Digital Infrastructure as a Catalyst for Employment in the Nigerian Agricultural Sector

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ABSTRACT

The Nigerian agricultural sector has been greatly despised since the discovery of oil. Agriculture has become unattractive to the Nigeria youth due to the crude practices employed. However, agriculture seems an alternative route for developing the Nigerian economy. Digital infrastructure is invaluable in the process of national development and its introduction to the Nigerian agricultural sector might be instrumental in transforming agriculture and making the sector a solution to the agelong problem of employment in the country. Therefore, this study investigated the role of digital infrastructure in enhancing employment in the Nigerian agricultural sector. Secondary data from the World bank, World Development Indicators (2025) and the Global Economy Database (2025) were employed in this study. Using correlation analysis Granger causality test on a time series data for a period of 34 years; from 1991 to 2024, the study established the nature and direction of association among the variables. Also, Johansen cointegration was used to ascertain whether there is the possibility of a long-run convergence among the variables. Finally, error correction mechanism was used to estimate the effect of digital infrastructure on employment in agriculture. The study found that moderate association exists between the key variables and unidirectional flow from digital infrastructure to employment in agriculture was established. Furthermore, the study found that current year digital infrastructure stock stimulates employment in agriculture. In addition, control of corruption and the absence of violence are crucial factors in expanding employment in agriculture. Therefore, the study recommended a systematic update of digital infrastructure stock and the intentional combat of corruption on the part of the Nigerian government. Subsequent studies could examine the effect of digital infrastructure on employment in other sectors of the economy and other institutional quality variables apart from control of corruption could be included in the model for the studies.

Keywords: Control of corruption, Digital marketing, Digital technology, Error correction mechanism, International market, Nigeria

INTRODUCTION

The Nigerian Agricultural sector is an area of great interest today because of the failure of the nation to transform its economy through the greatly cherished oil sector. Before the discovery of oil, agriculture was the mainstay of the Nigerian economy. Export earnings from agricultural products such as cocoa, timber, kolanut, and coffee were able to provide the nation with the needed capital and consumer goods from abroad at that time. Unemployment and poverty were not a problem and citizens of Nigeria lived comfortably. In a bid to improve its economy and join the league of advanced countries, Nigeria abandoned agriculture and focused on oil. However, the oil sector has not succeeded in moving the country to the desired height. Agriculture, which has been so despised and left in the hands of rural dwellers, who are majorly small-scale and peasant farmers, has now become a major alternative in the campaign for the diversification of the Nigerian economy.

Digital infrastructure refers to the physical and software components that provide information and other digital products and services that aid agricultural productivity. Digital infrastructure involves the stock of information and communication technology (ICT) systems that can be used to stimulate productivity and efficiency in the

Nigerian agricultural sector. Kim & Lee (2020) noted that ICT can help stimulate agricultural efficiency, productivity, and competitiveness by addressing issues such as rising costs, dwindling yields, and shifting consumer preferences. The application of digital infrastructure in the agricultural sector has been identified as invaluable in achieving a high level of production, reducing costs, and improving the quality of agricultural products (Koo & Lee, 2021). Foods and Agricultural Organisation (FAO, 2018) attests to the key role played by digital infrastructure in livestock monitoring, crop management, precision agriculture, supply chain management, and so on. Digital transformation of the agricultural sector is therefore desirable as it incorporates digital technologies into agricultural activities to increase productivity, yield and ensure sustainability of agricultural processes (Zhang, et al, 2019). Hence, the relevance of digital infrastructure in agricultural production, processing, quality assurance, and market access cannot be over-emphasized.

In advanced countries, agricultural activities are majorly mechanized, and agricultural production and processing are usually carried out on a large scale. Advanced countries benefit from economies of scale and their farmers are viewed differently from those in developing countries. In developing countries, especially Africa, agriculture is practiced on a small scale. Farmers are usually seen as poor and belonging to the low class. This is because agriculture is usually practiced by rural dwellers who lack basic infrastructural facilities such as electricity, pipe-borne water, good road network, to mention a few. For example, farming in Nigeria is characterized by smallholder farmers with fragments of land that cannot allow for a mechanized system of farming.

Unlike developing countries, advanced countries have been enjoying food security and; an all-year-round supply of food crops due to good storage facilities and high technologies used in the processing and preservation of arable crops. This translates into a healthy populace and labour productivity is enhanced. Digital infrastructure allows a country to easily gather information about its agricultural status, assess its level of production and productivity, and plan to improve the same. Also, in terms of digital infrastructure development, advanced countries have been intentional and have gone so far, leaving developing countries behind. Even though many of the developing countries, especially Nigeria are naturally endowed with vast land for agriculture and good weather conditions, agricultural practices are still crude and less productive. Embracing digital infrastructure therefore seem to be crucial in transforming the agricultural sector of the economy. Moreover, digital infrastructure has the potential of creating job opportunities for citizens of a country. The hardware and software sections of digital technologies and the sub-sectors of agriculture require experts, who are well equipped with programming skills.

Notwithstanding the availability of good land with favourable climatic conditions and a teeming population of labour, employment in the Nigerian agricultural sector has been dwindling over the years. In the period, 1991-1995, the share of agricultural employment in total employment averaged 50%. In the next period, 1996-2000, the value fell to 49%, and thereafter to 46%, 43%, 39% and 36% in the subsequent periods. The decline in employment in the agricultural sector could be mistaken to mean the use of advanced technology in agricultural production. However, agriculture in Nigeria is still majorly practiced at the small-scale and subsistence level. Therefore, Nigerian agriculture is labour-intensive.

In addition, despite the United Nations (2015) Sustainable Development Goal (SDG) 9, which aims at achieving resilient infrastructure for industrialization, digital infrastructure in Nigeria is grossly inadequate. Although the Global Economy data (2023) shows an increasing number of telephone lines per 100 people, the network is poor in some areas; particularly rural agricultural communities. In some cases, people have to climb mountains or trees before they can reach out to others. Also, digital infrastructural inadequacies in the agricultural sector could pose a ripple effect on other sectors of the economy due to its pivotal role in supplying raw materials for production in many industries. Therefore, this study investigates how well digital infrastructure boosts employment in the Nigerian agricultural sector.

Based on the issues discussed above, the study will answer the following pertinent questions:

i. Is there any significant relationship between digital infrastructure and employment in the Nigerian agricultural sector?

ii. What is the directional link between digital infrastructure and employment in the Nigerian agricultural sector?

iii. How does digital infrastructure impact on employment in the Nigerian agricultural sector?

Digital infrastructure provides the platform to evaluate agricultural performance and determine where we want to be as a nation in terms of agricultural development. Previous studies have examined the effect of infrastructure and its components on the Nigerian economy as a whole (Olaoye, 2019) but the effect of digital infrastructure specifically is yet to be explored. Also, other studies have concentrated on the industrial sector, especially the manufacturing sub-sector (Olaoye, 2023) or on trade (Nwaogwugwu & Olaoye, 2018). Investigating the relevance of digital infrastructure to employment in the Nigerian agricultural sector will help stakeholders prioritize investment to boost agricultural productivity. Stakeholders in the agricultural sector include agricultural farmers, ranchers, retailers, crop consultants, processors and distributors, seed and fertilizer companies, agricultural credit institutions, and others. Also, the study will sensitize the government and its agents to the importance of data capturing and record keeping in the agricultural sector. Digital infrastructure provides a good platform for this and easy access to such data; thereby improving the agriculture statistical databank of the country.

This study covers a period of thirty-four years from 1991 to 2024. The start period comes after the implementation of the Structural Adjustment Programme (SAP) of the World Bank, which was introduced in Nigeria in 1986. SAP had as one of its objectives, the improvement of agricultural productivity and reduction in the dependence on imports. The study expects that the agricultural sector should have derived some benefits from SAP and about thirty-nine years (39) after SAP, remarkable progress should have been recorded in the Nigerian agricultural sector. The end period was chosen to ensure the recency of the report. The study focused on the agricultural sector of Nigeria and particularly on labour employment. In addition, the scope of the study was limited to digital infrastructure; excluding all other components of infrastructure to allow for thorough investigation.

After this introductory section, Section Two handles the review of literature, while Section Three deals with the theoretical framework and methodology. Section Four presents the results and discusses the findings of the study and finally, Section Five concludes and presents policy recommendations.

LITERATURE REVIEW

Digital infrastructure aids agricultural production as well as the supply value chain. Through digital infrastructure farmers can reach several customers and sell their products at considerable and profitable prices; thereby positioning such farmers above the poverty line (Nagaraj, 2022). However, inadequate extension services cum inadequate information on technological advancement has widened the gap in the rate of technological adoption in the agricultural industry (Balu, 2020). It has therefore become imperative for agricultural extension workers to create awareness for farmers on the availability of digital infrastructural facilities, which helps to facilitate the marketing of agricultural products (Oseremen, 2020).

Digital technology enables digital marketing by establishing relationships between producers and potential end-users of agricultural products through the internet, mobile phones, and other digital media (Panda & Mishra, 2022). The technologies employed in the digital transformation of the Agricultural sector can be divided into categories and subcategories, including digital marketing (Zhang, et al. 2019). The adoption of digital infrastructural facilities for the marketing of agricultural products helps to avoid the operations of middlemen and provides direct access for farmers to international markets. Accountlearning (2023) identified poor pricing of products, lack of transparency, degradation of quality, and lack of adequate information as some of the shortcomings of the presence of middlemen in the supply value chain. Hence, incorporating digital infrastructure is one of the ways to ensure that the ill effects of the activities of middlemen in the supply value chain are checkmated and farmers get appropriate compensation for their labour and a well-deserved boost in their financial status.

Several studies have investigated the need to digitize market access for farmers, especially in rural areas. Nyarko, et al. (2020) noted that digitizing market access avails farmers the opportunity to have real-time information about pricing; thereby increasing their bargaining power. Agyei, et al. (2021) also emphasized the positive effect of digital infrastructure in enhancing transparency in the agricultural value chain. However, the existence of digital infrastructure is insufficient in yielding the desired outcome.

Digital Transformation is key in achieving the desired change in the performance of the agricultural sector. Therefore, Gatner Inc (2023) defines digital transformation as the record of changes in business operation and value provision to customers through the adoption of digital technology in every aspect of a business. Farmers must be strategic in their agricultural business by incorporating digital infrastructure in every phase of their venture. This study considered how well the use of digital infrastructure can enable employment in the Nigerian agricultural sector.

Several theories exist on digital infrastructure and employment. Theories showing the link between digital infrastructure and the agricultural sector include market access theory, technology adoption theory, market efficiency theory, and network effects theory. The Market Access theory contends that digitization can improve market access by lowering transaction costs, improving market information, and opening up new markets for small-scale farmers (Kalaintzandonakes & Beaudry, 2017). Overall, the Market Access theory suggests that digitization can help small-scale farmers gain market access and improve their livelihoods. The technology adoption theory proposes that farmers are more likely to adopt digital technologies if they are simple to use, easy to access, and provide clear benefits, such as increased profits or lower costs. This theory proposes that farmers make technology adoption decisions based on a cost-benefit analysis and the perceived ease of use of the technology (Rogers 2010, Bektas & Sarac, 2017). Overall, the Technology Adoption Theory suggests that the success of agricultural digitization is dependent on the technology's ease of use, accessibility, and perceived benefits.

Market Efficiency theory contends that digitization can improve market efficiency by reducing information asymmetry and improving price discovery. This theory assumes that digital technologies can provide real-time information about prices, supply, and demand, thereby reducing information asymmetry and improving market efficiency (Fafchamps 2011; Timmer 2015). The Network Effects theory proposes that agricultural digitization can increase market access by generating network effects, which are positive ripple effects that occur when a product becomes more valuable to users as more people use it. This theory is based on the idea that digital technologies can generate network effects that increase market access and improve small-scale farmers' livelihoods (Boudia & Salame 2017). Overall, the Network Effects Theory suggests that agriculture digitization can play an important role in increasing market access and improving the livelihoods of small-scale farmers through positive ripple effects (Molla & Falck 2017). These theories summarize the potential benefits of agriculture digitization and emphasize the importance of factoring in technology adoption, market efficiency, and network effects when designing and implementing digital solutions for small-scale farmers (Reardon et al., 2017).

Also, economic growth theories establish the link between digital infrastructure and employment in the agricultural sector. Keynesian theory holds that employment and output are functions of effective demand, which consists of aggregate demand and aggregate supply. On the demand side, consumption and investment determine the level of employment and output, while on the supply side, the two variables are determined by factor inputs. Keynesian theory accounts for the short-run period and since factor inputs do not vary in the short-run; then employment is a function of consumption and investment demands. Keynesian theory however failed to explain why the market suffers from weak aggregate demand.

The neoclassical theory holds that the level of employment is determined in a perfectly competitive market where firms supply goods that are demanded by the household at the market clearing price and firms demand for labour hours to produce the goods from the household who supply the labour services in exchange for the equilibrium wage rate. The Neoclassical theory assumes that the marginal productivity of labour falls as the number of workers using fixed capital increases. This suggests that the employment of more workers leads to lesser output. Another assumption is that supply creates its demand. This means that all goods produced and supplied to the market are demanded by consumers. However, this assumption seldom holds in real-life

situations. Finally, labour supply is solely determined by the utility derived from the real wage. Workers are motivated by the remuneration received for the labour hours invested into production processes.

According to the neoclassical economists, employment is available for everyone willing to work at the prevailing wage rate, so unemployment is voluntary. However, critics have argued that the neoclassical theory is deficient in explaining away recession by presenting potential workers who remain unemployed as lazy citizens. The critics argued that if truly recession represents periods of unemployment and an increase in the desire for leisure, the sale of recreational facilities should skyrocket during such periods.

Empirical evidence from case studies and field experiments validate the hypotheses of these theories. The International Food Policy Research Institute (IFPRI) undertook a case study in India to assess the influence of a mobile phone-based market intelligence service on farmer decision-making and market results (Kumar & Quiroz, 2012). Via text messages and voice conversations, the service offered farmers up-to-date information on market prices, weather, and agricultural techniques. According to the study, farmers who used the market information service had significantly greater levels of market participation, increased income, and enhanced market efficiency compared to those who did not use the programme. Farmers who used the service, in particular, were able to sell their products at greater prices and were less likely to sell their crops to intermediaries or brokers offering poor prices (Kumar & Quiroz, 2012).

Njagi et al. (2018) conducted a study in India to assess the influence of a mobile phone-based agricultural advising service on farmer adoption of improved agricultural practices. Via voice calls and text messages, the service informed farmers about improved farming techniques and market prices. The study discovered that the mobile phone-based service was beneficial in improving farmer acceptance of improved practices, particularly when the information provided was simple to grasp and implement. Farmers were more inclined to adopt new technologies if they were straightforward and inexpensive to deploy, and if they exhibited benefits such as improved yields and income (Njagi et al., 2018).

Minten et al. (2018) investigated the influence of a mobile phone-based agricultural market information system on farmer marketing behaviour and market efficiency in Ethiopia. Using voice calls and text messages, the system provided farmers with timely and accurate market pricing information. According to the study, the mobile phone-based market information system boosted market efficiency by lowering price discrepancies and increasing market participation. Farmers who got market information were more willing to participate in remote markets, and market pricing became more consistent across locations (Minten et al., 2018). It can therefore be submitted that digitizing market access has the potential to improve price discovery by providing real-time information, reducing information asymmetry, and improving market efficiency. When farmers have access to undiluted information, it allows them to compare prices and make better decisions about when to sell and who to sell to.

Kikulwe et al. (2014) conducted a study in Tanzania to assess the influence of a mobile phone-based market information service on farmer adoption of enhanced maize varieties and market participation. The service informed farmers about improved maize varieties and market pricing via phone calls and text messages. The study discovered that the mobile phone-based market information service had a favourable network effect on farmer adoption of enhanced maize varieties and market participation. Farmers who got the information were more likely to adopt the improved varieties, and the information spread quickly through social networks. As more farmers adopted the improved cultivars, market participation rose, resulting in higher prices and broader market access for all producers (Kikulwe et al., 2014).

Existing studies have examined the effect of digitizing market information on market outcomes and market access (Kikulwe et al. 2014, Njagi et al., 2018). However, these studies used only questionnaires and descriptive-analytical techniques which might not be robust compared to the current study that used econometric techniques to capture the nature and strength of the association of variables, the direction of flow of the variables, and the effect of digital infrastructure on employment in the Nigerian agriculture. Furthermore, there is a dearth of studies on the effect of digital infrastructure on employment in agriculture. Previous studies focused on agricultural output rather than employment. However, there cannot be output without employment. Therefore, this study examined how well the adoption of digital infrastructure has

affected employment in agriculture. In addition, this study is distinct for specifically focusing on Nigerian agriculture where limited attention has been paid in the past.

Theoretical Framework and Methodology

Keynesian theory forms the basis for this study. Keynes (1936) noted that in the short-run period, the level of agricultural output and employment depends on effective demand. Effective demand is determined by two factors: aggregate demand and aggregate supply. Aggregate supply is a function of physical and technical factors of production. Usually, these factors do not change in the short run. Therefore, Keynesian theory assumes that the aggregate supply function is stable in the short run. On the other hand, aggregate demand is assumed to be a function of consumption demand and investment demand. Therefore, the level of employment depends on consumption and investment.

According to Keynes, consumption depends on income and consumption increases as income rises; but not as much as the increase in income. Since income is either spent on consumption expenditure or saved, as income rises, savings also increase. Therefore, to increase output and employment, consumption can be increased by stimulating the marginal propensity to consume. The marginal propensity to consume depends on several factors such as the psychology of consumers, their tastes, habits, social structure, wants, expectations, and so on. However, these factors remain constant during the short run, hence, employment is majorly dependent on investment.

Investment is a function of interest rate and marginal efficiency of capital. Investment is inversely linked with interest rate but positively responds to the marginal efficiency of capital. The marginal efficiency of capital depends on the cost of capital and the prospective yield. Marginal efficiency of capital rises as the cost of capital falls and marginal efficiency of capital falls as the prospective yield rises. The cost of capital is fixed in the short-run so it cannot influence marginal efficiency of capital. Also, in the short run, the prospective yield might not have a substantive effect on the marginal efficiency of capital because it is a psychological factor that is subjective to the expectation of the investor.

Interest rate, being the other determinant of investment can be lowered to increase investment and employment. Interest rate is a function of the demand for and the supply of money. The demand side is based on the liquidity preference theory which holds that people will only be willing to part with their liquid assets if interest rate is high and vice-versa. People might prefer to hold their liquid assets in the form of cash for transactionary, precautionary, and speculative motives. Cash held for transactionary and precautionary motives are income-elastic, while that held for speculative motive is a function of interest rate. The higher the interest rate, the lower the demand for money (cash) and vice-versa. Liquidity preference is also a psychological factor, which is subject to the decision of the speculator. Therefore, it is not possible to influence the demand for money to lower interest rates.

The supply side, which is the second determinant of interest rate is assumed to be fixed during the short-run. Monetary authorities do not often vary the supply of money. Keynes further argued that the equilibrium level of output and employment is determined at the point where savings equals investment. Savings is a function of income *[s(Y)]* and is the excess of income over consumption *(S=Y-C)*. Also, the Keynesian theory noted that income is equal to the sum of consumption and investment *(Y=C+I).* Therefore,

$$I = Y - C \quad (1)$$

and $$S = Y - C \quad (2)$$

Hence, $$I = S \quad (3)$$

Keynesian theory of employment and output can also be explained in terms of aggregated demand *(C+I)* and aggregate supply *(C+S)*. A disequilibrium between aggregate demand and aggregate supply leads to unemployment. Therefore, employment and output can be stimulated by increasing aggregate demand. Moreover, Keynes noted that since consumption does not rise proportionately to income, there will be

underemployment in the economy. The employment gap created by the non-proportionality in the income-consumption movement cannot be filled up due to lack of required investment. To fill the income-consumption gap, there is need for increase in the level of investment.

Secondary data for the period of 34 years from 1991 to 2024 was obtained from the World Bank's World Development Indicators (2025) and the Global Economy data (2025). This source provides reliable and comprehensive data on the variables. The researcher had to ensure that a uniform unit of measurement was used. Thus, the variables were transformed into the logarithmic form.

Keynesian model is of the view that any change in the components of aggregate expenditure will affect output and employment. The study assumes that changes to the factors influencing agricultural employment will affect agricultural workers' productivity. Following Keynes (1936) the functional form of the model adapted for the study can be expressed as:

$$AGEP = f(DIF, AGVA, PKY, ER, IFL, INT, COR) \quad 4$$

Where,

AGEP = Employment in the Nigerian Agricultural sector

DIF = Digital infrastructure (proxy by the number of telephone lines per 100 people)

AGVA = Agricultural value-added

PKY = Remuneration to workers in the agricultural sector (proxy by per-capita income)

ER = Exchange rate

IFR = Inflation rate

INT = Interest rate

COR = Control of Corruption and absence of violence

The choice of the number of telephone lines per 100 people is informed by the fact that it is the least affordable form of digital infrastructure accessible to rural farm dwellers.

The model can be written in econometric form as:

$$lnAGEP_t = \alpha_0 + \alpha_1 lnAGEP_{t-1} + \alpha_2 lnDIF_t + \alpha_3 lnAGVA_t + \alpha_4 lnPKY_t + \alpha_5 lnER_t + \alpha_6 lnIFR_t + \alpha_7 lnINT_t + \alpha_8 lnCOR_t + ECM(-1) + \mu \quad 5$$

where *ln* shows that the variables are in logarithm form; α_0 is the intercept; α_1 *to* α_8 represent the elasticities of the explanatory variables; *t* is the time factor; *ECM(-1)* captures the residual and μ is the error term, which incorporates all other factors affecting employment in the agricultural sector that are not included in the model.

The descriptive properties of the variables were examined. Due to the non-stationarity of most macroeconomic variables at levels, the study examined the stationarity of the variables using the Augmented Dickey-Fuller Unit root test. The study proceeded to determine the relationship between the variables using correlation analysis, which shows the nature and strength of the association. Then the directional link between digital infrastructure and employment in the agricultural sector was investigated using the Granger causality test. Thereafter, the study used the Johansen cointegration technique to determine the existence or non-existence of long-run association among the variables before proceeding to the Error correction mechanism (ECM). Finally, diagnostic tests were carried out to validate the results.

A priori, it is expected that digital infrastructure, agricultural value-added, remuneration to workers in the agricultural sector, and control of corruption would positively affect employment in the agricultural sector, while inflation and interest rate would negatively affect employment in the agricultural sector. Exchange rate could be positively or negatively associated with employment in the agricultural sector depending on whether it is in favour of the Nigerian economy or otherwise.

RESULTS AND DISCUSSION

Table 1 presents the descriptive analysis of the variables. The mean values of employment in agriculture, digital infrastructure, agricultural value-added, remuneration to workers, inflation, interest rate, and corruption are $0.182, 31.239, $26.149, $7.45, 87.317, 1.751, and 0.929 respectively. The mean employment in agriculture represents the average number of labourers employed in the Nigerian agricultural sector. The mean employment in agriculture seems low. The average value of digital infrastructure appears to be downward biased as the average value is closer to the minimum value than the maximum. On the other hand, average agricultural value-added is closer to the maximum value, and average remuneration to agriculture workers is closer to the minimum. It appears that workers receive little remuneration for their labour compared to the output produced. The values of standard deviation show moderate dispersion from the mean values, except for the case of agricultural value-added.

Table 1: Descriptive Analysis of Variables

Variable	Mean	Std. Dev.	Min	Max
AGEP	0.182	1.667	-4.157	2.035
DIF	31.239	39.704	0.010	106.354
AGVA	26.149	0.553	25.394	26.952
PKY	7.450	0.253	7.154	7.827
IFL	87.317	107.292	0.494	379.201
INT	1.751	0.899	0.066	4.187
COR	0.929	0.508	0.013	2.290

Source: WDI (2025) and Global Economy data (2025)

Augmented Dickey-Fuller (ADF) unit roots test was employed to test the level of stationarity of the variables. The result of the test is presented in Table 2. The critical value for the test is 2.94. The results show that all the variables were found to be stationary at first difference. The implication of this result is that there is long-run association among the variables.

Table 2: Unit Roots Test

Augmented Dickey-Fuller (ADF)			
Variable	**Level**	**First Difference**	**Remark**
AGEP	2.218	9.273	I(1)
DIF	0.534	12.222	I(1)
AGVA	1.087	4.012	I(1)

ER	2.959	4.918	I(1)
IFL	2.825	5.506	I(1)
INT	6.068	12.179	I(1)
PKY	0.463	4.570	I(1)
COR	1.187	12.64	I(1)

Source: WDI (2025) and Global Economy data (2025)

The result in Table 3 shows that a positive and moderate association exists between employment in agriculture and some explanatory variables (digital infrastructure, agricultural value-added, remuneration to workers, and inflation). This implies a co-movement between employment in agriculture and these variables. While exchange rate and control of corruption show a positive but weak association with employment in agriculture, interest rate shows a negative and weak association. The inverse relationship between interest rate and employment in agriculture implies that interest rate moves in the opposite direction to employment in agriculture. Reduction in interest rates will probably stimulate investment in agriculture creating room for employment in agriculture.

Table 3 Correlation Matrix

	AGEP	DIF	AGVA	PKY	ER	INT	IFL	COR
AGEP	1.000							
DIF	0.578	1.000						
AGVA	0.463	0.982	1.000					
PKY	0.460	0.958	0.971	1.000				
ER	0.042	-0.230	-0.316	-0.230	1.000			
INT	-0.116	-0.217	0.228	-0.114	0.246	1.000		
IFL	0.588	0.945	0.926	0.850	-0.271	-0.263	1.000	
COR	0.342	0.649	0.697	0.613	-0.334	-0.330	0.723	1.000

Source: WDI (2025) and Global Economy data (2025)

The result of the Granger causality test in Table 4 shows that unidirectional causality exists between employment in agriculture and three of the explanatory variables (digital infrastructure, agricultural value-added, and inflation) at the 10%, 10%, and 5% levels of significance (lsf) respectively. The directional flow runs from the explanatory variables to the explained variable, employment in agriculture. This implies that any of digital infrastructure, agricultural value-added, and inflation granger-causes employment in agriculture. However, no directional flow exists between employment in agriculture and the other explanatory variables.

Table 4 Granger Causality Test Result

Null Hypotheses:	Obs	F-statistic	Probability	Remark
DIF does not granger-cause AGEP	41	2.589*	0.089	Unidirectional

AGEP does not granger-cause DIF		1.605	0.215	
AGVA does not granger-cause AGEP AGEP does not granger-cause AGVA	41	2.707* 0.836	0.080 0.442	Unidirectional
PKY does not granger-cause AGEP AGEP does not granger-cause PKY	41	2.141 0.124	0.132 0.884	No causality
ER does not granger-cause AGEP AGEP does not granger-cause ER	41	0.035 0.390	0.965 0.680	No causality
INT does not granger-cause AGEP AGEP does not granger-cause INT	41	1.161 0.949	0.325 0.397	No causality
IFL does not granger-cause AGEP AGEP does not granger-cause IFL	41	3.398** 1.177	0.045 0.320	Unidirectional
COR does not granger-cause AGEP AGEP does not granger-cause COR	41	1.177 1.190	0.320 0.316	No causality

** and * represents significance at the 10% and 5% significance levels

Source: WDI (2025) and Global Economy data (2025)

The result of Johansen cointegration test on Table 5 provides evidence to the presence of at least four cointegrating equations. The greater values of trace statistic over the critical values implies that long-run relationship exists among the variables. The null hypothesis of no long-run relationship among the variables is therefore rejected once there is at least one cointegrating equation.

Table 5 Johansen Cointegration Test Result

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Probability **
None*	0.711	208.104	159.530	0.000
At most 1*	0.654	157.190	125.615	0.000
At most 2*	0.629	113.721	95.754	0.002
At most 3*	0.497	73.086	69.819	0.027
At most 4	0.381	44.949	47.856	0.091
At most 5	0.332	25.268	29.797	0.152
At most 6	0.191	8.701	15.495	0.394
At most 7	0.000	0.019	3.841	0.889

Trace test indicates 4 cointegrating equations at the 0.05 level

* denotes rejection of the hypothesis at the 0.05 level

** MacKinnon-Haug-Michelis (1999) p-values

Source: WDI (2025) and Global Economy data (2025)

The result of the parsimonious error correction in Table 6 shows the effect of digital infrastructure on employment in the Nigerian agricultural sector. The validity of the result lies in the significance of the F-statistic value at the 1% level of significance (lsf). Also, the Durbin-Watson statistic (2.097) is low, and the R-squared (0.799) and the Adjusted R-squared (0.725) show that the model is well-fitted with the explanatory variables explaining approximately 80% and 73% respectively of the changes in employment in agriculture. Table 6 shows that the speed of adjustment of employment in agriculture to changes in the explanatory variables is significant and negative. In addition, employment in the previous year significantly and positively affects current-year employment at the 10% lsf. 1% increase in previous year employment leads to approximately 88% increase in current year employment in agriculture.

Furthermore, current year digital infrastructure significantly and positively affects employment in agriculture at the 5% lsf. 1% rise in current-year digital infrastructure leads to an approximately 19% increase in employment in agriculture. Worthy of note is the negative and significant effect of the previous year's digital infrastructure on current-year employment in agriculture. 1% increase in the previous year's digital infrastructure leads to an approximately 18% decline in current-year employment in agriculture. This implies that there is a need for a regular upgrade of digital infrastructure stock to complement employment in agriculture. Also, the result reflects the importance of the control of corruption. The previous year's control of corruption seems inadequate and so significantly and negatively affects employment in agriculture at the 5% lsf, while the current year's control of corruption on the other remains insignificant. 1% lack of control of corruption allows for a rise in violent acts within the country and leads to a 157% decline in control of corruption. This implies that if corruption is left uncontrolled and violence prevails in Nigeria, workers will be greatly discouraged from engaging in agriculture.

Table 6 Result of Parsimonious Error Correction Mechanism (ECM)

Dependent Variable: AGEP

Variable	Coefficient	Standard Error	t-Statistic	Probability
C	37.373	92.984	0.402	0.691
AGEP(-1)	0.883	0.508	1.737*	0.093
DIF	0.185	0.079	2.356**	0.025
DIF(-1)	-0.182	0.102	-1.782*	0.085
AGVA	-1.871	3.809	-0.491	0.627
PKY	1.534	3.431	0.447	0.658
ER	-0.109	0.383	-0.283	0.779
INT	0.237	0.206	1.150	0.259
IFL	0.007	0.012	0.574	0.570

COR	0.615	0.484	1.273	0.213
COR(-1)	-1.579	0.620	-2.547**	0.016
ECM(-1)	-0.717	0.518	-1.384	0.077

** and * represents significance at the 10% and 5% significance levels

Source: WDI (2025) and Global Economy data (2025)

This study set out to ascertain the nature and strength of the association and the directional causality between digital infrastructure and employment in agriculture. Then the study proceeded to investigate the effect of digital infrastructure on employment in Nigerian agriculture. The result of correlation analysis revealed that digital infrastructure was positively and moderately associated with employment in agriculture. This implies that as digital infrastructure improves, employment in agriculture increases. This result stresses the need for the use of technology in modern agriculture. Furthermore, the result showed that the exchange rate was weakly but positively associated with employment in agriculture. This implies that even though the exchange rate and employment in agriculture move in the same direction, the current exchange rate does not encourage labour supply to the agricultural sector. If this situation persists, there will be excess demand for labour and this will lead to wage rise leading to reduced profit for investors in the sector. Interest rates are negatively but weakly associated with employment in agriculture. This implies that the control variables move in the opposite direction to employment in agriculture. As the interest rate rises, employment in agriculture falls and vice-versa.

Moreover, the result of Granger causality shows that unidirectional flow exists from digital infrastructure to employment in agriculture. This implies that improvement in digital infrastructure boosts employment in agriculture. Workers are attracted to the agricultural sector if the working conditions are more conducive. In addition, unidirectional flow from agricultural value-added and inflation to employment in agriculture was recorded. This implies that increased agricultural output will provide job opportunities for more workers in the sector; probably in the processing and marketing sub-sectors. Furthermore, the causality result shows that inflation encourages more workers in the agricultural sector. This implies that workers are attracted to agriculture when agricultural produce is priced high.

The parsimonious error correction result shows that digital infrastructure spurs employment in agriculture and reliance on the previous year's infrastructure stock will reduce employment in agriculture. Also, an increase in the control of corruption stimulates employment in agriculture and vice-versa. This result implies that more people will be interested in engaging in agriculture if violence and corruption are reduced in Nigeria. Farmers who have abandoned farming due to the incessant kidnapping of farm workers for ransom will be encouraged to return to their farms. Also, those who have abandoned their farms due to cattle and herdsmen's invasion of their farms will see reason to return to their farms.

CONCLUSION AND RECOMMENDATIONS

The study examined the effect of digital infrastructure on employment in agriculture. The study covered a period of 34 years from 1991 to 2024. Using correlation analysis, the study found a moderate association between digital infrastructure and employment in agriculture. Also, the study established a unidirectional flow from digital infrastructure to employment in agriculture using the Granger causality test. Furthermore, using the Johansen cointegration and error correction mechanism, the study established the existence of long-run association among the variables and found that current year digital infrastructure stock spurs employment in agriculture. The previous year's digital infrastructure stock was found to be insufficient in stimulating current-year employment in agriculture. In addition, control of corruption and reduced violence stimulate employment in agriculture.

Therefore, the study concluded that a strong and positive flow from digital infrastructure to employment in agriculture exists. Also, continuous improvement in access of farmers to telephone services and other digital

infrastructure components stimulates employment in agriculture. Furthermore, control of corruption and reduced violence are inevitable for encouraging employment in agriculture. Control of corruption allows for the involvement of more workers in agriculture. Based on the findings, the study recommends that:

i. The telecommunication industry in Nigeria should plan and work towards systematically improving the access of rural dwellers to telephone lines and other digital infrastructure for better engagement of existing farmers and the attraction of potential ones.

ii. It is imperative for government agencies like the Independent Corrupt Practices and other related offences Commission (ICPC) to extend its focus on fighting corruption and terrorist's invasion to remote villages and farms to make the environment conducive for productive farming activities.

The study suggests that apart from employment in agriculture, further studies could examine the effect of digital infrastructure on employment in other sectors like manufacturing, health, education and so on. Also, the effect of other institutional quality variables like political stability, rule of law and regulatory quality could be examined.

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APPENDICES

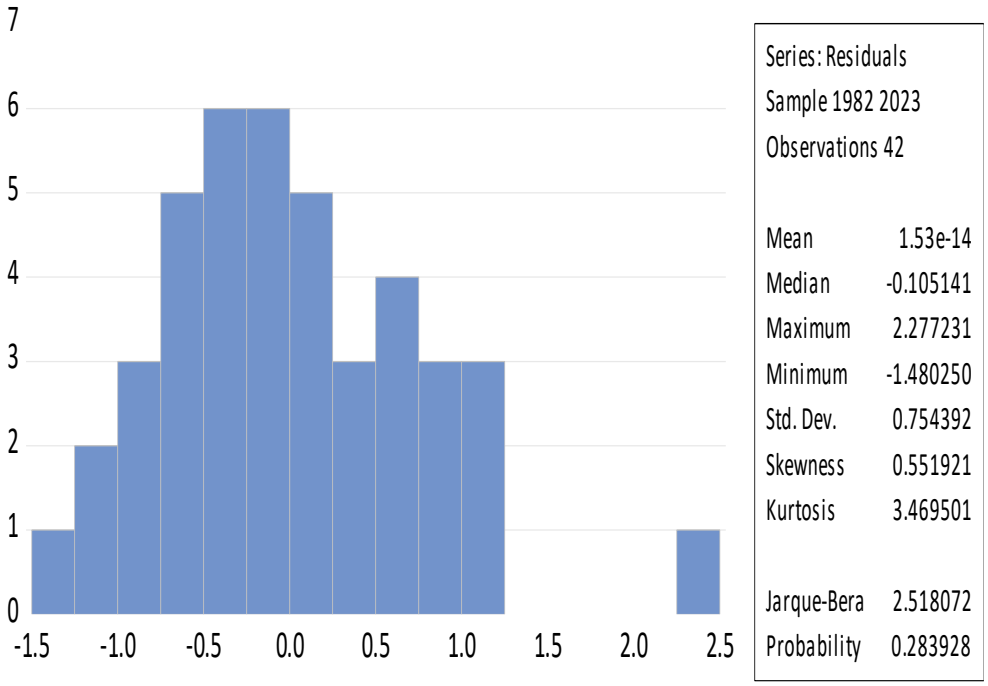
Appendix I: Static version of the error correction mechanism

Dependent Variable: AGEP
Method: Least Squares
Date: 03/06/24 Time: 14:47
Sample: 1981 2023
Included observations: 43

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	202.1855	26.19301	7.719062	0.0000
DIF	0.149313	0.022519	6.630616	0.0000
AGVA	-8.305625	1.256114	-6.612160	0.0000
ER	-0.558597	0.303400	-1.841123	0.0741
IF	-0.016824	0.005499	-3.059263	0.0042
IR	0.142031	0.185059	0.767487	0.4479
PKY	1.808100	2.624733	0.688870	0.4954
COR	0.989115	0.477477	2.071547	0.0457

R-squared	0.750165	Mean dependent var	0.182029
Adjusted R-squared	0.700198	S.D. dependent var	1.666847
S.E. of regression	0.912668	Akaike info criterion	2.821352
Sum squared resid	29.15370	Schwarz criterion	3.149017
Log likelihood	-52.65906	Hannan-Quinn criter.	2.942185
F-statistic	15.01323	Durbin-Watson stat	1.716540
Prob(F-statistic)	0.000000		

Appendix II: Normality Test



Appendix III: Test for Serial Correlation

Breusch-Godfrey Serial Correlation LM Test:
Null hypothesis: No serial correlation at up to 2 lags

F-statistic	0.289765	Prob. F(2,28)	0.7507
Obs*R-squared	0.851669	Prob. Chi-Square(2)	0.6532

Test Equation:
Dependent Variable: RESID
Method: Least Squares
Date: 03/06/24 Time: 15:18
Sample: 1982 2023
Included observations: 42
Presample missing value lagged residuals set to zero.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	9.372181	96.18433	0.097440	0.9231
AGEP(-1)	-0.008614	0.522624	-0.016482	0.9870
DIF	0.030072	0.089769	0.334991	0.7401
DIF(-1)	-0.019173	0.107782	-0.177885	0.8601
AGVA	-0.055313	3.915878	-0.014125	0.9888
PKY	-1.083087	3.819716	-0.283552	0.7788
ER	-0.028171	0.394728	-0.071367	0.9436
IR	-0.005246	0.212817	-0.024651	0.9805
IF	-0.001945	0.012154	-0.160005	0.8740
COR	0.043937	0.506927	0.086673	0.9315
COR(-1)	0.020397	0.635717	0.032085	0.9746
ECM(-1)	0.289609	0.655815	0.441602	0.6622
RESID(-1)	-0.383352	0.504400	-0.760016	0.4536
RESID(-2)	-0.073809	0.223575	-0.330131	0.7438

R-squared	0.020278	Mean dependent var	1.53E-14
Adjusted R-squared	-0.434593	S.D. dependent var	0.754392
S.E. of regression	0.903570	Akaike info criterion	2.896275
Sum squared resid	22.86027	Schwarz criterion	3.475498
Log likelihood	-46.82177	Hannan-Quinn criter.	3.108583
F-statistic	0.044579	Durbin-Watson stat	2.061449
Prob(F-statistic)	1.000000		

Source: Author's Computation (2024)

Appendix IV: Test for Homoskedasticity

Heteroskedasticity Test: Breusch-Pagan-Godfrey
Null hypothesis: Homoskedasticity

F-statistic	1.095282	Prob. F(11,30)	0.3978
Obs*R-squared	12.03432	Prob. Chi-Square(11)	0.3611
Scaled explained SS	7.581315	Prob. Chi-Square(11)	0.7502

Test Equation:
Dependent Variable: RESID^2
Method: Least Squares
Date: 03/06/24 Time: 15:18
Sample: 1982 2023
Included observations: 42

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	47.06883	91.99495	0.511646	0.6126
AGEP(-1)	-0.573539	0.503060	-1.140100	0.2633
DIF	-0.024193	0.077838	-0.310813	0.7581
DIF(-1)	0.076466	0.101198	0.755610	0.4558
AGVA	-1.766222	3.768806	-0.468642	0.6427
PKY	-0.020852	3.394842	-0.006142	0.9951
ER	-0.238922	0.378754	-0.630812	0.5329
IR	0.022366	0.203599	0.109854	0.9133
IF	-0.008493	0.011418	-0.743827	0.4628
COR	-0.247549	0.478395	-0.517458	0.6086
COR(-1)	0.597170	0.613338	0.973640	0.3380
ECM(-1)	0.288091	0.512923	0.561666	0.5785

R-squared	0.286531	Mean dependent var	0.555558
Adjusted R-squared	0.024926	S.D. dependent var	0.883622
S.E. of regression	0.872540	Akaike info criterion	2.800139
Sum squared resid	22.83976	Schwarz criterion	3.296616
Log likelihood	-46.80292	Hannan-Quinn criter.	2.982118
F-statistic	1.095282	Durbin-Watson stat	2.067700
Prob(F-statistic)	0.397833		