000967	0.0073
DLOG(CIA(-2))	0.090180	0.041083	2.195055	0.0408
DLOG(LFA)	-1.109840	0.410409	-2.704229	0.0141
DLOG(LFA(-1))	-2.199982	0.431802	-5.094891	0.0001
DLOG(LFA(-2))	-0.856822	0.421656	-2.032040	0.0564
DLOG(LFA(-3))	-0.802065	0.438057	-1.830961	0.0828
DLOG(ACGS)	0.040234	0.012199	3.298083	0.0038
DLOG(GFCF)	0.215732	0.039104	5.516835	0.0000
DLOG(GFCF(-1))	-0.127298	0.030684	-4.148721	0.0005
DLOG(GFCF(-2))	-0.035078	0.028554	-1.228491	0.2343
DLOG(GFCF(-3))	-0.114076	0.025952	-4.395565	0.0003
CointEq(-1)*	-0.272827	0.037084	-7.356993	0.0000
R-squared	0.851694	Mean dependent var		0.040261
Adjusted R-squared	0.765183	S.D. dependent var		0.036316
S.E. of regression	0.017598	Akaike info criterion		-4.958357
Sum squared resid	0.007432	Schwarz criterion		-4.318525
Log likelihood	111.6880	Hannan-Quinn criter.		-4.728791
Durbin-Watson stat	2.329187			

Source: Author's own computation using EViews 10.

The short-run ARDL-ECM regression results provide insights into the dynamics of the relationship between the variables and real gross domestic product (RGDP) in the short term. The coefficient of the error correction term (CointEq(-1)) is -0.2728, and it is statistically significant with a p-value of 0.0000. This indicates that about 27.28% of the deviation from the long-run equilibrium is corrected in each period. The negative sign confirms the convergence of the model towards long-run equilibrium, suggesting that the short-run shocks to RGDP are gradually adjusted back to the equilibrium level.

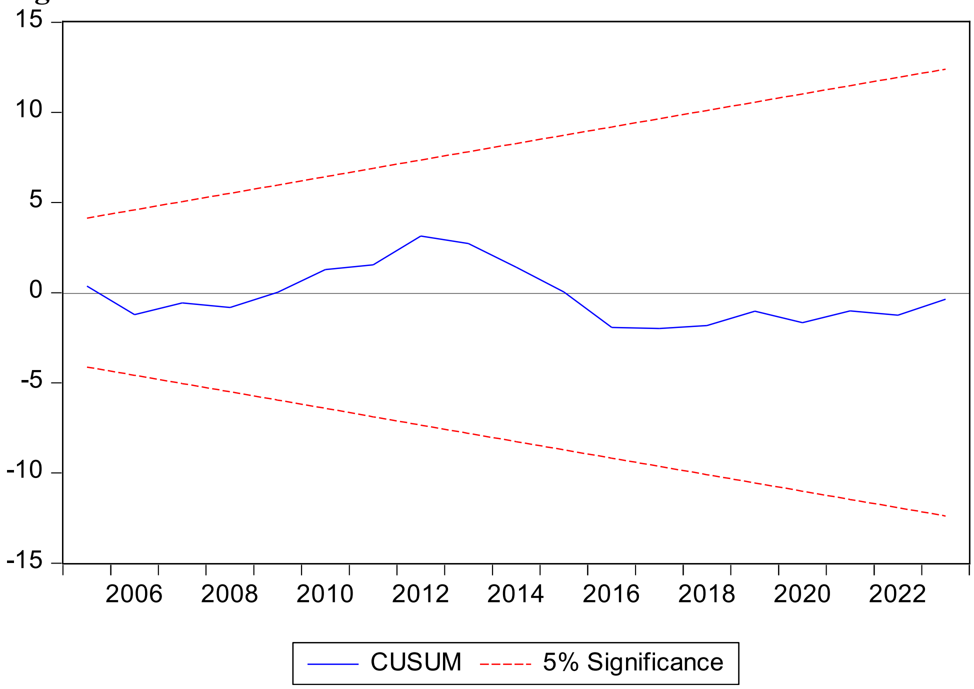
The R-squared value of 0.8517 signifies that approximately 85.17% of the variation in RGDP is explained by the independent variables in the short run. The adjusted R-squared value of 0.7652 reflects a slight adjustment for the number of predictors in the model, confirming a good fit and indicating that the model effectively captures the short-run dynamics. The Durbin-Watson statistic is 2.3292, which is close to the benchmark value of 2. This suggests that there is no significant autocorrelation in the residuals, ensuring the reliability of the model's estimates.

Economically, the results highlight that capital investment in agricultural outputs (CIA), gross fixed capital formation (GFCF), and the agricultural credit guarantee scheme (ACGS) positively influence RGDP in the short run, reflecting the importance of investment and financial support mechanisms for immediate economic output. Conversely, the labour force in agriculture (LFA) has a negative and statistically significant impact on RGDP in the short run, which may indicate inefficiencies or underemployment within the agricultural sector. The speed of adjustment confirms that while short-run fluctuations occur, the economy tends to revert to its long-term growth path. The high explanatory power and absence of autocorrelation validate the robustness of the model.

Stability Test

The CUSUM (Cumulative Sum) test in Figure 1 assesses the stability of the relationship between mechanized agriculture and the growth of the Nigerian economy over time. The CUSUM line shows the cumulative sum of the residuals from the regression model, with horizontal lines representing the 5% significance level bounds. Since the CUSUM line remains within these critical bounds, the test confirms the regression model's stability, indicating that the relationship between agricultural mechanization and economic growth in Nigeria was consistent from 1981 to 2023.

Figure 4.1 CUSUM test



5.0 Conclusion and Recommendations

The study investigates the effect of agricultural mechanization on the growth of the Nigerian economy, represented by real gross domestic product (RGDP). The results demonstrate the significant contributions of capital investment in agricultural outputs (CIA), the agricultural credit guarantee scheme (ACGS), and gross fixed capital formation (GFCF) to economic growth in both the short and long run. Specifically, the long-run ARDL results reveal that GFCF has the most significant positive impact on RGDP, emphasizing the importance of investments in durable goods and mechanization to sustain agricultural productivity and economic growth. ACGS also contributes significantly, underscoring the role of financial support in promoting agricultural activities. However, the labour force in agriculture (LFA) shows an insignificant and negative relationship with RGDP in both the short and long run, indicating inefficiencies in labour utilization due to the limited adoption of mechanized tools or outdated practices.

In the short run, the error correction term is significant, confirming a 27.28% speed of adjustment to long-run equilibrium following short-term shocks. The positive impact of CIA, GFCF, and ACGS on RGDP in the short term reflects the immediate benefits of agricultural mechanization and capital investment in enhancing productivity. The high R-squared value of 85.17% and the Durbin-Watson statistic close to 2 confirm the robustness of the model. Overall, the findings explain the transformative role of mechanization, financial investment, and capital formation in achieving sustainable economic growth, while also identifying the inefficiency in labour-intensive agricultural practices.

Based on the findings the following recommendations were made for policy formulations

i. The Nigerian government should prioritize increasing capital investments in agriculture by promoting mechanization and advanced technology adoption. Subsidized access to modern farming tools and mechanized equipment can enhance productivity and reduce labour inefficiencies.
ii. Policies should strengthen the Agricultural Credit Guarantee Scheme (ACGS) to expand its reach and ensure adequate funding for small- and large-scale farmers. This would stimulate agricultural activities, improve rural incomes, and boost economic growth.
iii. Reforms in the agricultural labour force are necessary. Vocational training and skills development programs tailored to modern agricultural practices should be implemented to improve efficiency and productivity, transitioning from labour-intensive to mechanized systems.
iv. Finally, gross fixed capital formation must remain a focus of agricultural policy. Investments in durable infrastructure, such as irrigation systems, storage facilities, and transportation networks, are critical to reducing post-harvest losses and enhancing agricultural output, leading to broader economic growth.

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