International Journal of Innovative Research and Advanced Studies (IJIRAS)
Volume 7 Issue 8, August 2020

ISSN: 2394-4404

Innovation Economics And Agribusiness In Nigeria

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***Abstract:** The increased need to ensure food security and end extreme poverty has made the agricultural sector key in countries globally. Recognising the need for increased productivity, this paper emphasised the need for a connexion between innovation and agriculture to improve production techniques in Nigeria. Time series secondary data for 24 years on agricultural output and innovation index were used in the study as the dependent and independent variables respectively while FDI and population were included in the study as control variables. Using the ARDL model, the study found that there is a weak significant short run relationship between agribusiness and innovation in Nigeria. The results are not far-fetched as majority of the agriculture activities in the country are small-scaled, with limited R&D, innovation and business consciousness. The study recommended policy-driven R&D and innovative practices in the agricultural sector to improve and sustain productivity.*

***Keywords:** Agribusiness, Agriculture, Innovation economics, Nigeria, R&D*

I. INTRODUCTION

The agricultural sector is fundamental to the growth and development of any country, particularly the developing countries basically because of its employment capacity. Evidently, the agricultural sector remains the main source of food income and raw materials in most countries. With a worldwide awareness on the need to ensure food security and end extreme poverty, agriculture has remained a key target sector to drive and sustain food production, growth and development both at the global and local level. Investing in the agricultural sector therefore becomes one of the most effective strategies to end hunger, end extreme poverty and improve general standard of living. However, for the agricultural sector to achieve its potential, the sector must be transformed. Many nations are noted to have begun their economic ascent with an agricultural transformation.

Goal 2 of the SDGs aims to end hunger and achieve food security through sustainable agriculture by the year 2030. This cannot be achieved where agriculture is practice on subsistence level. In highly industrialized countries, many activities essential to agriculture are carried on separately from the farm. Consequently, agricultural activities have become increasingly specialized and businesslike. This has led to increase production and more income to farmers in developed countries. However, although agriculture constitutes a significant portion of the economies of all African countries and contribute towards major continental priorities, the sector is still saddled with low productivity levels. Many African countries are increasingly dependent on food imports, despite its vast cultivable area, vibrant young population and favourable tropical climate. Africa is noted to have provided 8% of the world's total agricultural exports in the 1970s. Recently, this number has dropped to a negligible 2% (Veras, 2017).

Today, about 821 million – 1 in 9 people majority in African countries – are chronically undernourished. To meet growing food demand, agricultural output will need to significantly increase and the bulk of the increase is expected to come from family farmers who manage about 90 percent of the world's farms, produce over 80 percent of the world's food (FAO, 2014), but, paradoxically, are often poor and food insecure themselves. The main crux of this paper is therefore, to emphasise the need for a connexion of innovation and agriculture to improve production techniques and hence ensure increased productivity and sustainability in agribusiness in Africa with emphasis on Nigeria.

This paper is organised into five parts. Part 1 serves as a background to the study. Part 2 presents a review of the basic concepts. Part 3 presents the theoretical framework of the study and also examines empirical literature on the impact of innovation on agribusiness. Part 4 presents the methodology, data analysis and results. Part 5 presents the conclusion and recommendation.

II. CONCEPTUAL LITERATURE

AGRIBUSINESS

According to FAO (2017) agribusiness comprises business activities executed from farm to fork. The sector covers the entire value chain, including the supply of agricultural inputs, the production and transformation of agricultural products, and their distribution to final consumers. Its relevance is underlined by the fact that the sector: (1) serves as the main source of off-farm employment in rural areas in many countries particularly the developing countries; (2) has positive effects on poverty reduction and women's empowerment in countries where high-value agri-food exports are produced; (3) creates off-farm employment opportunities in agro-industrial firms located in rural areas: (4) improves the income of rural households through wage employment and spillover effects; (5) increases on-farm agricultural productivity through greater cash-flow that enables the purchase of inputs and increases capacity to innovate; (6) helps to forge the necessary link between the agriculture and manufacturing sectors, by providing material inputs for food processing, textiles and biofuels.

Agribusiness is when agriculture is treated as a vast and complex system that reaches far beyond activities on the farmland to include all others involved in bringing food and fibre to consumers…, (Wang, 2014) or the sum total of all operations involved in the manufacture and distribution of farm supplies, productions operations of the farm, and the storage, processing and distribution of the resulting farm commodities and items as noted by Davis and Goldberg (1957). Downey and Erickson (1987) sees it as all those business and management activities performed by firms that provide inputs to farm sector, produce farm products, and/or process, transport, finance, handle or market farm products. As noted by Nwuneli, (2011), agribusiness refers to the breadth of businesses engaged in all aspects of agriculture, from the provision of inputs such as seeds and fertilizer, to farming, processing, marketing, distribution, and retail sales.

According to Tersoo (2013), agribusiness is a concept that became popular in the early sixties in Nigeria. It arose along with recognition of the agro-processing sector as a new emerging sector. According to Marchet et al (2001), noted in Tersoo, 2013), agribusiness concerns in Nigeria constitute 70% of businesses operating in the country and has the potential to drive economic growth while curbing unemployment in the country.

INNOVATION ECONOMICS

Innovation is a rather subjective concept and sometimes difficult to define because what may be new to one person may be very outdated for another. However, despite this subjectivity, the '4Ps' model developed by Tidd and Bessant (2009) which describes product innovation, process innovation, position innovation, paradigm innovation, provides a powerful tool for identifying and classifying innovation. It builds on the hypothesis that successful innovation is essentially about positive change.

One of the earliest definition of innovation sees the concept as the introduction of a good (product), which is new to consumers, or one of higher quality than was available in the past or methods of production which are new to a particular branch of industry which are not necessarily based on new scientific discoveries and may have been used in other industrial sectors (Schumpeter, 1834) The OECD (1981) defines innovation as consisting of all those scientific, technical, commercial and financial steps necessary for the successful development and marketing of new and improved manufactured products, the commercial use of new or improved processes or equipment or the introduction of a new approach to a social service. According to the European Innovation Progress Report (2006) innovation is about creatively positioning or marketing an existing product, and about changing the business model; or a dynamic process which focuses on the creation and implementation of new or improved products and services, processes, positions and paradigms. Economists generally use the term to refer to increases in the quality and variety, or reductions in the cost, of goods and services provided by the market (Broughel and Thierer, 2019).

Innovation economics is an economic doctrine that reformulates the traditional model of economic growth so that knowledge, technology, entrepreneurship, and innovation are positioned at the center of the model rather than seen as independent forces that are largely unaffected by policy (Scott, 1996). Innovation economics is focused on how societies create new forms of production, products, and business models to expand wealth and quality of life (Robels, 2009). Therefore, innovation is the key element in providing aggressive top-line growth and for increasing bottom-line results (Davila, Epstein, and Shelton (2006).

From the standpoint of innovation economists, government policies which encourages innovation but distorts price signals can be accommodated in an economy since innovation rather than allocative efficiency drives today's knowledge-based economy (Robels, 2009).

Agricultural innovation is the process whereby individuals or organizations bring new or existing products, processes or ways of organization into use for the first time in a specific context in order to increase effectiveness, competitiveness, resilience to shocks or environmental sustainability and thereby contribute to food security and nutrition, economic development or sustainable natural resource management (FAO, 2018). From the foregone, agricultural Innovation is not limited to new a creation nor is it restricted to the modern use of technologies. It also the use of social, organisational, institutional or marketing processes or arrangements.

III. THEORETICAL FRAMEWORK

Endogenous growth theory (EGT) stresses that long-run economic growth rate is determined by forces that are internal or endogenous to the system, particularly those forces governing the opportunities and incentives to create technological knowledge. In other words, in the long run, the rate of per capita output depends on the rate of total factor productivity which is in turn determined by the rate of technological progress which itself takes place through innovations. Pioneered by Romer (1986), EGTs postulate that technological innovation is created in the R&D sectors using human capital and the existing knowledge stock. It is then used in the production of final goods and leads to permanent increases in the growth rate of output (Ulku, 2004).

Endogenous growth theories can be divided into two broad categories which are the accumulation-based models which postulates that that the combination of physical capital and human capital accumulation may be enough to sustain long-run productivity growth (Lucas 1988, Rebelo 1991), and innovation-based models which attempts to explain how technological change comes about and how it shapes economic growth (Groth, 2010).

The innovation-based growth theory recognizes intellectual capital, the source of technological progress, as distinct from physical and human capital. While physical and human capital are accumulated through saving and schooling, intellectual capital grows through innovation. For instance, increased demand for the output of the firm that requires the firms' actions can raise the pace of process innovation by giving firms more production experience.

Economists are increasingly of the view that differences in innovation capacity and potential are largely responsible for continual variations in economic performance and wealth creation among the nations in the world (Grossman and Helpman 1991). Research has established the link between weak productivity growth and lackluster development and diffusion of new technologies and knowledge (Hall and Scobie, 2005; Atkinson, 2013). R&D leads to the development of innovations that are the main contributor to technological progress and hence long term productivity growth.

The innovation-based theory is further sub-divided into (1) horizontal innovation - the effective transfer of knowledge and technology from one sector to another or the invention of new intermediate or final goods giving rise to new branches of trade, and (2) vertical innovation - the invention of better qualities of existing products and better production methods which make previous qualities and methods obsolete (Groth, 2010). The horizontal innovation theory finds ready application in this study. Romer (1990) simplified version of the horizontal innovation model is presented below, using the agriculture sector.

The output of a farmer is given by:

$$Y = \left(\sum_{i=1}^{N} x_i^{\alpha}\right) L_P^{1-\alpha},\; 0 < \alpha < 1 \qquad (1)$$

(1) is an extension of the Cobb-Douglas production function where *xi* describes the usage of all of the possible types of capital equipment *K* that could enter into production and L_P is labour input used in the production activity. Assuming K grows by the amount of forgone consumption, then

$$K = Y - C \qquad (2)$$

Romer further simplified the theory by assuming that the durables or capital goods do not depreciate. Given the stock of human capital devoted to the research sector or used in R&D as L^*, then total labour force is represented by (3) as

$$L = L_P + L^* \qquad (3)$$

Any person can devote human capital to either the final output sector or the research sector. However, research output depends on the amount of L^* devoted to research. It also depends on the stock of knowledge that is available to an individual doing research. Thus, if individual i devotes L^{i*} to research and has access to an amount A^i of the total stock of knowledge, with the simplifying assumption that anyone engaged in research has free access to the entire stock of knowledge, the rate of production of new knowledge will be

$$N_K = \varphi L^* A^i \qquad (4)$$

Where φ is a productivity parameter, relatively very small for individual researchers but an increasing function of the stock of technical knowledge in society. However, since knowledge is a non-rival input, and all researchers can take advantage of A at the same time then the output of new knowledge by individual *i* is

$$N_K = \varphi L^* A \qquad (5)$$

According to Romer (1990), summing across all individuals engaged in research, the aggregate stock of knowledge evolves according to:

$$\dot{A} = \varphi L^* A \qquad (6)$$

Thus, the number of new varieties invented per time unit is assumed proportional to amount of L^* devoted to R&D. Hence, the aggregate production function becomes

$$Y = K^{\alpha}(A L_Y)^{1-\alpha} \qquad (7)$$

The most basic proposition of this growth theory is that in order to sustain a positive growth rate of output per capita in the long run, there must be continual advances in technological knowledge in the form of new goods, new markets, or new processes according to Aghion and Howitt (1998). The theory holds that investment in human capital, innovation, and knowledge are significant contributors to economic growth. Thus EGTs emphasizes on endogenous technological change to explain the growth patterns of world economies.

EMPIRICAL LITERATURE

The relationships between productivity and innovation have longed been studied by many researchers. Solow (1956), Nelson (1959), Pavitt (1984), Wieser (2005), Hall and Scobie (2006), Shafi'I and Ismail (2015), Ifegwu (2016), FAO, 2018), for example, have shown a significant association between increases in per capita productivity and innovation. Wieser (2005) in his study concluded that on average there is a large and significant impact of R&D on firm performance. In China, Wei and Liu (2006) found positive impacts of R&D activities on productivity performance at the firm level. Their finding is consistent with observations at the sector level by Wu (2006) who showed that R&D contribution to productivity growth in manufacturing is statistically significant. The positive relationship between countries own R&D and productivity growth has also been confirmed by studies using international panel data (Frantzen (2000); Griffith, Redding and Reenen (2002). Savvides and Zachariadis (2003) showed that both domestic R&D and foreign direct investment increase the domestic productivity and value added growth.

Alston, Norton and Pardy (1995) described and measured how innovation affects the level of prosperity in the agricultural industry. Their study emphasized the importance of innovation in boosting productivity and increasing the income of farmers. To corroborate this view, FAO, (2018) noted that agricultural mechanization - a process innovation- enhances the workflow and sets standards for the processing, allowing easier access to agricultural markets. Studies such as those by Alston and Pardey (2014); Fuglie and Toole (2014); Pardey, Alston, and Chan-Kang (2013) have equally concluded that growth in agricultural productivity has played a leading role in meeting the growing global food demand.

Hall and Scobie (2005) in New Zealand estimated the contribution that R&D had made to agricultural productivity between 1927 and 2001. Their study found that the agricultural sector in New Zealand relied heavily on the foreign stock of knowledge generated off-shore and further revealed a significant positive relation between domestic knowledge and the growth of productivity in the agricultural sector. Ghazalian and Furtan (2007) using a theoretical gravity equation and panel data set from 21 OECD countries studied the effect of innovation on agriculture and agri-food exports in OECD countries. Their study concluded that R&D serving as a proxy for innovation has a net positive market expansion effect on exports for primary agricultural products as a 10% increase in R&D capital induced a 7.9% increase in exports of primary agricultural products. While R&D induced firms to increase their mark-up in the food processing sector.

Khan and Salim (2015) in their study analysed the role of research and development (R&D) in Australia's broad-acre farming using the semi-parametric smooth coefficient model proposed by Hastie and Tibshirani (1993) and Li *et al* (2002) and a state-level dataset covering the period 1995 to 2007. The results of the study showed that once both the direct and indirect effects are taken into consideration, R&D investments significantly increases outputs in the agricultural sector and that Australia may enhance its farming productivity by improving investment in public R&D.

In Africa, Dumbuya and Hongzhong (2015) examined the impact of National Innovation System on agricultural development productivity growth as a poverty alleviation tool towards the transformation of subsistence level of farming to commercialization in Sierra Leone from 2005 to 2014. Their empirical results reveal that national innovation system had a significant positive functional relationship with agricultural development productivity growth in the long run. While discussing the linkages between innovation, transformation and inclusion in Africa, Osakwe and Moussa (2017) concluded that technological innovation was necessary to drive structural transformation and inclusive development in the country. Using a cross-sectional World Bank Enterprise Survey dataset and the pooled ordinary least squares (OLS), Okumu, Bbaale and Guloba (2019) equally found employment growth to be positively associated with both process and product innovation for Uganda. Their study further revealed that a weak business environment especially intermittent electricity supply undermined the ability of innovation to induce employment growth. Policies and programs that encouraged firms' adoption of innovation, alongside a strong business environment was noted as necessary in driving employment growth in Africa.

Agricultural innovations have rapidly increased in India since the 1980s. Government data and surveys of seed firms show that from about 1990 to 2010 the number of new seed cultivars available to farmers in maize, wheat, and rice roughly doubled, while the number of cotton cultivars at least tripled. Biotechnology innovations went from zero in the 1990s to 5 genetically modified (GM) traits in hundreds of GM cotton cultivars by 2008. Pesticide registrations went from 104 in the period 1980–1989 to 228 during the period 2000–2010. Similar growth in innovations also occurred in the agricultural machinery, veterinary medicine, and agricultural processing industries. These innovations have come from foreign technology transferred into India as well as from in-country public and—increasingly—private research. Available data show that private investment in agricultural research grew from US$54 million in 1994/95 to US$250 million in 2008/09 (in 2005 dollars) Pray and Nagarajan (2012). All these have led to noticeable increase in agricultural products to cater for the teaming Indian population.

Studies such as Piesse and Thirtle (2010), Alston, Andersen, James, and Pardey (2011), Wang, Heisey, Huffman, and Fuglie (2013) and Fuglie and Toole (2014) have further provided evidence that R&D investments in agricultural helps to facilitate improvements in agricultural productivity in South Africa and the United States. Studies for developing countries such as the one done in Bangladesh by Rahman and Salim (2013) indicated that investment in R&D significantly improves agricultural productivity.

The International Symposium on Agricultural Innovation for Family Farmers organised by the FAO in 2018 reported several success cases of how innovation in agriculture has benefitted families and societies at large. Low-tech hydroponics enabled plant growth in arid environments with a soilless cultivation technique for the Sahrawi refugees Algerian Saharan desert. The International Institute of Tropical Agriculture (IITA), CIMMYT piloted the Drought Tolerant Maize for Africa (DTMA) particularly for Zimbabwean farmers while the FAO developed the eLocust3, a rugged tablet used by national survey and control teams in 30 countries. It was also reported that the Mediterranean fruit fly had finally been eradicated from the country through a nuclear technology known as the sterile insect technique (SIT) in 2017.

In Dakar, Senegal, agro-ecology – an integration of agronomy, ecology and social sciences is driving development and providing much needed employment opportunities for young people. In Tanzania, the Allanblackia supply chain serves as a source of additional income to farmers during harvest season. In Southern India, The Government of Telangana provided a non-repayable grant under the Agriculture Investment Support Scheme, to rural farmers and also a Farmers Group Life Insurance. This has helped farmers to escape the trap of perennial indebtedness to private money lenders (FAO, 2018).

Applying new technologies, practicing cost-effective extension programs, adopting flexible and low-cost financial instruments that can extend credit to poor small family farmers, treating agriculture as business and encouraging private investment in the agricultural sector are some ways of managing and hedging risk.in the sector while also increasing productivity (Fuglie, Gautam, Goyal, and Maloney, 2019).

IV. METHODOLOGY AND RESULTS

A. DATA AND DATA SOURCES

The paper used annual time series secondary data taken at successive equally spaced points in time. The data spans the period 24 years from 1994 to 2018. Data for agricultural output (*AGROT*) was used as a proxy for agribusiness in the study. The innovation index (*INDX*) for Nigeria was used to represent innovation economics. Population (*POP*) and Foreign Direct Investment (*FDI*) were included as control variables in the model. The former was used as a proxy for human capital while FDI - a substantial channel of international knowledge transfers as noted by Lee (2006) was used as a proxy for international knowledge spillover into agribusiness respectively. Agricultural output population and FDI were sourced from the Statistical Bulletin of the Central Bank of Nigeria (CBN) while the innovation index was sourced form the World Development Indicators (WDI).

B. ANALYTICAL MODEL

The model employed in this model is derived from the endogenous growth theory with emphasis on the innovation based model which holds that investment in human capital, innovation, and knowledge are significant contributors to and determinants of productivity. The study therefore assumes a linear relationship between agribusiness and innovation, human capital and stock of knowledge transfer. The functional relationship for the model is specified in equation (1).

$$AGROT_t = f(INDX_t, POP_t, FDI_t) \qquad (1)$$

We expand the functional relationship expressed in equation (1) in to an ARDL model specified in equation (2).

$$\Delta AGROT_t = \beta_0 + \beta_1 AGROT_{t-1} + \beta_{21} INDX_{t-1} + \beta_3 POP_{t-1} + \beta_4 FDI_{t-1} + \sum_{i=1}^{p} \alpha_1 \Delta AGROT_{t-1} + \sum_{i=1}^{q} \alpha_1 \Delta INDX_{t-1} + \sum_{i=1}^{s} \alpha_1 \Delta POP_{t-1} + \sum_{i=1}^{t} \alpha_1 \Delta FDI_{t-1} + U_i \qquad (2)$$

Where βs are the long-run parameters while α_s are short run parameters. p,q,s, and t are maximum lag. *U* is the stochastic error term, and *t* is point in time at which values of the variables are considered and i=1, 2, 3…T.

C. TREND ANALYSIS

The movement of the variables over the years is presented in figure 4.1

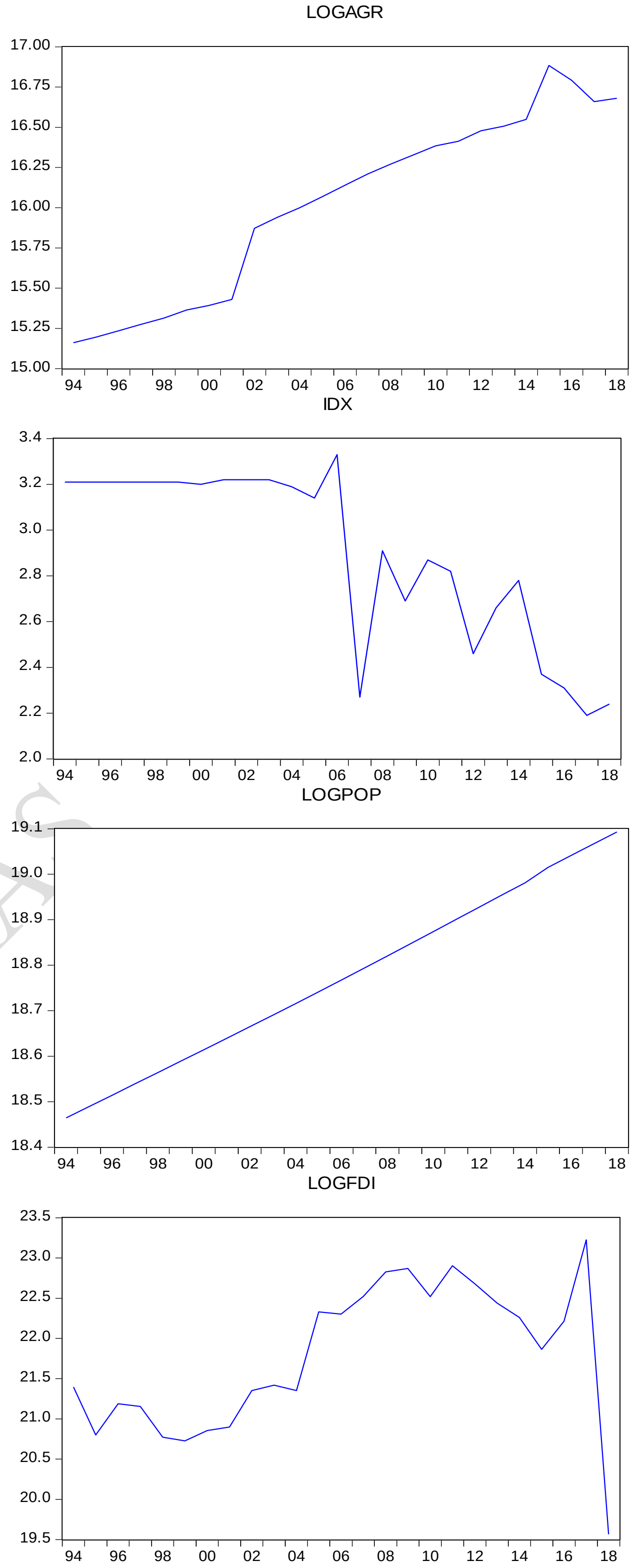

Figure 4.1: Trends of Variables

The time series plot of the natural logarithm of the annual output in the agricultural sector for the estimation period 1994 - 2018 presented in the Fig 4.1. Agricultural output exhibits an increasing trend with a spike in 2015 followed by a deep in 2016 due to the recession experienced that year in Nigeria. Innovation index remained constant at 3.21 for six years from 1994 to 1999 after which there was a marginal decline of 0.01 to 3.20 in 2000. The index increased thereafter by 0.02 and reached its highest in 2006 after which there was a drastic fall and series fluctuations. The lowest index was recorded in 2017 with a value of 2.19. In 2019 Global Innovation Ranking, the GII reported that Nigeria ranked below development expectation with an innovation performance that was underachieving compared to other African countries (World Intellectual Property Organization (WIPO), 2019).

Figure 4.1 further reveals a steady upward growth in population in Nigeria. According to the World Population Prospect (2019) the Nigerian government has been doing its best to curb the rapid growth in population in the country. However, the teeming population is an indication of a ready labour supply in the country. A sluggish and fluctuating upward trend is seen in FDI. There was a drastic decease in FDI in 2015 following the change in governance in the country and uncertainty that loomed around economic policies. The highest was recorded in 2017 due to government's policies that attracted FDI in t the country in a bid to end the recession experienced in 2016.

D. DESCRIPTIVE STATISTICS AND CORRELATIONS MATRIX

Table 4.1 presents the descriptive statistics of the variables for the estimation period 1994 to 2018

	LAGROT	INDX	LFDI	LPOP
Mean	16.02	2.89	26.4	18.7
Median	16.14	3.14	27.1	18.7
Maximum	16.8	3.33	29.1	19.0
Minimum	15.16	2.19	23.8	18.4
Std. Dev.	0.57	0.39	1.47	0.19
Skewness	-0.24	-0.64	-0.34	0.05
Kurtosis	1.65	1.875	2.02	1.80

Source: Authors' Computation, 2020

Table 4.1: Descriptive Statistics

The negative values of skewness for AGROT, INDX and FDI reveal that they all have long left tail while POP has a long right tail. The values of Kurtosis for all the variables which are less than three for a normal distribution means that AGROT, INDX, FDI and POP are all platykurtic. The Jarque Bera (JB) statistic is employed as a goodness-of-fit test to determine whether the sample data have a skewness and kurtosis that matches a normal distribution. Since the p-values associated with the JB statistic for all the variables are greater than 5%, we can conclude that the data are a normally distributed

	LOGAGR	INDX	LOGFDI	LOGPOP
LOGAGROT	1	-0.8035	0.5696	0.9732
INDX	-0.8035	1	-0.3892	-0.8494
LOGFDI	0.5696	-0.3892	1	0.4779
LOGPOP	0.9732	-0.8494	0.4779	1

Source: Authors' Computation, 2020

Table 4.2: correlation Matrix

From Table 4.2, we can infer the direction of relationship between AGROT and the determinants included in the model. Expectedly, the correlation matrix reveals a positive relationship between AGROT and FDI and POP indicating that as these variables increase, AGROT will equally increase. However, against expectation, INDX has a negative correlation with AGROT, suggesting an increase in INDX will lead to a fall in productivity in agribusiness Also we see from table 42 that the correlation between AGROT and the other variables included in the model are high.

Table 4.3 Augmented Dickey Fuller Test

Variable	Level	Decision	First difference	Decision
LAGROT	-1.81	Nonstationary	-4.803***	Stationary
INDX	-4.62***	Stationary	-9.02***	Stationary
LFDI	-0.19	Nonstationary	-5.00***	Stationary
LPOP	3.36	Nonstationary	-4.437***	Stationary

Where *, **, and *** represents 10%, 5% and 1% statistical significance

Source: Authors' Computation

Unit root test rest based on Augmented Dickey Fuller (ADF) test is reported in table 4.3. All variables are stationary after first difference except investment which is stationary at level. Having established the order of integration of the variables, we followed Lutkephohl (1993) to determine the optimum lag length k. Most of the test statistics including AIC, SC and HQ suggested lag 1 and lag 4 as reported in table 4.4.

Lag	LogL	LR	FPE	AIC	SC	HQ
0	0.692943	NA	1.59e-05	0.300642	0.499013	0.347372
1	122.4584	188.1831*	1.09e-09*	-9.314404*	-8.322548*	-9.080753*
2	128.7944	7.487994	3.12e-09	3.12e-09	-6.650516	-8.015286
3	152.771	19.61781	2.50e-	2.50e-09	-6.582242	-8.553575

*indicates lag order selection by the criterion

Table 4.4: VAR Lag Order Selection Criteria

The bound F statistics is greater than both lower and upper bound at 10% significance level when 3 lags are considered and also significant at 5% in model with 1 lag as reported in table 4.5a and 4.5b respectively. This result indicates presence of long run co integration which enables us to proceed into estimation of long run and short run estimates. The error correction term reported in table 5a further indicates the presence of long run relationship.

Selected Model: ARDL(1, 0, 1, 1)

Variable	Coefficient	Std. Error	t-statistic	Prob.
PANEL A: Cointegrating Form				
D(INDX)	0.074	0.09	0.83	0.42
D(LFDI)	0.024	0.02	0.97	0.34
D(LPOP)	45.90*	11.67	3.93	0.00
CointEq(-1)	-0.47*	0.18	-2.58	0.01
PANEL B: Long Run Coefficients				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
INDX	0.16	0.20	0.78	0.45
LFDI	0.15*	0.07	2.18	0.04
LPOP	1.48**	0.76	1.95	0.07
C	-18.7	12.5	-1.49	0.15
PANEL C: DIAGNOSTICS				
Serial Correleation	LM	0.40		
Heteroschedasticity	ARCH	0.47		
Linearity	Ramsey Reset	0.11		
Stability	CUSUM	Within 5%		
Cointegration	Bounds F-test	4.41***		

Where *, **, and *** represents 10%, 5% and 1% statistical significance

Table 4.5: ARDL Cointegrating and Long Run Form

Based on SIC the lag 1 was selected by the VAR lag selection criteria. We implement the ARDL model at the selected lag length. The error correction term reported in

Table 4.5a is negative and statistically significant which indicates the presence of co-integration. The bounds test F-statistics also confirms the presence of long run co-integration. The short-run and long-run results are reported in panel A and B of Table 4.5 respectively.

The short run estimates in panel A indicates that all the variables (innovation, FDI and population) have a positive impact on AGROT however, only the impact of population is statistically significant in the short-run. The result shows that a 1% increase in population will bring about 45.9% increase in agribusiness.

The long-run estimates are reported in panel B of Table 4.5 shows all the variables under consideration are positively related to AGROT though the impact of innovation on AGROT is not statistically significant. An increase of 1% in FDI will on the average bring about a 0.15% increase in AGROT. While a 1% increase in population will on average be accompanied by a 1.48% increase in AGROT.

Null Hypothesis:	LAG 1 F-Statistic	LAG 1 CONCLUSION	LAG 2 F-statistics	LAG 2 CONCLUSION
LFDI does not Granger Cause LAGROT	1.78	LAGROT → FDI	2.11	No Causality
LAGROT does not Granger Cause LFDI	5.62**		1.12	
LPOP2 does not Granger Cause LAGROT	2.23	LAGROT →LPOP	2.37	LAGROT →LPOP2
LAGROT does not Granger Cause LPOP2	8.45***		3.91**	
INDX does not Granger Cause LAGROT	1.25	LAGROT →INDX	0.63	IAGROT→ INDX
LAGROT does not Granger Cause INDX	12.9***		3.50**	
LPOP2 does not Granger Cause LFDI	1.21	LFDI→LPOP	0.92	LFDI →LPOP
LFDI does not Granger Cause LPOP2	9.43***		15.6***	
INDX does not Granger Cause LFDI	0.12	LFDI→INDX	0.20	LFDI→INDX
LFDI does not Granger Cause INDX	5.71**		1.47	
INDX does not Granger Cause LPOP2	0.97	LPOP→INDX	4.00**	INDX↔POP2
LPOP2 does not Granger Cause INDX	17.8***		4.20**	

Where *, **, *** represents statistical significance at 10%, 5% and 1% respectively

Table 4.6: Granger Causality

In table 4.6, we report the Granger causality test result estimated at lag 1 and lag 2 respectively. At lag 1, there is a statistically significant unidirectional causality from AGROT to FDI and not from FDI to AGROT; while at lag 2 there is no evidence of causality between AGROT and FDI causality in all directions.

There is a unidirectional causality from INDX to FDI at lag 1 but no evidence of causality is found at lag 2. In both lag 1 and 2, the result also shows a unidirectional causality from AGROT to POP; unidirectional causality from INDX to AGROT; while a unidirectional causality is found from INDX to POP only in lag 2. Both lag 1 and 2 show evidence of bidirectional causality from POP to INDX. Thus The granger causality test shows evidence that FDI, POP and INDX do not granger cause AGROT rather AGROT granger causes FDI, POP, and INDX in Nigeria.

5. CONCLUSION AND RECOMMENDATION

There is no significant long run relationship between innovation and agricultural output in Nigeria. Though there is a significant short run relationship, the effect of innovation on agricultural output is very marginal. This results are further corroborated with the Granger causality test that reveals that innovation does not cause changes in agricultural output in the country. These results are to be expected. In spite of the reality that the Nigeria economy is heavily dependent on agriculture, the sector remains largely underdeveloped and mostly primitive in its activities to date. Majority of the agriculture activities in the country are small-scale, with limited R&D to aid production and a near absence of innovation and business consciousness in agricultural activities. Most agricultural activities in the country still operate at the subsistence level, and mostly in the rural areas with uneducated labour force. The sector still remains largely unattractive to the teeming youth population and workers in the sector have limited access to training. The country's exports is still dominated by petroleum and related products even in the face of crashing oil prices, while the agricultural sector often recognised as the mainstay of the economy cannot even produce enough to feed the domestic economy.

The poor performance of the sector can also be traced to severe underinvestment in agriculture by the both the public and private agencies. Conflicting and poorly implemented policies have also been the bane of the sector. Hence we recommend that government must intentionally encourage R&D and innovative practices in the agricultural sector through adequate investment and ground breaking policies that will enable the sector operate as a business rather than a mere means for subsistence existence.

Nigeria has the capacity to become a leading agribusiness and agro-allied industrial nation considering the vast arable land in the country. It is noted that of the 923 million square kilometers in Nigeria, over 90 percent is arable, 40 percent is cultivated, and only 10 percent is properly cultivated. Animal husbandry is near absent and concept of agribusiness is yet to be exploited to its full potential in the country. Adopting innovating technologies in the agriculture sector can ensure value-addition to activities in the sector thus boosting productivity.

In addition, innovative application of ICT is a key strategy to attract the youth into the agricultural sector. In addition to its youth appeal, ICT also has great potential to improve agricultural and agribusiness efficiency in Nigeria.

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