

The Impact of Agricultural Modernization on Socio-Economic Growth in Nigeria

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ABSTRACT

Agriculture remains a central pillar of Nigeria's economy, yet its productivity continues to lag behind that of global competitors due to structural bottlenecks, reliance on traditional farming techniques, and inadequate technological adoption. This paper provides a critical examination of how agricultural modernization affects socio-economic growth in Nigeria. The study uses time series data covering the period 1990 to 2022. Per Capita Income (PCI) is used as the dependent variable, while the Agricultural Machinery Import (AMI), government expenditure on farm mechanization (GEM), and exchange rate (EXR) serve as the independent variables. Tests conducted include descriptive statistics, stationary tests, integration tests, and ARDL regression analysis. The result found a positive and significant relationship between PCI and AMI and GEM, while there is a negative but significant relationship between PCI and exchange rate over the period. The study concluded that agricultural mechanization has the potential to improve the PCI of the people and therefore recommends that more focus should be given to agricultural mechanization as it improves the overall well-being of the people through increases in per capita income.

INTRODUCTION

The rapid growth of populations across many countries, combined with a decline in the carrying capacity of agricultural land, has intensified the demand for strategies that can boost farm output and ensure food security, as pointed out by Abate et al. (2023). One of the most prominent approaches has been the promotion of modern agricultural practices among farmers. In Nigeria, recognizing the centrality of agriculture to national development, the government has launched many plans targeted at modernizing agriculture in Nigeria over the years.

According to Etuk & Ayuk (2021), agricultural modernization forms a key component of global modernization, involving a transition from traditional, subsistence-oriented agriculture to market-driven agriculture, and eventually to advanced, knowledge-based agricultural systems. Similarly, Ghosh et al. (2008), as cited in Masoud and Asghar (2011), describe agricultural modernization as a process characterized by increasing farmer awareness, attitudinal change, and the provision of conducive conditions that encourage adoption of improved technologies. The core features of agricultural modernization include hybridization, mechanization, the use of fertilizers and pesticides, and the expansion of large-scale, intensive farming systems (Etuk & Ayuk, 2021). Hybridization involves crossing genetically distinct plants to produce new varieties with desirable traits (Alemu & Tripp, 2010). Mechanization introduces higher capital intensity, while chemicalization refers to the adoption of practices that enhance the efficient use of fertilizers and pesticides to achieve higher yields (Otchia, 2014; Zhang et al., 2022).

Villar (2000) further explains that modernizing the agricultural sector entails transforming it into a dynamic, technologically advanced, and competitive system. This transformation is reflected in continuous improvements in agricultural efficiency, increased farmer incomes, enhanced socio-economic welfare, stable supply-demand dynamics for agricultural products, and strengthened national food security.

The drivers of agricultural modernization are multifaceted, according to Giller et al. (2021). They include the need to raise labor productivity and profitability, strengthen food security, improve overall agricultural performance, create employment opportunities, reduce unit production costs to remain competitive, and support the development of agro-industrial value chains (Huang et al., 2024). Achieving these goals requires the development, dissemination, and adoption of yield-enhancing technologies, particularly among smallholder farmers.

Given its substantial contribution to incomes and livelihoods, especially in developing countries where agriculture remains the backbone of rural employment, agricultural growth is widely regarded as one of the most effective pathways to poverty reduction. Nearly 75% of the global poor, living on less than one dollar per day, depend on agriculture, and projections indicate that more than 60% of the poor will remain in rural areas through 2040 (Mukhtar & Saleh, 2025). As Olatunji et al. (2022) aptly state, the long-term success of economic

development efforts will ultimately be determined by what happens in the agricultural sector.

Agriculture has historically been the backbone of the Nigerian economy, contributing significantly to employment, food security, and rural livelihoods (Olatunji et al., 2022). Despite this, its contribution to GDP has declined relative to the services and oil sectors due to inadequate modernization and structural neglect (Omotoso et al., 2023). Nigeria's agricultural sector is dominated by smallholder farmers who rely on rain-fed, low-input, and labor-intensive practices, according to Smidt and Jokonya (2022). These limitations result in low yields, post-harvest losses, poor value chain development, and a widening food import bill estimated at billions of dollars annually.

Udo et al. (2024) note that in the context of global food insecurity, population growth, and rising technological innovations, agricultural modernization has emerged as a critical pathway to transform the sector. Modernization encompasses mechanization, biotechnology, digital agriculture, improved seeds, irrigation systems, value-chain integration, and better institutional frameworks. The central question addressed in this paper is, to what extent does agricultural modernization impact socio-economic growth in Nigeria?

Specifically, the study will examine the impact of agricultural machinery import (AMI) on the per capita income in Nigeria, evaluate the impact of government expenditure on farm mechanization (GEM) on the per capita income, and analyze the impact of exchange rate on per capita income in Nigeria over the period.

LITERATURE REVIEW

Conceptual Framework

This study posits that agricultural mechanization enhances economic performance. Agricultural machinery imports and government expenditure on farm mechanization are expected to raise productivity, stimulate agricultural output, and improve per capita income. Conversely, inflation may distort investment incentives and weaken income growth. The framework links mechanization inputs and macroeconomic stability to income outcomes.

Theoretical Review

Agricultural Transformation Theory

This theory argues that modernization is central to shifting agriculture from subsistence to commercial and industrial productivity. It involves technological adoption, market integration, and institutional reforms (Uyeh et al., 2023).

Endogenous Growth Theory

Yang (2023) emphasizes innovation, human capital, and technological change as key drivers of long-term growth. Agricultural modernization contributes through innovations that increase productivity and spill over into other sectors.

Structural Change Theory

Lewis' dual-sector model explains how labor shifts from low-productivity agriculture to high-productivity industries (Yaqoob et al., 2023). Modern agriculture releases surplus labor and produces raw materials for industrialization.

Relevance to Nigeria

Nigeria remains trapped in a traditional agricultural structure; modernization is a key determinant for driving structural change and diversifying the economy away from oil dependence (Omotoso et al., 2023).

Empirical Literature Review

Etuk and Ayuk (2021) evaluated the impact of the Commercial Agricultural Development Project (CADP) in Nigeria on poverty reduction and agricultural commercialization using a counterfactual research design. Drawing on survey data from 1,199 households, comprising 678 beneficiaries and 521 non-beneficiaries, they applied propensity score matching (PSM) to obtain 1,142 comparable observations (655 beneficiaries and 487 non-beneficiaries). Analytical techniques included descriptive statistics, Foster-Greer-Thorbecke (FGT) poverty measures, Average Treatment Effect on the Treated (ATT), and the Poverty Equivalent Growth Rate (PEGR). Their findings reveal significantly lower FGT poverty indices among beneficiaries compared to non-beneficiaries. Participation in the CADP increased beneficiaries' income by ₦446,073.89 (US\$1,239.09), indicating substantial welfare gains. The program also significantly increased beneficiaries' commercialization index. However, PEGR results showed that while non-beneficiaries experienced pro-poor growth, CADP beneficiaries did not, suggesting the project was not pro-poor despite reducing participants' poverty levels. The authors emphasize the need for better targeting of the poor in future agricultural interventions.

Mukhtar and Saleh (2025) investigated the role of agricultural revitalization in promoting economic growth and sustainable development in Nigeria using secondary data. Their review highlights the long-term neglect of agriculture since the rise of the petroleum sector in the 1960s and argues that this shift contributed to macroeconomic instability, including recession, inflation, currency devaluation, rising poverty, and unemployment. The study concludes that Nigeria's sustainable development is strongly tied to a revitalized agricultural sector, given agriculture's crucial role in food production, raw material supply, local market support, and foreign exchange generation. The authors recommend enhanced support for small-scale farmers and modernization of agricultural practices across production scales as fundamental to economic diversification.

Olatunji et al. (2022) examined the effect of agricultural mechanization on agricultural production in Lagos State, where modern technologies are widely adopted. Using a structured questionnaire and a five-point rating scale, data were analyzed through descriptive statistics and chi-square tests at a 0.05 significance level. Results indicate that mechanization substantially increased cultivated land area, crop yield, and farmers' income, with cumulative means of

2.34, 1.07, and 1.44, respectively. Mechanization was also influenced by socioeconomic characteristics, technology availability, and government policies. All six hypotheses tested were significant, as chi-square values far exceeded critical thresholds. The study concludes that mechanization positively impacts crop production and farmer income, underscoring the need for improved technology access and policy support to enhance mechanization sustainability. Udo et al. (2024) explored the relationship between women's participation in agriculture and socio-economic development in Akwa Ibom State, Nigeria. Using a combination of survey (475 respondents), historical, and descriptive methods, and guided by the dualism theory of modernization, the study demonstrates that women make substantial contributions to employment generation, household income, agro-processing, marketing, and industrial raw material supply. Despite these contributions, women face persistent challenges such as gender disparities, limited access to land and credit, inadequate infrastructure, and constrained productive resources. The authors recommend reforms including improved access to land, increased agricultural budgeting, enhanced research and development investment, and better information dissemination to support women agro-entrepreneurs.

Yang (2023) analyzed agricultural modernization and its relationship with carbon emissions across 30 Chinese provinces from 2010 to 2019, excluding Hong Kong, Macao, Taiwan, and Tibet. Agricultural modernization was decomposed into production, management, and ecological dimensions. Using a spatial Durbin model, the study found strong spatial dependence in agricultural carbon emissions, indicating that modernization levels and transportation development in one province significantly influence emissions in neighboring regions. The findings reveal differentiated direct and spillover effects across eastern, central, and western China. Under the context of rural revitalization and low-carbon agricultural policies, the study recommends region-specific modernization strategies to optimize the spatial distribution of agricultural carbon emissions.

METHODOLOGY

Research Design

This study adopts an **observational research design**, which is suitable for examining causal relationships among variables without random assignment of subjects into treatment and control groups. Unlike true experimental designs that rely on randomization, observational designs are preferred where random assignment is impractical or ethically constrained. This approach allows for the analysis of real-world economic relationships while maintaining analytical control over the variables (Eng et al., 2022).

Model Specification

The functional relationship for the study is expressed as:

$$PCI = f(AMI, EXR, GEM) \dots \dots \dots equ(1)$$

The functional equation above will be stated econometrically as

$$PCI = \beta_0 + \beta_1 AMI_t - \beta_2 EXR_t + \beta_4 GEM_t + \varepsilon_t \quad equ(2)$$

PCI = Per capita income (dependent variable)

AMI = Agricultural Machinery Import

GEM = Government Expenditure on Farm Mechanisation

EXR = Exchange rate

β = Constant term

Where:

- PCI = Per capita income (dependent variable)
- AMI = Agricultural Machinery Import
- GEM = Government Expenditure on Farm Mechanisation
- EXR = Exchange Rate
- β_0 = Constant term
- β_1 - β_3 = Parameter estimates
- ε_t = Error term

Estimation Procedure

ARDL Bounds Testing Approach

The Autoregressive Distributed Lag (ARDL) bounds testing technique developed by Pesaran et al. (2001) is employed to examine the existence of a long-run equilibrium relationship among the variables. The ARDL approach is suitable when the variables are integrated of mixed orders, I(0) and I(1), but not I(2).

Pre-Estimation Tests

To avoid spurious regression results, unit root tests are conducted on all variables to ascertain their orders of integration. The **Augmented Dickey-Fuller (ADF)** and **Phillips-Perron (PP)** tests are applied. The null hypothesis of these tests is the presence of a unit root (random walk). If the variables are found to be stationary at level or first difference, the ARDL technique becomes appropriate (Amaefula, 2021). Where necessary, cointegration tests are then conducted.

Sources of Data

This study relies exclusively on **secondary data** obtained from publications of the **Central Bank of Nigeria (CBN, 2023)** and the **National Bureau of Statistics (NBS, 2024)**. The data cover the period **1990-2023**.

RESEARCH RESULT

Descriptive Statistics

	LOG_PCI_	LOG_INF_	LOG_GEM_	LOG_EXR_
Mean	9.380403	2.647081	2.922566	2.958027
Median	10.05372	2.542080	2.883308	3.087930
Maximum	10.82824	4.288204	3.454738	4.056643
Minimum	6.048927	1.684176	2.440879	0.254642
Std. Dev.	1.333868	0.641813	0.195191	0.879205
Skewness	-1.093993	1.129214	0.341263	-1.349072
Kurtosis	3.106498	3.715948	3.987149	4.910533

Jarque-Bera	6.398168	7.484102	1.920408	13.66265
Probability	0.140800	0.123705	0.382815	0.001079
Sum	300.1729	84.70661	93.52211	88.74080
Sum Sq. Dev.	55.07266	12.76965	1.181088	22.41704

Observations 33 33 33 33

Source: Author's computation using Eviews (2025)

Descriptive statistics summarize the key characteristics of the dataset and provide a preliminary basis for assessing its suitability for further analysis (George, 2018). The results indicate that the variables are generally normally distributed, as reflected in the probabilities of their Jarque-Bera statistics. The distributions exhibit slight left skewness, while the kurtosis values reveal that PCI, INF, AMI, and GEM are mesokurtic (moderate peakedness), whereas EXR is leptokurtic with a kurtosis value exceeding three. This suggests that, except for EXR, the variables are largely free from extreme outliers and closely approximate normality, thus supporting their suitability for empirical analysis.

Unit Root Analysis

Unit root tests are statistical procedures employed to determine whether a time series is stationary or contains a unit root, which implies non-stationarity (Yilanci & Pata, 2020). The presence of a unit root indicates that the series may exhibit long-term stochastic trends or follow a random walk. Non-stationary time series pose serious challenges in econometric analysis because their means and variances change over time, making reliable inference difficult (Nishi & Kurozumi, 2023). Consequently, unit root tests are essential for verifying the stationarity of the data and ensuring the validity of subsequent econometric estimates.

Variables	At levels (Prob)	First difference (Prob)	Comments
LOG_PCI_	0.1250	0.0048	I(0) Stationary at levels
Log_INF_	0.1429	0.0010	I(1) Stationary at first difference
LOG_GEM_	0.0017	0.0000	I(1) Stationary at first difference
Log_EXR_	0.2200	0.0021	I(1) Stationary at first difference
LOG_AMI_	0.2200	0.0021	I(1) Stationary at first difference

Source: Author's computation (2025)

The unit root test results reveal that the variables are stationary at a mixture of levels and first differences. This combination of integration orders justifies the application of the Autoregressive Distributed Lag (ARDL) modelling technique. This finding is consistent with Rehman et al. (2020), who also adopted the ARDL approach upon establishing mixed orders of integration in their unit root analysis.

Bounds Test for Cointegration

The bounds test for Cointegration tests for long term relationship between the dependent and the independent variables used in the study (Rehman et al, 2020).

F-Bounds Test		Null Hypothesis: No levels relationship		
Test Statistic	Value	Signif.	I(0)	I(1)
			Asymptotic: n=1000	
F-statistic	7.78444	10%	2.62	4.01
k	1	5%	3.11	4.52
		2.5%	3.12	5.21
		1%	4.91	5.38

Source: *Eviews*, 2025

The ARDL bounds test for cointegration indicates the existence of a long-run equilibrium relationship among the variables in all estimated models. At the 5% level of significance, the computed F-statistics exceed the corresponding upper critical bounds, confirming the presence of cointegration. This implies that the variables move together in the long run despite possible short-run fluctuations.

ARDL ECM Tests

ECM Regression

Case 5: Unrestricted Constant and Unrestricted Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	3.303465	1.489058	2.218493	0.0198
@TREND	-0.006789	0.906595	-0.074884	0.6540
D(LOG_AMI_(-1))	1.733640	0.776501	-2.232630	0.0000
D(LOG_GEM_(-1))	2.372393	0.179011	2.012189	0.0000
D(LOG_EXR_(-1))	-4.789913	2.372223	-2.019166	0.0000
CointEq(-1)*	-0.178239	0.081623	-2.183685	0.0000
R-squared	0.728661	Mean dependent var		0.122236
Adjusted R-squared	0.660225	S.D. dependent var		0.316059
S.E. of regression	0.252798	Akaike info criterion		0.253121
Sum squared resid	1.405946	Schwarz criterion		0.493091
Log likelihood	1.582870	Hannan-Quinn criter.		0.334476
F-statistic	4.660258	Durbin-Watson stat		1.865558
Prob(F-statistic)	0.007071			

Source: *Author's computation using Eviews (2025)*

The ARDL error correction model (ECM) estimates reveal both the short-run and long-run relationships between the dependent and independent variables. The coefficient of determination (R^2) is 72.9%, indicating that approximately 72.9% of the variations in the dependent variable are explained by the explanatory variables included in the model. The F-statistic further confirms that the model is jointly significant, demonstrating its overall reliability. The coefficient of the error correction term is -17.8%, implying a speed of adjustment of 17.8% annually toward long-run equilibrium following short-run disequilibrium.

Serial Correlation Tests

Breusch-Godfrey Serial Correlation LM Test:

F-statistic	2.001220	Prob. F(2,33)	0.1512
Obs*R-squared	4.434844	Prob. Chi-Square(2)	0.1089

Source: Author's computation using Eviews (2025)

The serial correlation test examines whether the current values of a variable are influenced by its past values. The presence of serial correlation can lead to biased estimates and spurious regression results, thereby undermining predictive reliability (Schork, 2022). The test results show that the probability values of the F-statistics exceed 0.05, indicating the absence of serial correlation in the model.

Heteroskedasticity Tests

F-statistic	8.770465	Prob. F(7,24)	0.4670
Obs*R-squared	23.00632	Prob. Chi-Square(7)	0.3317
Scaled explained SS	32.55961	Prob. Chi-Square(7)	0.5770

Source: Author's computation using Eviews (2025)

The heteroskedasticity test assesses whether the variance of the error term remains constant over time. One of the key assumptions of classical regression is homoskedasticity; violations of this assumption can lead to inefficient and biased estimates (Daryanto, 2020). The results reveal that the probabilities of the F-statistics are greater than 0.05, suggesting that the residuals are homoskedastic and that the model satisfies this critical diagnostic condition.

Tests of Hypotheses

Hypothesis One (H_{01}):

There is no significant relationship between PCI and GEM.

The results indicate a positive and statistically significant relationship between PCI and GEM. Specifically, a one-unit increase in GEM leads to an increase of 2.372393 units in PCI. The probability value of the t-statistic (0.0000) confirms the statistical significance of GEM. Consequently, the null hypothesis is rejected, and the alternative hypothesis is accepted, implying a significant relationship between GEM and PCI over the study period.

Hypothesis Two (H_{02}):

There is no significant relationship between PCI and EXR.

The results reveal a negative and statistically significant relationship between PCI and EXR. A one-unit increase in EXR leads to a decrease of 4.789913 units in PCI. The associated probability value is less than 0.05, indicating statistical significance. Hence, the null hypothesis is rejected, and the alternative hypothesis is accepted.

Hypothesis Three (H_{03}):

There is no significant relationship between PCI and AMI.

The results show that AMI exert a significant influence on PCI. Specifically, a one percentage unit increase in AMI leads to changes in PCI by 1.733640 percentage units. The probability value of the t-statistics (0.0000) confirms the statistical significance. The null hypothesis is therefore rejected in favour of the alternative, indicating a significant relationship between PCI and AMI over the period studied.

DISCUSSION

The results of the analysis indicate significant relationships between PCI and economic indicators such as agricultural machineries, government mechanization expenditures on agriculture (GEM), and Exchange Rate (EXR). The positive and significant relationship suggests that as GEM, EXR, and AMI increase, PCI also rises and vice versa. This implies that agricultural mechanisation, exchange rate fluctuations, and government mechanization expenditure influence PCI performance over the period. The findings align with existing studies such as Etuk and Ayuk (2021) and Mukhtar and Saleh (2025) that highlight the impact of agricultural mechanization and socio-economic growth of Nigeria over the period.

In summary, the findings underscore the need for policymakers to adopt measures that enhance socio-economic growth and stability, promote investment in the agricultural sector, and ensure a favorable business environment to sustain favorable agricultural policies.

CONCLUSIONS AND RECOMMENDATIONS

Agricultural modernization is a critical determinant of socio-economic growth in Nigeria. Modernizing the sector enhances productivity, stimulates employment, drives industrialization, reduces poverty, strengthens food security, and improves the trade balance. While Nigeria possesses vast agricultural potential, the absence of sustained modernization continues to limit its growth trajectory. To achieve inclusive development and long-term economic transformation, Nigeria must adopt a coherent modernization strategy that integrates finance, technology, infrastructure, and institutional reforms. With the right policy and investment framework, agriculture can become the engine of socio-economic transformation capable of lifting millions out of poverty and positioning Nigeria as a regional agricultural powerhouse.

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