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Technology in Agricultural Transformation and Food Security: A Panacea for National Development

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Abstract

This study examined the impact of technology in agricultural transformation and food security on national development in Nigeria, with national development proxied by the poverty rate (POV) as the dependent variable. Specifically, the study investigated the effects of agricultural Information and Communication Technology ICT adoption (AGRICT), agricultural gross domestic product (AGRGDP), fertiliser application (FERTAPPL), nutritional adequacy (NUTADE), and food accessibility on poverty reduction (ACCESS). It was anchored on the Diffusion of Innovation Theory and the Sustainable Livelihoods Framework, which explain how technological innovation enhances agricultural productivity, food security, and socioeconomic welfare. An ex post facto research design was adopted using annual time-series data obtained from secondary sources, including the World Development Indicators (World Bank), the Food and Agriculture Organization (FAO), and the National Bureau of Statistics (NBS). Data were analysed using descriptive statistics, unit root tests, cointegration analysis, and the Autoregressive Distributed Lag (ARDL) model to determine both the short-run and long-run relationships among the variables. The findings revealed that agricultural GDP, fertiliser application, nutritional adequacy, and food accessibility had positive *and statistically significant effects on national development, indicating that improvements in agricultural productivity and food security are critical drivers of economic welfare and poverty reduction in Nigeria. In contrast, agricultural ICT adoption exerted a negative but statistically insignificant effect on the poverty rate, suggesting that although increased ICT adoption tends to reduce poverty, its impact has not been sufficiently strong to produce significant national development outcomes during the study period. The study concluded that technology remains an indispensable catalyst for agricultural transformation and food security, but its effectiveness depends on complementary investments in infrastructure, human capital, agricultural financing, and supportive government policies. Accordingly, the study recommended that the government should pursue integrated strategies that combine ICT expansion with investments in rural infrastructure, agricultural financing, human capital development, and market reforms. Such a comprehensive approach is more likely to improve food security, reduce poverty, and promote sustainable national development. These measures will enhance agricultural productivity, improve food security, reduce poverty, and accelerate sustainable national development in Nigeria.*

Keywords: agricultural technology, ICT adoption, agricultural transformation, food security, agricultural GDP, fertiliser application, nutritional adequacy, food accessibility, poverty rate, national development, Nigeria

1.1 Introduction

Agriculture has historically remained one of the most important sectors of the Nigerian economy, contributing significantly to employment generation, poverty reduction, food production, rural development, and national economic growth. Despite the discovery of crude oil in the 1970s, agriculture continues to provide livelihoods for a large proportion of the Nigerian population, especially those residing in rural communities. According to the Food and Agriculture Organisation (FAO), agriculture remains fundamental to achieving sustainable development because it directly influences food availability, income generation, environmental sustainability, and economic resilience (FAO, 2023). However, the sector has experienced persistent productivity challenges resulting from inadequate mechanisation, poor access to improved inputs, climate change, insecurity, poor extension services, and limited adoption of modern agricultural technologies (World Bank, 2023).

Globally, agriculture is undergoing unprecedented technological transformation, often referred to as Agriculture 4.0 or smart agriculture. This transformation is characterised by the application of precision farming, artificial intelligence (AI), geographic information systems (GIS), remote sensing, drones, Internet of Things (IoT), blockchain technology, biotechnology, improved seed varieties, digital extension platforms, mobile applications, climate-smart agriculture, and automated irrigation systems to improve agricultural productivity and sustainability (Gyamfi et al., 2024). These innovations have significantly increased farm efficiency, minimised production costs, reduced post-harvest losses, improved resource utilisation, and enhanced food production in both developed and emerging economies (Ayim et al., 2020).

The current global trend indicates that countries investing heavily in agricultural technology are achieving remarkable improvements in food security and economic development. Nations such as the Netherlands, Israel, China, Brazil, and India have successfully transformed their agricultural sectors through digital technologies, mechanisation, biotechnology, and precision agriculture, thereby increasing crop yields, improving export earnings, and strengthening national food systems (FAO, 2023). The World Bank has also emphasised that digital agriculture is becoming an indispensable strategy for addressing food insecurity, climate variability, and rural poverty in developing countries (World Bank, 2023). These developments demonstrate that technology has become the driving force behind agricultural competitiveness in the twenty-first century.

Nigeria possesses enormous agricultural potential, with over 70 million hectares of agricultural land, favourable climatic conditions, abundant water resources, and a youthful labour force. However, the country continues to experience declining agricultural productivity and rising food insecurity. Despite agriculture's significant contribution to national employment and non-oil economic activities, food production has not kept pace with rapid population growth, urbanisation, and changing consumption patterns (FAO, 2023). Consequently, Nigeria has increasingly depended on food imports despite its vast agricultural resources.

Nigeria's agricultural sector is the paradox of abundant agricultural resources coexisting with persistent food insecurity. While agriculture remains one of the country's largest employers, productivity per hectare remains considerably lower than global averages because production is dominated by smallholder farmers using traditional farming methods with minimal mechanisation and limited access to modern technologies (Nano, 2023). Another observable pattern is the widening gap between food demand and domestic food supply, leading to rising food prices, inflation, malnutrition, and increased dependence on imported food products. Recent evidence also indicates that climate change, insecurity in major food-producing regions, and post-harvest losses continue to undermine agricultural productivity and national food availability.

The trajectory of agricultural transformation in Nigeria has evolved through several policy regimes. Following independence, agriculture served as the backbone of the Nigerian economy through the production of cocoa, groundnuts, palm oil, cotton, and rubber. However, the oil boom of the 1970s shifted government attention away from agriculture, resulting in declining investment and reduced productivity. To reverse this trend, successive governments introduced several agricultural development initiatives, including Operation Feed the Nation (1976), the Green Revolution Programme (1980), the Directorate of Food, Roads and Rural Infrastructure (DFRRI), the National Fadama Development Projects, the Agricultural Transformation Agenda (ATA), and the Agricultural Promotion Policy (APP). More recently, digital agriculture, climate-smart agriculture, value-chain development, and mechanisation have become central components of Nigeria's agricultural transformation strategy (Federal Ministry of Agriculture and Rural Development, 2016; World Bank, 2023).

Recently, the Nigerian government and development partners have intensified efforts to promote technology-driven agricultural transformation. Investments have focused on digital extension services, improved irrigation systems, climate-resilient seed varieties, mechanisation, digital farmer registries, precision agriculture, and agricultural value chain modernisation. The World Bank has identified technology adoption, improved research and extension systems, digital advisory services, improved seeds, and stronger value chains as essential for improving productivity, reducing poverty, and strengthening food security in Nigeria.

Another notable trend is the increasing adoption of mobile technology in Nigerian agriculture. Mobile applications now enable farmers to obtain weather forecasts, market prices, financial services, pest management information, and extension support. Digital financial platforms are also improving access to agricultural credit, insurance, and input markets. These innovations have reduced information asymmetry and improved decision-making among farmers, particularly smallholders (Ayim et al., 2020). Furthermore, evidence suggests that improvements in farmers' technical efficiency through technology adoption significantly reduce moderate and severe food insecurity, highlighting the importance of technological innovation in agricultural development (Nano, 2023).

Despite these encouraging developments, technology adoption in Nigerian agriculture remains relatively low compared with global standards. Constraints such as inadequate infrastructure, poor rural electrification, limited broadband connectivity, high cost of agricultural machinery, weak research-extension linkages, inadequate funding, poor access to finance, digital illiteracy, and insecurity continue to hinder widespread technological adoption (Ayim et al., 2020). Smallholder farmers, who account for the majority of domestic food production, often lack the financial capacity and technical knowledge required to adopt modern agricultural technologies effectively.

Food security remains one of Nigeria's most pressing development challenges. Food security exists when all people, at all times, have physical, social, and economic access to sufficient, safe, and nutritious food that meets their dietary needs for an active and healthy life (FAO, 2023). However, Nigeria continues to experience rising food inflation, declining purchasing power, increasing malnutrition, and periodic food shortages driven by insecurity, climate change, population growth, and weak agricultural productivity. These challenges underscore the urgent need to accelerate agricultural transformation through technology-driven interventions that improve productivity, reduce production risks, strengthen value chains, and enhance market access.

The relationship between technology in agriculture, food security, and national development is multidimensional. Increased adoption of modern technologies enhances crop and livestock productivity; improves resource-use efficiency; minimises post-harvest losses; increases farmers' incomes; creates employment opportunities; strengthens agro-industrial development; reduces food imports; stabilises food prices; and contributes to overall economic growth. A productive agricultural sector also supports industrialisation through raw material supply while promoting rural transformation and poverty reduction. Consequently, agricultural technology serves as a catalyst for achieving several Sustainable Development Goals (SDGs), particularly SDG 1 (No Poverty), SDG 2 (Zero Hunger), SDG 8 (Decent Work and Economic Growth), and SDG 9 (Industry, Innovation and Infrastructure).

In view of Nigeria's growing population, rising food demand, and increasing vulnerability to climate change and economic shocks, transforming agriculture through technological innovation has become both an economic necessity and a national development imperative. Strengthening investments in agricultural research, digital technologies, mechanisation, irrigation, biotechnology, climate-smart agriculture, and farmer education can significantly improve food production, enhance national food security, stimulate economic diversification, and accelerate sustainable national development. Therefore, this study seeks to examine the role of technology in agricultural transformation and food security as a panacea for national development in Nigeria and will seek to answer the question: does technology in agriculture bring about food security and national development?

1.2 Objective of the study

The main objective of this study is to examine how technology in agriculture contributes to national development through food security in Nigeria. The specific objectives are:

i. to examine the impact of agricultural GDP, fertiliser application, agriculture ICT, nutritional adequacy of food security and accessibility to food security on national development in Nigeria.

ii. to proffer policy recommendations on the challenges of technology in agriculture and food security in national development.

1.3 Research Hypothesis

The study seeks to test this hypothesis stated in null form:

H_{01}: Agricultural GDP, fertiliser application, agriculture ICT, nutritional adequacy and accessibility do not have significantly influence on national development in Nigeria

2.0 Literature Review

2.1 Conceptual Framework

2.1.1 The Concept of National Development

National development refers to the overall improvement of a nation's economic, political, social, technological, and cultural systems with the aim of enhancing the quality of life of its citizens. It is a multidimensional process that involves sustainable economic growth, good governance, human capital development, infrastructure, social justice, national unity, and environmental sustainability. National development is achieved when the resources of a country are effectively utilised to improve the welfare and living standards of the people (Idike et al., 2020). In the Nigerian context, national development goes beyond economic growth. It includes reducing poverty and unemployment, improving education and healthcare, strengthening democratic institutions, ensuring security, promoting social inclusion, and providing essential infrastructure such as roads, electricity, and water supply.

The Federal Ministry of Budget and Economic Planning identifies inclusive economic growth, human capital development, infrastructure, and institutional strengthening as key pillars of Nigeria's national development agenda. Scholars argue that national development is reflected in the progressive transformation of a nation's social, political, and economic structures from less efficient to more efficient systems. It also involves promoting national integration, political stability, economic prosperity, and citizens' participation in governance (Obasi, as cited in Bamgbose, 2022).

Despite Nigeria's abundant natural and human resources, national development has been constrained by challenges such as corruption, insecurity, poor governance, inadequate infrastructure, unemployment, and policy inconsistency. Addressing these challenges through transparent leadership, effective institutions, quality education, and sustainable economic policies is essential for achieving meaningful national development.

2.1.2 The Concept of Technology in Agriculture in Nigeria:

Technology in agriculture refers to the application of scientific knowledge, innovations, skills, tools, machines, equipment, and modern techniques to improve agricultural production, processing, storage, marketing, and distribution. It encompasses both physical technologies, such as tractors, irrigation systems, improved seed varieties, fertilisers, drones, and harvesters, and knowledge-based technologies, including improved farm management practices, digital advisory services, and extension education. The primary goal of agricultural technology is to increase productivity, improve efficiency, reduce production costs, enhance food security, and promote sustainable agricultural development.

According to the FAO (2024), technology in agriculture is the application of science and knowledge to develop products, services, and techniques that improve the sustainability, productivity, resilience, and efficiency of agrifood systems. The FAO emphasises that technology alone is insufficient; its successful deployment depends on supportive policies, institutions, investment, and human capacity development.

In Nigeria, agricultural technology has evolved from traditional farming methods to the adoption of modern technologies aimed at improving productivity and food security. These technologies include mechanisation (tractors, planters, and harvesters), improved crop varieties, irrigation facilities, precision agriculture, biotechnology, information and communication technologies (ICTs), mobile-based advisory services, remote sensing, Geographic Information Systems (GIS), artificial intelligence (AI), and climate-smart agricultural practices. The integration of these technologies is intended to address persistent challenges such as low productivity, post-harvest losses, climate change, labour shortages, and poor market access.

The National Open University of Nigeria defines agricultural technology as the practical application of knowledge to improve agricultural production and farmers' livelihoods. It classifies agricultural technology into two broad categories: material technology, which includes machinery, improved seeds, agrochemicals, and livestock breeds, and knowledge-based technology, which includes management skills, integrated pest management, soil conservation techniques, and improved production practices. Both forms of technology are essential for increasing farm productivity and achieving sustainable agricultural development.

Agricultural technology in Nigeria also involves digital transformation through e-agriculture. E-agriculture integrates information and communication technologies into agricultural production and value chains by providing farmers with weather forecasts, market information, extension services, mobile banking, pest and disease alerts, and precision farming recommendations. These innovations enable farmers to make informed decisions, improve productivity, reduce production risks, and strengthen food security. However, adoption remains constrained by inadequate digital infrastructure, poor internet connectivity, limited technical knowledge, and insufficient access to finance.

Furthermore, technology in agriculture is increasingly recognised as a critical driver of Nigeria's agricultural transformation agenda. Modern technologies facilitate efficient resource utilisation, improve crop and livestock productivity, reduce post-harvest losses, increase farmers' incomes, create employment opportunities, and contribute significantly to economic growth and national development. Despite these benefits, widespread adoption requires sustained government investment in agricultural research, rural infrastructure, extension services, digital connectivity, and farmer education.

2.1.3 The Concept of Food Security in Nigeria

Food security in Nigeria refers to a situation where all people, at all times, have physical, social, and economic access to sufficient, safe, and nutritious food that meets their dietary needs and food preferences for an active and healthy life. It is an important aspect of national development because adequate food is essential for good health, productivity, and economic growth. Food security is built on four main pillars: Food Availability – Ensuring that enough food is produced locally or imported to meet the needs of the population. Food Access – Ensuring that individuals and households have the financial means and physical ability to obtain adequate food. Food Utilisation – Ensuring that food is nutritious, safely prepared, and properly consumed to promote good health. Food Stability – Ensuring that food remains consistently available and accessible despite economic, environmental, or social shocks.

In Nigeria, achieving food security is challenged by several factors, including climate change, insecurity in farming communities, poor infrastructure, limited access to modern farming technologies, inadequate storage facilities, post-harvest losses, high cost of agricultural inputs, and rapid population growth. These challenges reduce agricultural productivity and increase food prices, making it difficult for many households to afford nutritious meals. To improve food security, Nigeria can invest in modern agricultural practices, improve rural infrastructure, provide affordable credit and inputs to farmers, strengthen irrigation systems, reduce post-harvest losses through better storage and processing, enhance security in farming areas, and implement policies that encourage sustainable agricultural production and food distribution.

In conclusion, food security is essential for Nigeria's economic development and the well-being of its citizens. Ensuring reliable access to sufficient, safe, and nutritious food requires coordinated efforts from the government, private sector, farmers, and other stakeholders to address the country's agricultural and food system challenges.

2.2 Theoretical Framework:

Sustainable Livelihoods Framework (SLF) and the Diffusion of Innovation (DOI) Theory provide strong foundations for this study.

2.2.1 Sustainable Livelihoods Framework (SLF)

The Sustainable Livelihoods Framework was developed by Robert Chambers and Gordon Conway in 1992. It was later refined and popularised by the UK Department for International Development in 1999. The Sustainable Livelihoods Framework states that people's livelihoods are sustainable when they can cope with and recover from shocks and stresses, maintain or enhance their capabilities and assets, improve their well-being without degrading natural resources and provide opportunities for future generations. The framework identifies five livelihood assets (capitals): human capital – education, knowledge, health, and skills; natural capital – land, water, forests, and biodiversity; financial capital – income, savings, loans, and credit; physical capital – roads, machinery, irrigation, storage, and infrastructure; and social capital – networks, associations, and community support. These assets interact with institutions, policies, and external factors to determine livelihood outcomes.

The Sustainable Livelihoods Framework implies that agricultural technology strengthens farmers' livelihood assets. Technologies such as mechanisation, improved seeds, irrigation, precision agriculture, and digital extension services increase productivity and income. Improved livelihoods enhance food availability, accessibility, and household food security. Sustainable agricultural practices contribute to long-term national development. The Sustainable Livelihoods Framework is relevant because it explains how technology contributes to increased agricultural productivity, poverty reduction among rural households, sustainable use of natural resources, improved food security and economic growth and national development in Nigeria.

2.2.2 Diffusion of Innovation (DOI) Theory

The Diffusion of Innovation Theory was developed by Everett M. Rogers in 1962 through his book Diffusion of Innovations. The theory has been revised through several editions. The theory explains how new ideas, technologies, or innovations spread through a social system over time. According to Rogers, adoption depends on: Awareness of the innovation, interest in the innovation, evaluation of its usefulness and trial of the innovation. The theory identifies five categories of adopters: innovators (2.5%), early adopters (13.5%), early majority (34%), late majority (34%) and laggards (16%). It also identifies five characteristics that influence adoption: Relative advantage, compatibility, complexity, trialability and observability

The theory implies that: Farmers do not adopt agricultural technologies simultaneously. Adoption depends on education, awareness, extension services, access to information, affordability, and perceived benefits. Government policies, extension agents, and research institutions play important roles in accelerating technology adoption. Increased adoption leads to greater agricultural productivity and improved food security.

The Diffusion of Innovation Theory is relevant because it explains how agricultural technologies spread among Nigerian farmers, why some farmers adopt innovations quickly while others are reluctant, the role of extension services, media, farmer groups, and demonstration farms in technology dissemination, and how widespread adoption of agricultural innovations contributes to agricultural transformation, food security, and national development.

2.3 Empirical Review

Ayim et al. (2022) examined the adoption of ICT innovations in the agriculture sector in Africa: a review of the literature. The study reviewed the adoption of Information and Communication Technology (ICT) innovations in African agriculture and identified factors influencing their adoption by farmers. The findings revealed that ICT innovations such as mobile applications, digital advisory services, geographic information systems (GIS), and remote sensing significantly improve agricultural productivity, market access, and decision-making. However, poor digital infrastructure, inadequate training, and limited financial resources hinder widespread adoption across Africa. The study is relevant because Nigeria faces similar challenges regarding the adoption of agricultural technologies. It supports the argument that digital technologies can transform agriculture and improve food security. The study recommended increased investment in rural ICT infrastructure, farmers' digital literacy, and supportive government policies to encourage technology adoption.

Brenya, Zhu, and Sampene (2023) investigated how agriculture technology improves food security in low- and middle-income nations. A Systematic Review: How Agricultural Technologies Contribute to Food Security in Low- and Middle-Income Countries. The study directly supports the present research by demonstrating that agricultural technology is essential for increasing productivity and achieving food security in developing countries such as Nigeria. The study found out that agricultural technologies, including precision agriculture, artificial intelligence, mechanisation, improved seed varieties, drones, and digital farming, enhance crop yields, improve farmers' incomes, and strengthen food security. It also identified inadequate financing, poor technical knowledge, and weak policy implementation as barriers to technology adoption. The authors recommended that governments increase investments in agricultural technology, improve farmers' access to credit, and strengthen extension services.

Krupitzer and Stein (2024) examined unleashing the potential of digitalisation in the agri-food chain for integrated food systems. The study examined how digital technologies can transform the agricultural and food supply chains into integrated and sustainable food systems. The study supports the argument that digital transformation enhances agricultural productivity, food security, and economic development. The findings revealed that digital technologies such as IoT, cloud computing, artificial intelligence, and big data improve agricultural efficiency, supply chain management, food traceability, and sustainability. However, implementation requires substantial investment and institutional support, and hence the study recommended stronger collaboration among governments, technology providers, and agricultural stakeholders to accelerate digital transformation.

Onomu and Aliber (2024) examined Nigeria's Agriculture and Technology Use: Current Structure and Challenges. The study reviewed the current level of agricultural technology use in Nigeria and examined factors affecting technology adoption. The study is directly related to the present research because it focuses specifically on Nigeria and highlights technology as a catalyst for agricultural transformation. The findings show that although Nigeria has abundant agricultural resources, technology adoption remains low due to poor funding, inadequate infrastructure, limited extension services, and weak government support. The study concluded that increased technology adoption would improve agricultural productivity and food security. The authors therefore recommended increased government investment in agricultural technology, rural infrastructure, and farmer training.

Okafor and Bello (2024) investigated leveraging digital innovation for agricultural transformation in Nigeria: Pathways toward smart food systems by exploring the role of digital innovation in transforming agriculture and improving food security in Nigeria. The study is highly relevant because it focuses specifically on Nigeria and demonstrates how digital technologies can support agricultural transformation and national development. The findings reveal that precision farming, digital marketplaces, mobile applications, and smart farming technologies improve agricultural productivity, reduce post-harvest losses, and strengthen food systems. Nevertheless, inadequate infrastructure, poor internet connectivity, and insufficient digital skills remain significant constraints. The study recommended increased investment in digital infrastructure, public-private partnerships, and farmer capacity-building programmes.

Bolaji et al. (2023) examined leveraging precision agriculture for sustainable food security in Nigeria. The study reviewed the potential of precision agriculture technologies in improving sustainable food security in Nigeria. The study found out that precision agriculture technologies such as Global Positioning Systems (GPS), remote sensing, drones, sensors, and Geographic Information Systems (GIS) significantly improve resource-use efficiency, crop productivity, and environmental sustainability. The study also identified poor funding, inadequate technical expertise, and weak digital infrastructure as major constraints to technology adoption in Nigeria. The authors recommended increased government investment in digital agriculture, improved extension services, and training programmes for farmers.

Eze and Abe (2024) investigated Green Agricultural Technology and Food Security: Implications for Nigeria. The study examined the effect of green agricultural technologies on food security among Nigerian farmers. The findings of the study established a significant positive relationship between green agricultural technology adoption and food security. Farmers who adopted climate-smart technologies, improved irrigation, organic farming practices, and environmentally sustainable innovations experienced increased productivity and improved household food security. The study supports the present research by demonstrating that sustainable agricultural technologies contribute to food security and national development. The study recommended expanding access to climate-smart technologies, providing financial support for farmers, and strengthening environmental sustainability policies.

Olatunji, Bamidele, and Akinyemi (2023) explored the investigating and quantifying of food insecurity in Nigeria: a systematic review. The study systematically reviewed research on food insecurity in Nigeria and examined the major determinants affecting household food security. The findings revealed that food insecurity in Nigeria is driven by low agricultural productivity, climate change, insecurity, poverty, inadequate infrastructure, and limited adoption of improved agricultural technologies. It concluded that technological innovation is essential for improving food production and ensuring sustainable food security. The study provides empirical evidence that improving agricultural technology is one of the most effective strategies for addressing food insecurity in Nigeria and recommended increased investment in agricultural innovation, improved rural infrastructure, and stronger government support for technology adoption.

2.4 Summary of the Literature Review and Research Gap

The reviewed literature consistently demonstrates that agricultural technology is a major driver of agricultural transformation, food security, and national development. Studies by Ayim et al. (2022), Brenya et al. (2023), Bolaji et al. (2023), Onomu and Aliber (2024), Okafor and Bello (2024), and Eze and Abe (2024) established that technologies such as precision agriculture, mechanisation, artificial intelligence, mobile technologies, improved seed varieties, irrigation systems, drones, remote sensing, and digital extension services significantly increase agricultural productivity, reduce post-harvest losses, improve farmers' incomes, and enhance food security.

The literature also reveals that the adoption of agricultural technologies in Nigeria remains relatively low due to poor rural infrastructure, inadequate access to finance, weak extension services, insufficient digital literacy, insecurity, and inconsistent government policies. These challenges continue to limit the full realisation of the benefits of technological innovation in agriculture.

Furthermore, the studies agree that technology adoption contributes not only to increased food production but also to poverty reduction, employment generation, environmental sustainability, and overall economic development. They recommend increased government investment in agricultural research, digital infrastructure, extension services, farmer education, climate-smart agriculture, and public-private partnerships to accelerate technology adoption and strengthen Nigeria's food system. Although existing studies have extensively examined agricultural technology adoption and food security, most focus on specific technologies, particular regions, or Africa as a whole. Few studies comprehensively examine technology in agricultural transformation and food security as an integrated strategy for national development in Nigeria. Additionally, limited empirical attention has been given to how multiple technologies collectively influence agricultural transformation, food security, employment creation, and sustainable national development within the Nigerian context. This gap provides the justification for the present study, which seeks to offer a holistic assessment of the role of technology in agricultural transformation and food security as a panacea for national development in Nigeria.

3.0 Research Methodology

The study adopted an ex post facto (after the fact) design. The choice of this design is made because the researcher has no control of the independent variables, and inferences about the relationship among the variables are made without the current interaction between the regressand and the regressors (Ndiyo, 2005).

This study used information and data from secondary sources, and therefore, time series data sourced from various publications of the Central Bank of Nigeria Statistical Bulletin and World Development Indicators (WDI) were used. The models for this study were estimated using data on some technology in agriculture transformation and food security: a panacea for national development indicators, such as poverty rate (POV) as a dependent variable and agriculture GDP (AGRGDP), fertiliser application (FERTAPPL), agriculture ICT adoption (AGRICT), nutritional adequacy (NUTADE), and accessibility (ACCESS) for the period 1990-2024. A multiple regression analysis was used, predicated on various data diagnostics, including the Augmented Dickey-Fuller (ADF) and Philip-Peron

(PP) unit root tests, as well as the autoregressive distributed lag technique (ARDL), which was employed in this study to determine the relationship between macroeconomic instability and economic development within the specified time frame.

3.1 Model Specification:

The model specified for this study is anchored on the Diffusion of Innovation Theory and the Sustainable Livelihoods Framework, which explain how technological innovation enhances agricultural productivity, food security, and socioeconomic welfare. Hence, the model is as follows:

3.1.1 Technology in Agriculture Transformation, Food Security and National Development

The functional form of the model for Technology in Agriculture Transformation, Food Security and National Development equation for this study is given as:

POV = F (AGRGDP, FERTAPPL, NUTADE, AGRICT, ACCESS) …………… (1)

The econometric form of the model is given as:

$POVt = a_0 + a_1AGRGDP_t + a_2FERTAPPLt + a_3NUTADE_t + a_4AGRICT_t + a_5ACCESS_t + U_t$

………………………………………………………………………………………..… (2)

POV_t – Human Development Index in time t

$AGRGDP_t$ – Self Employment Rate in time t

$FERTAPPL_t$ – Access to credit to Private Sector (% of GDP) in time t

$NUTADE_t$ – Technology Export s or digital economy indicators in time t

$AGRICT_t$ – ICT Adoption (e.g. internet penetration) in time t

$ACCESS_t$ – Inflation Rate in time t

U_t – Error term

a_0 to a_5 are the parameter to be estimated

A priori Expectation shows that $a_1 > 0$, $a_2 > 0$, $a_3 > 0$, $a_4 > 0$, and $a_5 > 0$.

Table 1: Data Description and Sources

S/N	VARIABLES	DESCRIPTION OF DATA	EXPECTED SOURCE
1	POV	This represents the rate of poverty. This study adopts consumption expenditure per capita as measure of poverty because there is existing data on the variable, and it is assumed that people consume more of their income leaving little proportion for savings and investment. This is premised on the fact that poor nations consume greater of their income while they have little or no savings and hence resolve to public debt to finance economic growth and development. This is derived by dividing overall household consumption expenditure by overall population for each year within the period of study. It is a dependent variable in the model. A priori expectation (-)	CBN Statistical Bulletin (2024)
2	AGRGDP	This is agricultural GDP which is the portion of Nigeria's gross domestic product that comes from the agricultural sector. It measures the value added by agricultural activities. A priori expectation: positive (+)	WDI (2024)

3	FERTAPPL	This is the process of applying natural or synthetic fertilizer to soil or plants to supply essential nutrients needed for healthy growth and higher crop yields. It is measured by the amount of fertilizer applied to a given area of land. It serves as an explanatory variable for the model. A priori expectation: positive (+)	CBN Statistical Bulletin (2024)
4	NUTADE	Nutritional adequacy is a dimension of food security that refers to whether a person's diet provides sufficient energy, protein, vitamins and minerals to meet their nutritional needs for a healthy and active life. In this study it is measure by a dietary diversity score (DDS). A priori expectation: positive (+)	WDI (2024)
5	ACCESS	Accessibility (food access) is one of the four pillars of food security. It refers to the ability of individuals and households to obtain sufficient, safe, and nutrition food through purchase, production, barter, or food assistance. For this study, food price index was used to measure accessibility to food security. It serves as a control variable for the model. A priori expectation: negative (-)	WDI (2024)
6	AGRICT	ICT adoption refers to the degree of usage and integration of digital agriculture. A priori expectation: positive (-)	World Bank Indicator (2024)

4.1 Descriptive statistics and matrix of correlations

Table 4.1: Descriptive Statistics

	POV	AGRGDP	FERTAPPL	NUTADE	ACCESS	AGRICT
Mean	44.48	29.29	10.07	10.50	1.93	7.33
Median	43.00	28.40	8.46	8.08	1.98	3.45
Maximum	60.90	37.00	22.60	28.89	3.41	57.28
Minimum	18.59	20.00	4.15	3.27	0.49	0.01
Std. Dev.	10.28	6.35	5.88	6.52	0.83	11.71
Skewness	-0.26	-0.03	0.86	1.74	-0.08	3.87
Kurtosis	2.65	1.39	2.39	4.65	1.78	11.35
Jarque-Bera	0.56	3.74	4.89	21.68	2.21	149.65
Probability	0.76	0.15	0.09	0.00	0.33	0.00
Sum	155.68	102.54	352.28	367.67	67.64	256.62
Sum Sq. Dev.	359.15	136.91	117.52	144.41	23.25	466.15
Observations	**35**	**35**	**35**	**35**	**35**	**35**

Source: Researcher's Computation (2026)

The descriptive statistics of the variables are presented in Table 4.1 above. This table highlights key trends in how technology in agriculture contributes to national development through food security in Nigeria during the review period. The data reveal a high level of poverty rate (POV), agricultural GDP (AGRGDP), fertiliser application (FERTAPPL) and nutritional adequacy in food security (NUTADE). For poverty rate (POV), the mean, median, and maximum values are 44.48, 43.00, and 60.90. For agricultural GDP (AGRGDP), the mean, median and maximum values are 29.29, 28.40 and 37.00. Fertiliser application (FERTAPPL) values are 10.07 (mean), 8.46 (median), and a maximum value of 22.60, and for nutritional adequacy in food security (NUTADE), the mean, median, and maximum values are 10.50, 8.08, and 28.89, respectively.

In contrast, Accessibility to Food Security (ACCESS) and Agricultural ICT (AGRICT) made relatively low contributions to technology in agriculture, food security and national development in Nigeria, with statistics of 1.93 (mean), 1.98 (median) and 3.41 (maximum) for Accessibility to Food Security (ACCESS) and 7.33 (mean), 3.45 (median) and 57.28 (maximum) for Agricultural ICT (AGRICT), respectively.

The response of poverty rate (POV), agricultural GDP (AGRGDP), fertiliser application (FERTAPPL), nutritional adequacy in food security (NUTADE) and agricultural ICT (AGRICT) to technology in agriculture, food security and national development has been volatile, showing fluctuations during the period. Poverty rate

(POV) statistics include a mean of 44.48, a median of 43.00 and a maximum of 60.90 with a standard deviation of 10.28. Agricultural GDP (AGRGDP) statistics reveal a mean of 29.29, a median of 28.40, a maximum of 37.00, and a standard deviation of 6.35. Fertiliser application (FERTAPPL) statistics reveal a mean of 10.07, a median of 8.46, a maximum of 22.60, and a standard deviation of 5.88. Nutritional adequacy in food security (NUTADE) statistics reveals a mean of 10.50, a median of 8.08, a maximum of 28.89, and a standard deviation of 6.52. Agricultural ICT (AGRICT) statistics reveal a mean of 7.33, a median of 3.45, a maximum of 57.28, and a standard deviation of 11.71, respectively.

Skewness and Kurtosis

Analysis

The skewness results indicate that only one variable is positively skewed, suggesting right-tailed distributions. The kurtosis results show that nutritional adequacy in food security (NUTADE) and agriculture ICT (AGRICT) are leptokurtic (kurtosis > 3), indicating peaked distributions. Conversely, poverty rate (POV), agriculture GDP (AGRGDP), fertiliser application (FERTAPPL), and accessibility to food security (ACCESS) are platykurtic (kurtosis < 3), reflecting flatter distributions.

Normality and Variability

The Jarque-Bera test confirms that all variables are normally distributed over the analysis period. The standard deviation values highlight the extent of variation in the data, with most variables showing significant deviations from their true values. The only exception is accessibility to food security (ACCESS), which has relatively small deviations of 0.83.

Table 4.2: correlation Matrix

	POV	AGRGDP	FERTAPPL	NUTADE	ACCESS	AGRICT
POV	1					
AGRGDP	0.33	1				
FERTAPPL	-0.61	-0.51	1			
NUTADE	0.03	0.58	-0.19	1		
ACCESS	-0.02	-0.63	0.36	-0.55	1	
AGRICT	-0.31	0.33	-0.28	0.79	-0.42	1

Source: Researcher's Computation (2026)

The correlation matrix of the variables is shown in Table 4.2 above. The correlation matrix is a statistical tool that measures the relationship between multiple variables. It provides a table of correlation coefficients which describe the strength and direction of the linear relationships between each pair of variables. From the table above, therefore, POV has a positive correlation coefficient with AGRGDP and NUTADE. This therefore indicates that the variables tend to move in the same direction. Meanwhile, FERTAPPL, ACCESS and AGRICT have a weak negative correlation (-0.61, -0.02 and -0.31), indicating that as POV increases, FERTAPPL, ACCESS and AGRICT tend to decrease. Also, from the table, there exists a positive correlation coefficient between AGRGDP and NUTADE, AGRICT; FERTAPPL and ACCESS; NUTADE and AGRICT; while there is a weak negative correlation between AGRGDP and FERTAPPL, ACCESS; FERTAPPL and NUTADE, AGRICT; NUTADE and ACCESS; as well as ACCESS and AGRICT, respectively.

4.2 Unit Root Test

The augmented Dickey-Fuller and the Philip-Perron unit root tests were conducted to examine the stationarity condition of the variables. As indicated in Table 4.3 below, AGRICT and POV were stationary at level in ADF, and PP, while AGRGDP, ACCESS, FERTAPPL and NUTADE were stationary after first differencing in both ADF and PP. In other words, the variables are integrated of order zero and one (i.e., I(0) and I(1)).

Where some of the variables are I(0) while others are I(1), one suggests the problem of unit roots in the equations. It becomes imperative to perform co-integration tests to determine the presence of an equilibrium relationship among the variables in each equation. The study adopts the ARDL bound testing technique for co-integration, as the variables are integrated of diverse orders (i.e., order zero and order one).

Table 4.3: ADF and Philip-Perron Unit Root Test Results

Variables	ADF Level	1st Difference	Order of integration	PP Level	1st Difference	Order of integration
POV	-	-	I(0)	-3.016641	-	I(0)
AGRGDP	-1.684958	-3.374704	I(1)	-	-	I(1)
ACCESS	-1.090455	-6.430786	I(1)	-	-	I(1)
FERTAPPL	-2.023553	-5.980595	I(1)	-	-	I(1)
AGRICT			I(0)	-	-	I(0)
NUTADE	-3.057465 -0.675533	- -5.944291	I(1)	-	-	I(1)

Source: Researcher's computation (2026), using E-Views 9

Note: Mackinnon critical values for ADF at 1, 5 and 10% levels are -3.60, -2.93 and -2.60 respectively, and for PP are 3.605, 2.936 and 2.606, respectively. ** means significant at 5% level.

4.3 Lag Length Selection

Table 4.4: Lag Length Criteria

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-507.5641	NA	9880176.	33.13317	33.41071	33.22364
1	-359.2169	229.6989	7370.326	25.88496	27.82778	26.51827
2	-311.5299	55.37846	4602.473	25.13096	28.73906	26.30711
3	-264.0185	36.78305	5265.260	24.38829	29.66166	26.10728
4	-97.67960	64.38924*	14.52978*	15.97933*	22.91798*	18.24116*

* indicates lag order selected by the criterion

Source: Researcher's computation (2026), using E-Views 9

The efficiency and validity of an error correction model depend on the lag structure. The study used VAR lag order selection criteria to determine the lag lengths. The study employed the Akaike Information Criterion (AIC) and Schwarz Criterion (SC), and the result shows four optimal lag lengths in the inclusive growth index and fiscal deficit models as shown in Table 4.5 above. In order to reduce the possibilities of underestimation whilst maximising the likelihood of recovering the true lag (Venus, 2004), the study used three and four as the maximum lag lengths, respectively.

4.1.4 Co-integration Test Results

From the bound testing result reported in Table 4.5 below, a long-run relationship exists amongst the variables in all the estimated equations, given that the values of the F-statistic are greater than the critical values at the five per cent level in both the upper and the lower bounds. Therefore, the null hypothesis of absence of co-integration is rejected, while the study proceeds to estimate the long-run coefficient of each of the equations.

Table 4.5: Co-Integration Test Results

5% critical value				
Equations	K	F-Stat	I (0)	I (1)
Outcome				
POV (AGRGDP, FERTAPPL, NUTADE, AGRICT, ACCESS)	5	4.73	2.62	3.79
Co-integration				

Note: K =number of parameters
Source: Researcher's computation (2026), using E-Views 9

4.2 Findings, Presentation and Analysis of Econometric Results of the Long run coefficients of Technology in Agriculture Transformation, Food Security and National Development Equation Results

Table 4.6: Dependent variable: POV

Variable	Coefficient	Std. Error	t-Statistic	Prob.
AGRGDP	0.938705	0.427348	2.196583	0.2720
FERTAPPL	1.962068	2.400140	2.817481	0.0537
NUTADE	1.241306	1.138785	2.090027	0.0426
ACCESS	7.521238	3.591896	2.093946	0.2836
AGRICT	-0.696231	0.541891	-1.284818	0.4210
C	15.491199	16.390535	0.945131	0.5180

Source: Researcher's computation (2026), using E-Views 9.

Long Run coefficients of Technology in Agricultural Transformation, Food Security and National Development Equation

The long-run relationship between national development and technology in agriculture transformation and food security variables is presented in Table 4.6 above. Based on the ARDL long-run estimates, the findings reveal the following insights:

The coefficient for agricultural GDP (AGRGDP) is positive and statistically significant, indicating that a unit increase in AGRGDP results in a 93.8% decrease in national development proxied by poverty rate (POV). This finding is in line with a priori expectations in the long run, suggesting that growth in the agricultural sector has not been sufficiently inclusive to reduce poverty in Nigeria. Although agricultural output has expanded, the gains may be concentrated among commercial producers, while smallholder farmers continue to face constraints such as inadequate access to technology, finance, markets, and infrastructure. This indicates that agricultural growth alone is insufficient to achieve national development unless complemented by policies that ensure equitable distribution of income, promote inclusive technological adoption, and improve rural livelihoods.

Conversely, the coefficient for fertiliser application (FERTAPPL) is positive and statistically significant, indicating that a unit rise in FERTAPPL will result in a 196.2% increase in national development proxied by poverty rate (POV). This result conforms to a priori expectations, indicating that increased fertiliser use has not translated into improved national development in Nigeria. Rather than reducing poverty, greater fertiliser application is associated with higher poverty levels, suggesting that the benefits of fertiliser use have been constrained by structural and institutional challenges. These findings imply that fertiliser alone cannot guarantee agricultural transformation or food security unless it is accompanied by complementary technologies, effective policy implementation, improved infrastructure, and equitable access to agricultural inputs. Therefore, achieving sustainable national development requires a comprehensive approach that enhances the efficiency and inclusiveness of agricultural technology adoption.

More so, the coefficient of nutritional adequacy (NUTADE) exhibits a positive and statistically significant relationship with POV. Therefore, a one-unit increase in NUTADE is associated with a 124.1% increase in POV. This result deviates from a priori expectations, implying that improvements in nutritional adequacy have not produced proportional reductions in poverty in Nigeria in the period under review. This finding suggests that the benefits of improved nutrition may not be evenly distributed across the population and that structural constraints, including income inequality, limited access to productive resources, and weak policy implementation, reduce the effectiveness of nutritional improvements in promoting national development. Therefore, while nutritional adequacy remains an essential component of food security, its contribution to long-run national development depends on complementary policies that foster inclusive economic growth, equitable access to food, and sustainable agricultural transformation.

The coefficient for accessibility to food security (ACCESS) is positive and statistically significant, indicating that a one-unit increase in ACCESS will lead to a 75.2% decrease in POV. This finding is in line with theoretical expectation, reflecting that improvements in food accessibility have not translated into enhanced national development over the study period. The result may reflect structural challenges such as income inequality, rising food prices, weak purchasing power, unequal distribution of food resources, and limited access to productive opportunities among poor households. Consequently, while improving food accessibility remains an important objective, it is insufficient on its own to reduce poverty or promote sustainable national development.

Finally, the coefficient for agricultural ICT adoption (AGRICT) is negative and statistically insignificant, showing that a unit rise in AGRICT will lead to -69.6% increases in POV. This result deviates from a priori expectation, indicating that increased adoption of information and communication technologies in agriculture tends to reduce poverty in Nigeria, although the effect is not sufficiently strong to be statistically confirmed. Economically, this suggests that while ICT possesses the potential to enhance agricultural productivity, improve farmers' incomes, strengthen food security, and contribute to national development, these benefits have not been fully realised over the study period. The insignificant relationship may be attributed to structural constraints such as inadequate rural infrastructure, low digital literacy, poor internet connectivity, limited access to finance, and weak extension services, which reduce the effectiveness of ICT adoption. Consequently, ICT alone cannot serve as a panacea for national development. Its contribution to poverty reduction and sustainable development depends on complementary investments in infrastructure, institutional support, education, and inclusive agricultural policies that enable farmers to effectively utilize digital technologies.

In summary, the long-run analysis highlights the complex interplay between technology in agriculture transformation, food security and national development variables in Nigeria. While certain factors such as agricultural GDP (AGRGDP) and accessibility to food security (ACCESS) positively influenced technology in agricultural transformation, food security and national development in Nigeria, others like fertiliser application (FERTAPPL), nutritional adequacy in food security (NUTADE) and agricultural ICT adoption (AGRICT) posed significant challenges. These findings underscore the need for targeted policy interventions to focus on prioritising policies that strengthen the complementary conditions for effective ICT utilisation. These include expanding rural digital infrastructure, improving electricity and broadband connectivity, enhancing digital literacy among farmers, integrating ICT into agricultural extension services, increasing access to affordable digital technologies and agricultural finance and promoting public-private partnerships in agritech innovation.

Table 4.8: Dependent variable: POV

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(POV(-1))	1.075143	0.790902	1.359389	0.4038
D(POV(-2))	0.063545	0.064923	0.978778	0.5068
D(POV(-3))	0.050933	0.062546	0.814326	0.5649
D(AGRGDP)	-0.087040	0.156875	-0.554832	0.6775
D(AGRGDP(-1))	0.032364	0.168701	0.191840	0.8793
D(AGRGDP(-2))	0.694568	0.269939	2.573053	0.2360
D(AGRGDP(-3))	-0.525698	0.291935	-1.800738	0.3227
D(FERTAPPL)	-0.218175	0.073686	-2.960875	0.2074
D(FERTAPPL(-1))	0.002620	0.243531	0.010759	0.9932
D(FERTAPPL(-2))	0.185841	0.236500	0.785797	0.5760
D(FERTAPPL(-3))	0.167830	0.146040	1.149208	0.4559
D(NUTADE)	0.586113	0.277748	2.110232	0.2817
D(NUTADE(-1))	0.235661	0.074896	3.146520	0.1959
D(NUTADE(-2))	-0.384548	0.246504	-1.560010	0.3629
D(NUTADE(-3))	0.111800	0.205056	0.545216	0.6822
D(ACCESS)	0.422118	0.527513	0.800204	0.5704
D(ACCESS(-1))	-0.855133	0.521939	-1.638378	0.3489
D(ACCESS(-2))	0.346563	0.869834	0.398425	0.7586
D(ACCESS(-3))	-1.318677	1.110710	-1.187238	0.4456
D(AGRICT)	-0.068174	0.024626	-2.768404	0.2207
D(AGRICT(-1))	-0.024003	0.019074	-1.258410	0.4275
D(AGRICT(-2))	-0.064714	0.042117	-1.536536	0.3673
D(AGRICT(-3))	0.186628	0.059986	3.111199	0.1980
CointEq(-1)	-0.521954	0.115781	-2.917022	0.3061

R-squared	0.955945	Mean dependent var	45.21613
Adjusted R-squared	0.948364	S.D. dependent var	8.603453
S.E. of regression	0.348004	Akaike info criterion	-0.771712
Sum squared resid	0.121106	Schwarz criterion	0.616018
Log likelihood	41.96153	Hannan-Quinn criter.	-0.319346
F-statistic	6.322340	Durbin-Watson stat	2.461043
Prob(F-statistic)	0.031451		

Source: Researcher's Computation (2026)

The short-run dynamics of the relationship between technology in agriculture transformation, food security and national development equation results are as presented in Table 4.8, revealing several significant findings.

4.2 Findings, Presentation and Analysis of Econometric Results of the Short run coefficients of Technology in Agriculture Transformation, Food Security and National Development Equation Results

In the current and third-period lag, AGRGDP exhibits a negative and insignificant relationship with POV but becomes positive and insignificant in the first and second-period lag. Specifically, a 1% increase in AGRGDP will lead to an 8.7% and 52.5% increase in POV during the current and third periods, respectively, and a 3.2% and 69.4% decrease in POV during the first and second period lags of the short run. The result of the current and third-period lags are not in line with a priori expectations, while the result of the first- and second-period lags conform to theoretical expectations, suggesting that agricultural GDP does not have a statistically significant impact on poverty reduction and food security in Nigeria in the short run, despite the changing signs across lag periods. This indicates that increases in agricultural production alone are insufficient to produce immediate improvements in national development.

The short-run dynamics of fertiliser application (FERTAPPL) show that in the current period it is negative and significantly related to POV, while it became positive and insignificant at the first, second and third period lags of the short run, indicating that a one per cent rise in FERTAPPL will lead to -21.8% increases in POV in the current period and 0.2%, 18.5% and 16.7% decreases in POV in the first, second and third period lags of the short run. The result of the current period lag deviates from a priori expectations, while the results of first, second and third period lags conform to theoretical expectations, suggesting that fertiliser application has an immediate and statistically significant poverty-reducing effect, confirming its importance as a technological input for agricultural transformation and food security in Nigeria. However, the insignificant positive coefficients in the first, second and third lags suggest that this immediate benefit is not sustained in subsequent periods, possibly due to structural constraints, implementation challenges, and delays in transmitting productivity gains into broader improvements in household welfare.

Nutritional adequacy in food security (NUTADE) shows a positive and significant relationship with POV in current, first and third period lags of the short run and a negative but insignificant relationship with POV in the second period lag of the short run. Specifically, a unit rise in NUTADE will lead to 58.6%, 23.5%, and 11.1% decreases in POV in current, first, and third period lags and a -38.4% increase in POV at the second period lag. The result of the current, first and third period lags is in line with a priori expectations, while the results of the second period lag deviate from theoretical expectations, implying that improvements in nutritional adequacy do not immediately translate into poverty reduction in Nigeria during the study period. Instead, they are associated with higher poverty levels in most short-run periods, contrary to theoretical expectations. This unexpected result may reflect structural challenges such as unequal access to nutritious food, high food inflation, low household purchasing power, weak distribution systems, and ineffective targeting of food security interventions. Consequently, although nutritional adequacy is an important pillar of food security, its contribution to national development through poverty reduction appears limited in the short run unless it is complemented by policies that promote income growth, employment creation, agricultural productivity, and equitable access to nutritious food.

The coefficient of accessibility to food security (ACCESS) is positive and statistically insignificant in current and second period lags of the short run and negative and insignificantly related to POV in first and third period lags. Therefore, a unit rise in ACCESS will lead to 42.2% and 34.6% decreases in POV in current and second period lags and -85.5% and -13.1% increases in POV in first and third period lags of the short run. The results of current and second period lags is in line with a priori expectation, while the result of first and third period lags does not conform to a priori expectation, reflecting that improving physical or economic access to food alone is insufficient to achieve immediate national development through poverty reduction. The benefits of improved food accessibility may be constrained by factors such as low household incomes and purchasing power, high food price inflation, poor transportation and market infrastructure, unequal distribution of food, limited employment opportunities and weak implementation of food security policies.

Finally, the coefficient of agricultural ICT (AGRICT) exhibits a negative and significant relationship with POV in the current period, a negative but insignificant relationship in the first and second periods, and a positive but significant relationship at the third period lag. Therefore, a unit rise in AGRICT will lead to -6.8%, -2.4% and -6.4% increases in POV in current, first and third period lags and 18.6% decreases in the third period lag. The results of current, first and second period lags are not in line with a priori expectations, while the result of the third period lag conforms to theoretical expectations, suggesting that agricultural ICT adoption has an immediate and significant poverty-reducing effect, demonstrating its importance for agricultural transformation and national development in Nigeria. The negative but insignificant first and second lag coefficients suggest that this beneficial effect continues but is not statistically robust. However, the positive and significant coefficient in the third lag indicates that the initial gains from ICT adoption may diminish or even reverse over time because of structural constraints such as inadequate digital infrastructure, unequal access to ICT, limited technical capacity, and weak institutional support.

The ECM coefficient (-0.521954) is correctly signed and statistically significant, indicating that approximately 52% of short-run disequilibria adjust to the long-run equilibrium within a year. The t-statistic (2.917022) confirms the significance of the ECM at the 5% level.

The R-squared value (0.955945) and adjusted R-squared (0.948364) demonstrate that approximately 95% of the variation in POV is explained by the included variables (both current and lagged), with 5% attributable to factors outside the model. The F-statistic (6.32) confirms the joint significance of the model's variables, ensuring a good overall fit. Additionally, the Durbin-Watson statistic (2.46) indicates no autocorrelation, affirming the reliability of the results for forecasting and policy formulation.

The stability test using the cumulative sum (CUSUM) test in figure 4.1 below further shows that the variables included in the national development proxied by the poverty rate (POV) equation were stable within the period of the study. This is evidenced by the swing of the trends within the CUSUM bound at the ± five per cent significance level. The study, therefore, infers that the equation is stable and consistent enough to be adopted for economic policies and forecasts.

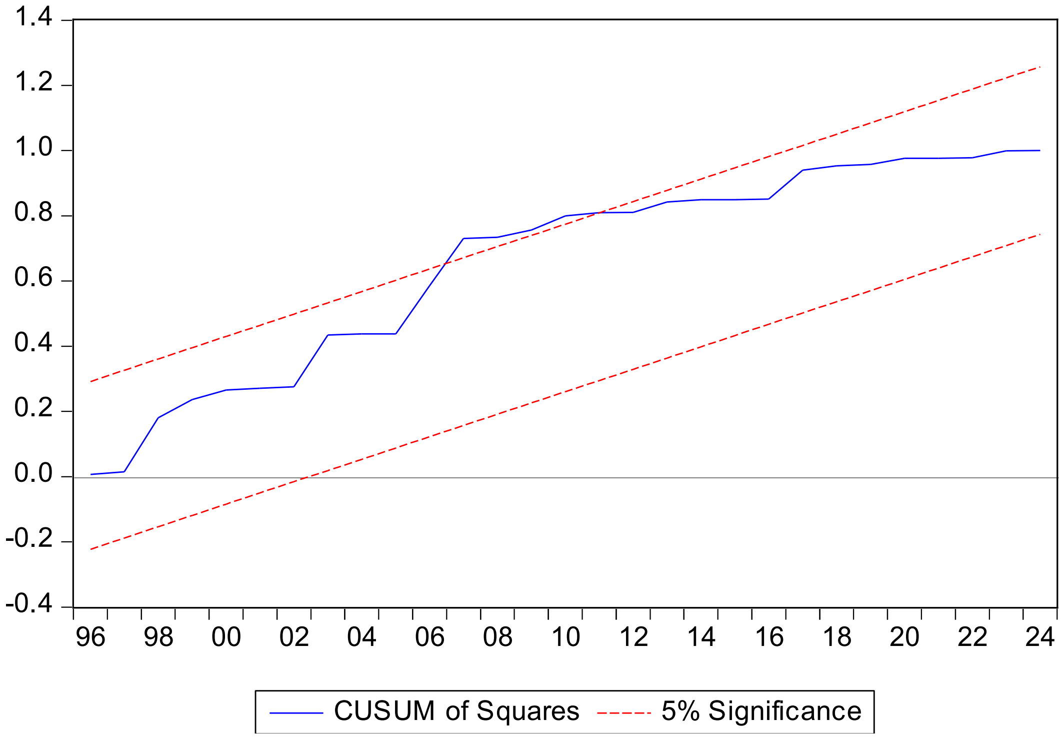

Figure 4.1: Technology in Agriculture Transformation, Food Security and National Development equation CUSUM.
Source: Researcher's Computation (2026).

Discussion of Findings

The short-run and the long-run ARDL dynamics show an intriguing insight, as the regression result offers a positive and significant relationship between the four key variables of technology in agriculture transformation and food security: agricultural GDP (AGRGDP), fertiliser application (FERTAPPL), nutritional adequacy in food security (NUTADE) and accessibility to food security (ACCESS), which interacted with the dependent variable national development proxied by poverty rate (POV). The results suggest that increases in the underlisted variables, in essence, will lead to corresponding increases in agricultural technology transformation, food security and national development in Nigeria. This finding therefore suggests that continued investment in agricultural technology, input support, extension services, and food security policies will strengthen Nigeria's economic resilience and accelerate poverty reduction.

However, agricultural ICT adoption (AGRICT) showed a shocking negative and insignificant relationship with agricultural technology transformation, food security and national development in Nigeria in both the long and short run periods under review, reflecting that when this variable increases, national development tends to increase, suggesting that in both the short and long run, agricultural ICT has potential as a contributor to food security and national development, but its benefits are constrained by structural, institutional and socioeconomic challenges that limit its effectiveness.

The models were estimated using the error correction mechanism (ECM), and the outcome of the key urbanisation and economic development equations revealed a positive and significant relationship among the variables in both the short run and long run.

The error correction coefficients in all the estimated models met the three criteria for its acceptability given that they are negative, fractional and statistically significant. Consequently, the estimated result confirms the presence of a long-run relationship among the variables in the models. It also shows that the speed of adjustments is moderate in all the estimated models. The value of the adjusted R-squared implies that the models have a good fit, as the independent variables have high explanatory powers. The Durbin-Watson statistic connotes the absence of autocorrelation in the estimated equations. The study, therefore, accepts the null hypotheses of no serial correlation in the models. This further implies that the error terms of different periods are not serially correlated. The stability test using the cumulative sum tests showed that the variables included in all the models were stable within the period of the study.

Conclusion and Recommendation

The study examines how technology in agriculture contributes to national development through food security in Nigeria using data from 1990 to 2024, adopting the autoregressive distributive lag model. The study observed that changes in the ratios of agricultural GDP (AGRGDP), fertiliser application (FERTAPPL), nutritional adequacy in food security (NUTADE) and accessibility to food security (ACCESS) interacted with the dependent variable, national development in Nigeria. In addition, the study revealed a negative influence of agricultural ICT adoption (AGRICT) on national development in Nigeria. It means that although agricultural ICT has potential as a contributor to food security and national development, its benefits are constrained by structural, institutional, and socioeconomic challenges that limit its effectiveness.

Recommendations

Therefore, we recommend that:

i. Government and policymakers should pursue integrated strategies that combine ICT expansion with investments in rural infrastructure, agricultural financing, human capital development, and market reforms. Such a comprehensive approach is more likely to improve food security, reduce poverty, and promote sustainable national development.

ii. Government and policymakers should focus on sustaining agricultural growth, expanding food security initiatives, promoting technological innovation, and ensuring that the benefits of agricultural development are broadly shared. These measures can help reduce poverty, improve household welfare, and support sustainable economic development in Nigeria.

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