TALLINN UNIVERSITY OF TECHNOLOGY
School of Business and Governance
Ragnar Nurske Department of Innovation and Governance

Olamide Ogunsolu

# Technological Transformation of the Agricultural Sector in Nigeria: An Antidote for Economic Recession

MA thesis
Technology Governance and Digital Transformation

Supervisor: Professor Erik S. Reinert, PhD
Co-supervisor: Salah Chafik, MA

Tallinn 2021

I hereby declare that I have compiled the thesis independently
and all works, important standpoints and data by other authors
have been properly referenced and the same paper
has not been previously presented for grading.
The document length is **9354** words from the introduction to the end of conclusion.

Olamide Ogunsolu

……

(signature, date)

Student code: 194526HAGM

Student e-mail address: nifemi.ogunsolu@gmail.com

Supervisor: Professor Erik S. Reinert, PhD:

The paper conforms to requirements in force

……

(signature, date)

Co-supervisor: Salah Chafik, MA:

The paper conforms to requirements in force

……

(signature, date)

Chairman of the Defence Committee:

Permitted to the defence

……

(name, signature, date)

# Table of Contents

# Abstract

Nigeria is presently in a state of an economic recession caused by a decline in oil price. Various scholars and researchers have embarked on research journeys to find a viable way out of the recession. The most recent solution provided by these scholars and researchers is the adoption of digital technologies to transform the agricultural sector which will lead to an increase in economic growth and consequently serve as a means to mitigate economic recession. The belief is that, since agricultural performance has been linked to economic growth in Nigeria for over a decade, then a technological advancement of the agricultural sector will not only lead to an increase in economic growth in Nigeria but serve as a means out of the current recession.

This thesis, therefore, attempts to investigate the effect of digital technologies on the agricultural sector in Nigeria and to examine the possible impact of a digitalized agricultural sector in revamping the economy of Nigeria. The research method used in this study is the exploratory research method and a case study research design which made use of a qualitative method of analysis to generate findings and provide analysis. The result and findings of the study shows that, agreeably there is a likelihood of a technological transformed agricultural sector in to increase domestic economic activity in Nigeria. However, it cannot solve the issue of recession and neither is it a sustainable solution.



Keywords: Technological transformation, digital technologies, recession, agricultural sector, Keynesian theory, economic growth.

# 1 Introduction

In recent times, there has been a technological shift in the agricultural sector across the globe. This technological innovation has paved ways for many countries and has a role to play in their economic development. A vivid example is The Republic of Korea, the Food and Agriculture Organizations (FAO) of the United Nations stated that:

> "*The Republic of Korea, one of the so-called "East Asian tigers", achieved extremely rapid economic growth and industrialization following the upheaval resulting from the Korean War (1950-1953). This growth was marked by the ability of the economy to absorb surplus agricultural labour, increase the productivity of farm labour and avoid a serious discrepancy between rural and urban incomes"* (FAO , 2006).

Also, according to David Blandford in 'Contributions of Agriculture to green growth', an *OECD* article, he pointed out that high productivity growth in agriculture has played a fundamental role in achieving tremendous development in most countries (Blandford, n.d.). In line with this David Gale Johnson estimates that "the average growth rate in labour productivity in industrial countries in the post-war period to 1980 was 4.3% per annum, compared to 2.6% in other sectors" (Johnson, 1991). African/Nigerian scholars, experts, academic researchers, etc. believe that a technological transformation of the agricultural sector will have a significant impact on the country's GDP, which will, in turn, lead to economic advancement. In one of the biggest news outlets in Africa The *Punch*, in his concluding remarks Chukwuemeka Fred Agbata Jnr stated:

> *"...it is pertinent to note that the agricultural sector in Africa has really come of age and the application of ICT to its operation is absolutely necessary for the growth and development of the industry. ICT must be taken as a priority. In this regard, we look up to the policymakers and stakeholders in the agricultural sector in Nigeria to put heads together and work towards making this happen"* (Agbata, 2019).

In an article on *Harvard Business Review*, Ndubuisi Ekekwe presented his view on 'How digital technology is changing farming in Africa'. In his view, digital technology paves a pathway and holds a hidden potential for farmers, investors and entrepreneurs to develop a more efficient means of food production and consumption in Africa which could bring about a

considerable amount of economic, social and environmental benefits (Ekekwe, 2017). In agreement with Ndubuisi, Olasupo Ojo mentioned in his report 'Technology as a key to agriculture's success in Nigeria' on *African Harvesters Agribusiness Hub* that, the implementation of technology in agriculture coupled with envisioned and sound policies can usher Nigeria out from the belly of poverty, inflation and unemployment issues currently faced by the country (Ojo, 2016).

However, what they fail to understand is, what works for *all* may not work for *one*. Also, these countries that are being potentially emulated, are industrialized. It is impossible to emulate just an aspect of a particular country without any obvious similarities. Nigeria has indeed recorded a reasonable amount of growth over the years according to the statistics shown by the Manufacturers Association of Nigeria (MAN), nevertheless, GDP remains static. In an article written by Femi Adekoya in *The Guardian,* MAN noted that "global evidence has shown that no country in the world had ever fully industrialized without a robust railway system" (Adekoya, 2019).

Nigeria is presently in a state of economic recession. Nigeria has had more political crises, debt servicing issues, high inflation, fluctuation in the foreign exchange markets and fall in revenue than most countries. The oil boom which would have been a permanent blessing to Nigeria has unfortunately taken a great shift of attention to oil money, this, in turn, led to the abandonment of agriculture (Maria 2015 cited in Chukwuma 2018, 147). It can therefore be said that agriculture in Nigeria has suffered from years of abandonment, negligence, inconsistent and poorly envisioned government policies, Inadequate government incentive to farmers, short supply of basic infrastructure and a lot of bureaucratic blockages in executing policies and agricultural programmes amongst governmental agencies (Ariyo 1997 cited in Uzonwanne 2019, 195).

Flowing from the premise of the first paragraph, it can be understood that there is a shift of focus on the technological transformation of the agricultural sector in Nigeria as the only way out of an economic setback. This thesis, therefore, attempts to investigate the effect of digital technologies on the agricultural sector in Nigeria and to examine the possible impact of a digitalized agricultural sector in revamping the economy of Nigeria. In line with this, the main research questions of this thesis will be:

1. To what extent can digital technologies transform the agricultural sector in Nigeria?
2. To what extent can a digitalized agricultural sector serve as a viable tool to lead Nigeria out of the current recession?

The research method employed in this study is the exploratory research method. This method best justifies this thesis because the subject matter under investigation has not been comprehensively explored in the past. Also, employing the exploratory research method provides a deeper and concrete understanding of the subject matter which is to investigate the effect of digital technologies on the agricultural sector in Nigeria and to examine the possible impact of a digitalized agricultural sector in revamping the economy of Nigeria, consequently, this thesis opens a pathway for future related research with more tangible analyses. In respect to research design, this thesis adopts a case study research, which made use of the qualitative method of analysis to gain an understanding of the current subject of the thesis. Data used in this thesis was collated from secondary sources such as academic literature, news articles, document analysis and other online journals.

The structure of the remainder of the thesis will proceed as follows; Section 2 comprises an overview of the Nigerian economy, empirical reviews (previous literature that relates to this thesis) and the gap in the literature. The following section which is Section 3 outlines the theoretical framework that was used in this thesis as a guide for analysis. Section 4 is the empirical part of the thesis which covers the research methods used in this thesis, introduction of the research objectives and research questions, presentation of findings and analyses of findings using the theoretical framework provided in the previous section, as the basis of analysis. The final section, Section 5, which is the concluding part of the thesis contains, discussion and concluding remarks (summary and recommendations).

# 2 Literature Review

## 2.1 Overview of The Nigerian Economy

Nigeria is the most populated country in Africa. In an assessment carried out by *Worldometer* centred on the United Nation data, Nigeria can account for over 207 million residents, followed by Ethiopia which counted for over 114 million people (Worldometer, 2020). Furthermore, Nigeria is ranked 7$^{th}$ position among the world most populated countries, according to the statistics provided by the *World Population Review* (World Population Review, 2020). The Federal Republic of Nigeria is located in the western part of Africa and commonly referred to as "Giant of Africa". The Federal Republic of Nigeria gained independence in 1960 and is currently ruled by the commander-in-chief of the Nigerian Armed forces, President Muhammadu Buhari also known as grand commander of the order of the Federal Republic of Nigeria (GCFR). Since the discovery of oil in 1958 in Niger Delta, Nigeria has been a paramount exporter of crude oil. There was a shift from agriculture which was the main export and means of revenue for the country to crude oil. This is what economists refer to as evidence of "Dutch disease" (Pinto, 1987). Notwithstanding, in as much as oil revenue accounts for a substantial percentage of Nigeria's total export earnings and an average percentage of government revenue, it's contribution to the country's GDP is of little or no importance compared to non-oil revenue (Evbuomwan, 2017, p. 2). According to the annual report presented by *The Central Bank of Nigeria*, it was stated that:

> *"Total federally-collected revenue (gross) rose by 6.9 per cent to N10,215.1 billion, or 6.9 per cent of GDP in 2019. The development was attributed to significant improvement in receipts from non-oil. Oil revenue (gross), at N5,536.7 billion or 3.8 percent of GDP, fell by 0.2 per cent below the level in 2018 and accounted for 54.2 percent of total federally- collected revenue"* (Central Bank Of Nigeria, 2019, p. 155).

Prior to this, The Federal Republic of Nigeria fell into a recession in 2016 as a result reduction in oil prices and production which was caused by pipeline repairs, vandalism activities as well as issues that resulted from the circle of shutting down and turning the operating system back on over and over again (Central Intelligence Agency, 2019). This led to a clamour for diversification of the economy with emphasis on Agriculture as a roadmap to economic development. Various scholars such as Suberu O. J., Ajala O. A., Akande M. O., etc. are

advocates of this school of thought, in the journal on '*Diversification of the Nigerian Economy towards a Sustainable Growth and Economic Development'*. They expressed their view on the issue of diversification. Suberu O. J., et al are of the notion that the only viable way to bring Nigeria out of the current economic recession caused majorly by the decline of oil price is through diversification since the root of the problem initially was focusing on oil as the main source of revenue (J., et al., 2015). In correspondence with the above, Ogundele Olorunfemi et al on '*Agricultural diversification as an antidote to Economic recession in Nigeria: product option*' in a conference proceeding, gave an outlook on the subject of diversification. According to them, the result of findings shows that "crops such as maize, sesame seeds, and soybean and fish production can go a long way in rescuing the situation. More investments into these commodities are, therefore, recommended" (Olorunfemi & Cajetan, 2017, p. 84).

However, another school of thought emerged in disagreement with the above assumption. Joseph E. Tonuchi and Nwankwegu A. Onyebuchi believe that in as much as diversification of the economy has the potential to revamp the economy, certain events have to take place for the diversification of the Nigerian economy to fulfil its potential. In their words; *"In spite of the potential of Nigeria in diversifying her economy and most other African countries, the continents have not achieved any meaningful progress in attracting foreign investor in the country*" (Tonuchi & Onyebuchi, 2019, p. 918). Also, the Nigerian government has formulated various diversification related policies especially on agriculture that would produce sustainable growth, nonetheless, the inconsistency on the part of the government in following these policies through to the end is one of the main reasons for the failure of diversification in Nigeria. The moment a new government emerges, the policies made by the former government gets kicked to the curb and new policies are being implemented, the circle goes on and on.

For instance, according to the Transformation Agender (2011-2015) that contains the summary of Federal government's key priority policies, programmes and project under the government of the former president of Nigeria, Goodluck Jonathan, mapped out seven sectors as the main growth drivers during the transformation period of 2011-2015, they are agriculture, water resources, solid minerals, manufacturing, oil and gas, trade and commerce as well as culture and tourism (National Planning Commission, 2011). However, the current president of Nigeria, Muhammadu Buhari, during his first tenure in 2015, channelled his resources and attention to fighting corruption and dealing with insecurities (for example, the attempt to eradicate Boko haram). This is not to say that the agenda was not important as Nigeria at the time was in a

deep state of terrorism attacks, but this should not have to put a stop to the previous transformation agenda and or shy away from the activities that were carried out by the agricultural sector, water and resources sector, solid minerals sector, manufacturing sector, oil and gas sector, trade and commerce sector and culture and tourism sector, as they were drivers of growth during the transformation period (National Planning Commission, 2011). This shows the level of inconsistency on the part of the government. In 2019 nevertheless, after he won the presidential election for the second time, the president of Nigeria, Muhammmadu Buhari in his second tenure, has decided to focus his attention towards growing the economy and fighting against poverty and unemployment by banning the importation of food and the empowerment of more local farmers. His goal is to "use agriculture as a means to solve unemployment among youths" (Ukpe, 2020), knowing fully that the policies put in place for the previous agenda during his first tenure has not been completely fulfilled.

The current pandemic (Covid-19) being faced by the world today has an obvious impact on the Nigerian economy. Before the outbreak, the Nigerian economy has been struggling to recover from developmental challenges that relate to education, employment opportunities, poverty and hunger, national security, low productivity, corruption, low income, etc. These issues still exist and prominent, to crown it all, if it was difficult to find strategies against these issues, the pandemic had made it worse for a breakthrough to occur. According to the press release '*Nigeria's Economy Faces Worst Recession in Four Decades, says New World Bank Report*' by *The World Bank* stated that:

> *"The report shows that the human cost of COVID-19 could be high. Beyond the loss of life, the COVID-19 shock alone is projected to push about 5 million more Nigerians into poverty in 2020. While before the pandemic, the number of poor Nigerians was expected to increase by about 2 million largely due to population growth, the number would now increase by 7 million with a poverty rate projected to rise from 40.1% in 2019 to 42.5% in 2020. …Over 40% of Nigerians employed in non-farm enterprises reported a loss of income in April-May 2020…"* (The World Bank, 2020).

As a result of this, various individuals took to social media to find a remedy for their current situation. Since many people have lost their jobs and source of income, people have started to invest their time in e-commerce, online advertisement, website and application design, virtual assistant, fish business and farming to have various sources of income. The truth is this, the

Nigerian government would not in any way aid its citizens by giving out stipends and pensions because Nigeria is currently in a state of loss of oil revenue as a result of the decline in oil price. The Federal Republic of Nigeria plans to cut health care spending by more than 40%, according to the article '*Nigeria proposes steep basic healthcare budget cuts despite coronavirus*' written by Paul Carsten and Camillus Eboh on *Reuters* United States edition (Carsten & Eboh, 2020).

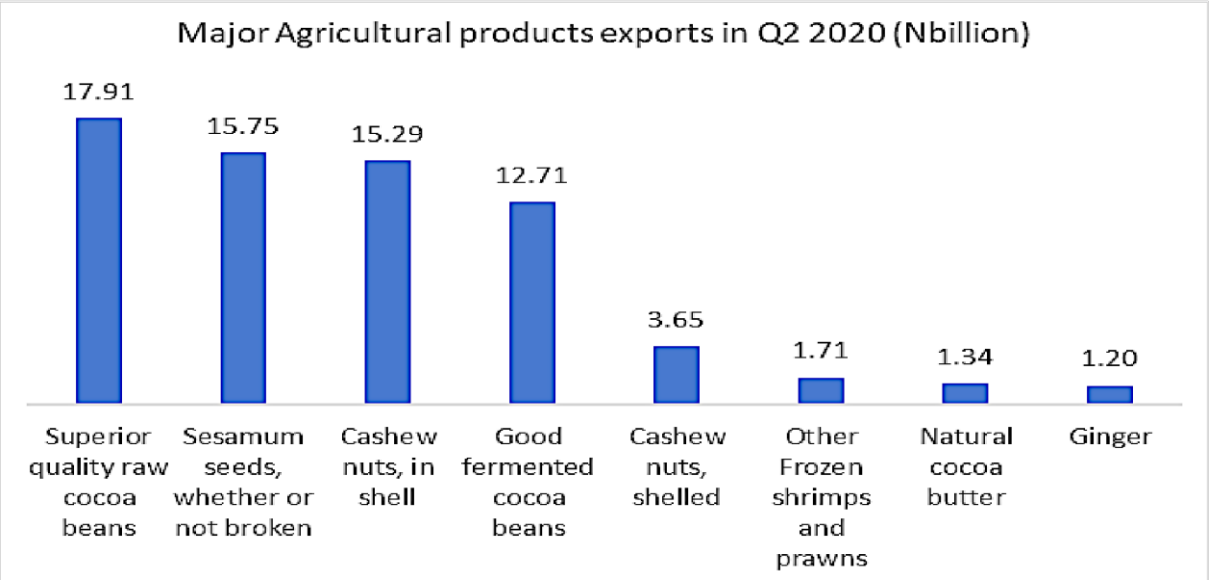
## 2.2 A Brief Bird's Eye View of the Agricultural Sector in Nigeria

It has been established that before the discovery of crude oil in 1958, agriculture served as a means of survival and a major source of government revenue and the country's total earnings. Also, during the pre-colonial era, the economy of Nigeria was shaped with fishing, farming, craftsmanship, etc. Agriculture was the driving force of the nation, until the advent of colonialism, imperialism as well as the discovery of crude oil, which has made the Nigerian economy into a mono-product economy, with the attention on only oil. Agricultural practices and activities in time turned into an industry with various branches and sub-activities (crop production, livestock, forestry and fishing). The latest foreign trade released by the National Bureau of Statistics shows that the major traded agricultural products are, superior quality raw cocoa beans, sesamum seeds, whether or not broken, cashew nuts, in shell, good fermented Nigerian cocoa beans, cashew nuts, shelled, other frozen shrimps and prawns, natural cocoa butter, ginger, coconuts, desiccated, fresh or dried, whether or not shelled or peeled and Shea nuts (National Bureau of Statistics, 2020).

Furthermore, concerning import/export, the National Bureau of Statistics on Foreign Trade in Goods Statistics stated that:

> *"... The main consumers of superior quality cocoa were The Netherlands (N9.3 billion), Indonesia (N3.7 billion) and United States (N2.4 billion). Other Agricultural exports were Sesamum seeds exported to Japan (N6.0 billion) and to China, worth N2.3 billion. Also, Cashew nuts were exported to Vietnam, worth N12 billion. In terms of imports, Durum wheat worth N41billion was imported from the United States, Russia (N28.8 billion) and Latvia (N24.5 billion)"* (National Bureau of Statistics, 2020)

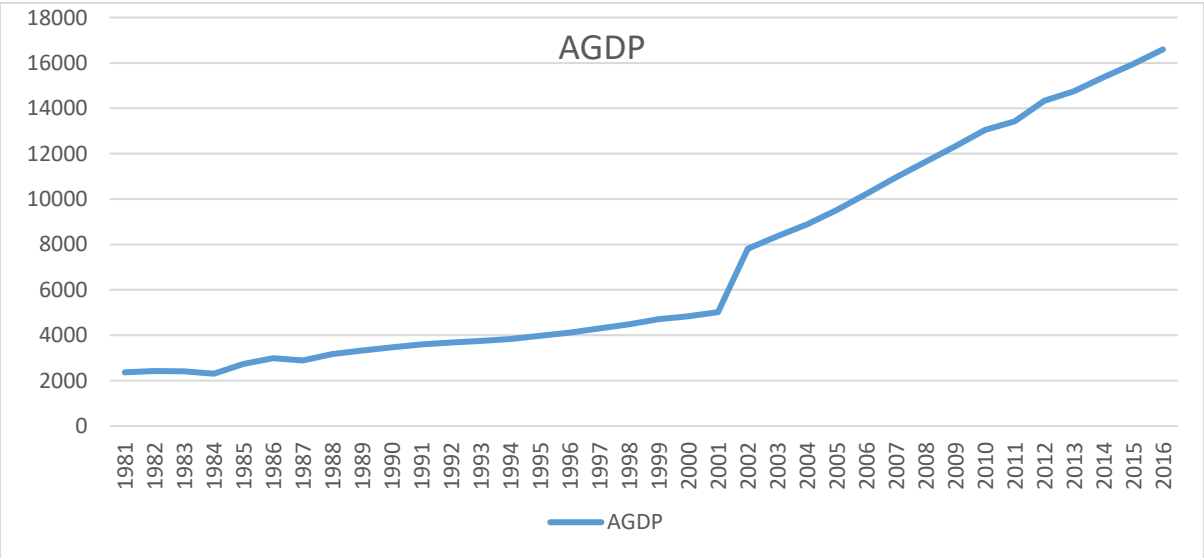
Figure 1. Major Agricultural products in Q2 2020 (₦billion)




*Source:* (National Bureau of Statistics, 2020).

The agricultural sector in Nigeria has indeed registered a substantial amount of growth and development over the years. In a research study carried out by Olamide Ogunsolu on '*Agricultural Performance and Nigerian Economy; An Antidote for Economic Recession (1981-2016)*' using the econometric technique of analysis, the econometric tool for analysis, was EViews 9. The result from the graphical analysis of the trend of AGDP using the time series of 1981-2016, shows the growth of agricultural output in each year (Ogunsolu, 2018). Below is a graphical representation of the trend of analysis.

Figure 2. Graphical Trend of Analysis for Agricultural Output (1981-2016)




*Source:* (Ogunsolu, 2018).

The debate, however, is on the impact of agricultural output and development on the economic growth of Nigeria. Most scholars, researchers, writers, philosophers all over the globe believe that agricultural performance has a significant impact on the overall economic growth in Nigeria. According to the standard in respect to determining the relation between two or more series which in this case is between agricultural output and economic growth, a period of over five decades must be covered (Omorogiuwa, et al., 2014, p. 141).

A research study carried out by Ewetan Olabanji, Fakile Adebisi, Urhie Ese and Oduntan Emmanuel at Covenant University, Ota, Nigeria, on '*Agricultural output and economic growth in Nigeria'*, showed that there is a long-run relationship between agricultural and economic growth in Nigeria (1981-2014) having implemented the Johansen co-integration approach and Vector error correction model. This proves that agricultural output has an impact on the economic growth of Nigeria. However, according to the researchers, the result may differ if variables used to measure agricultural output are not the same (Olabanji, et al., 2017). This proves that there are discrepancies in selecting the variables for measuring Agricultural Output (AGDP) and it also proves that there is evidence of a discrepancy in various sources of data.

Likewise, in a study carried out by Onunze M. Tochukwu on the '*Impact of agricultural development on Nigeria economic growth*' with the implementation of the ordinary least square method (OLS) and the following independent variables; Agricultural Development (AGD), Capital Formation (CFN) Inflation Rate (INF), and Interest Rate (INT), the result of the analysis shows that agricultural development has "appreciably impacted positively on the economic growth in Nigeria" (Tochukwu, 2012).

Similarly, in a journal article written by Oji-Okoro Izuchukwu on '*Analysis of the Contribution of Agricultural Sector on the Nigerian Economic Development'*, shows a positive relationship between GDP and the three independent variables that were used in the study, namely; Domestic Saving, Government Expenditure on Agriculture and Foreign Direct Investment on Agriculture (Izuchukwu, 2011, p. 193).

### 2.2.1 Regional Breakdown of Agriculture in Nigeria.

Nigeria is divided into three main regions, the Southern zone, Middle belt zone and Northern zone. The Southern zone consists of the South East (Abia, Anambra, Ebonyi, Enugu & Imo), the South-South (Niger Delta region) and the South West (Ekiti, Lagos, Ogun, Ondo, Osun & Oyo). The Middle belt Zone is mainly referred to as the North Central which consists of the following states; Benue, Kogi, Kwara, Nasarawa, Niger, Plateau & Federal Capital Territory. All other northern states fall under the North East and the North West zones which is considered as the Northern zone. These zones were formed under the ruling of the late president General Sani Abacha. The formation was not completely "based on geographic location but rather states with similar ethnic groups, and/or common political history was classified in the same zone" (Nigerian Index, 2019).

***Major Crops***

Generally, Nigeria's climate allows the cultivation of a variety of crops. The figure below shows the major crops grown in Nigeria by regions "before oil gained prominence in 1965" (A. & Asadu, 2015, p. 6).

Figure 3. Major Crops grown in Nigeria by Region

| *Crop category* | *Southern zone* | *Middle belt zone* | *Northern zone* |
|---|---|---|---|
| **Cash crops** | Cocoa<br>Rubber<br>Oil palm | Beniseed<br>Rubber<br>Cocoa | Groundnut<br>Cotton<br>Beniseed |
| **Food crops** | Yam<br>Cassava<br>Maize<br>Rice<br>Cocoyam<br>Plantain<br>Sweet potatoes | Yam<br>Cassava<br>Maize<br>Rice<br>Cocoyam<br>Plantain<br>Sorghum potatoes<br>Millet<br>Soya beans<br>Beniseed<br>Cowpeas<br>Pigeon pea<br>Sweet potatoes | Sorghum<br>Millet<br>Rice<br>Soya beans<br>Pigeon pea<br>potatoes |

*Source: ((Asadu, 1989; Metzi, 1991; Asadu, et al. 1999 cited in A. & Asadu, 2015, p. 5)*

Presently, the major crops for export are sesamum seed, cocoa beans (fermented and raw), natural cocoa butter and cashew nuts (in shelled and shelled), other frozen shrimps and prawns, ginger and other agro-food products (Nairametrics, 2019). The sesamum seed is mainly grown in the Northern and Middle belt zone in Nigeria. Nigeria is the second-largest producer of the sesamum seed in Africa right behind Sudan (Akeredolu, 2017). Cocoa which has been the leading agricultural export in Nigeria since government restored the production of cocoa between the late 1970s and early 1980s (A. & Asadu, 2015, p. 6), is grown in the Southern zone as a result of its "favourable soil and climate condition" (Proshare, 2017). The Niger Delta region (South-South) which is also categorized under the Southern zone is known for shrimp farming as a result of its marine ecosystems. Other agro-food items such as cashew nuts and ginger are produced across the various regions in Nigeria particularly in Kaduna which can be found in the Northern zone (Dauda and Waziri, 2006 cited in Ibrahim, 2018, p. 155).

***Major Livestock***

Nigeria's livestock consists of farm animals such as cattle, goats, sheep, etc. and are majorly found in the northern and southern regions of the country. Particularly about 96 per cent of cattle in the country are concentrated in the northern region, this is as a result of the ecological condition of the region which is characterised by low rainfall duration, lighter sandy soils and longer dry season which is more favourable to farm animals. Below is a graphical representation of major livestock distribution by major production zones.

Figure 4. Major livestock distribution by major production regions

| *Regions* | *Livestock reared* |
|---|---|
| **Southern region** | Sheep<br>Goat<br>Pigs<br>Poultry<br>Some Tryps-resistant cattle |
| **Northern region** | Sheep<br>Goat<br>Pigs<br>Poultry<br>Cattle<br>Horses<br>Donkeys<br>Camels |

*Source:* (A. & Asadu, 2015)

As regards livestock export, Bello Agaie the president of the Nigeria Veterinary Medical Association (NVMA) made a statement during a press briefing on the annual summit of NVMA in 2019 that Nigeria is not exporting livestock or livestock product because Nigeria does not meet the basic criteria for export (Premium Times, 2019).

### 2.3 Gap in Literature

It can be deduced that most of the previous studies were focused on agriculture and economic performance and also on the impact and effect of agricultural output on economic growth in Nigeria. In as much as there are have been extensive research study on the relationship between agricultural output and economic growth, there has been little or no research or data on the feasibility of a technological transformation of the agricultural sector in Nigeria and what difference or impact it would make on the economy, even though diversification and implementation of ICT especially in agriculture have been one of the most discussed subjects. This study, therefore, attempts to fill in the existing gap in the literature by investigating the effect of digital technologies on the agricultural sector in Nigeria and to examine the possible impact of a digitalized agricultural sector in revamping the economy of Nigeria.

## 3 Theoretical Frameworks

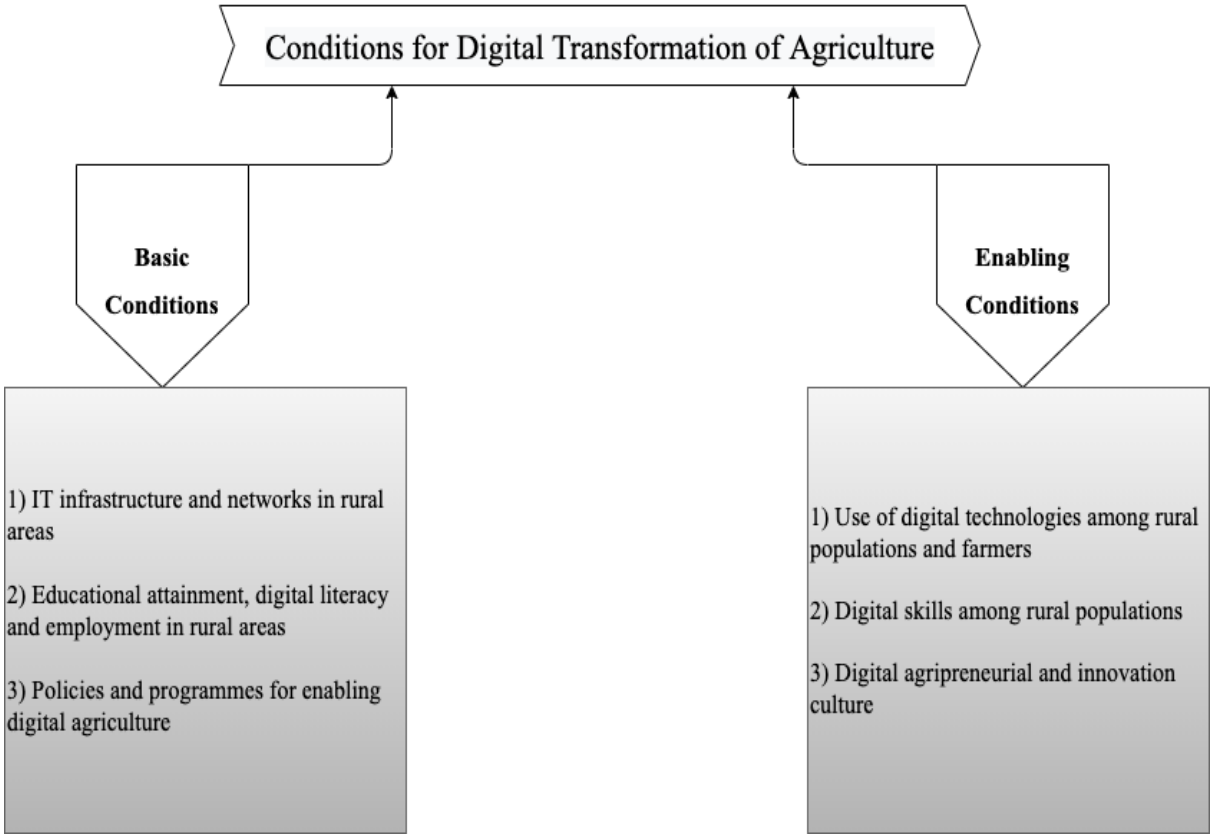
For clarity and complete understanding of the research study, two distinct theoretical frameworks emerged and would serve as a relevant reference to the study. These theoretical frameworks would serve as the bedrock and core for analysis as well as providing a broad understanding of the purpose of the study. The theoretical frameworks to be employed in this study are, conditions for digital transformation of agriculture by Trendov, et al., and the Keynesian economic theory.

### 3.1 Conditions for Digital Transformation of Agriculture

In a briefing paper by Nikola M. Trendov, Samuel Varas, and Meng Zeng on *'Digital technologies in agriculture and rural areas'* the conditions for a digital transformation of agriculture surfaced. This includes the basic conditions for a digital transformation of agriculture to occur as well as the enabling conditions which are the factors that further facilitate the adoption of technologies. According to them, these conditions must exist for the

"use of digital technologies and therefore for digital transformation" (Trendov, et al., 2019). The figure below provides a graphical illustration of what both the basic conditions and enabling conditions entail.

Figure 5. Conditions for Digital Transformation of Agriculture



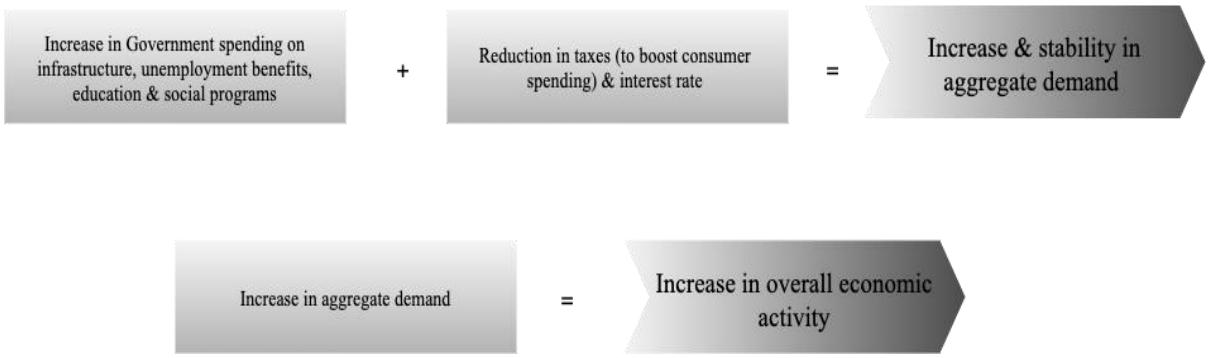

*Source:* (Trendov, et al., 2019)

## 3.2 The Keynesian Economic Theory

The Keynesian economics or macroeconomic theory is sometimes referred to as the "depression theory". The theory was developed by a British economist John Maynard Keynes during the great depression of the 1930s to understand the cause of the great depression as well as to provide a way out of the depression and to offer a preventive measure against economic downturns. Keynesian theory is a school of thought in which government plays an important role in mitigating economic recessions. Keynes believes that the government should spend less during times of economic prosperity and spend more during times of economic downturn. The bone of contention of this theory is, during an economic recession government should undertake deficit spending to make up for the decline in investment, cut taxes to boost consumer spending to stabilize and increase aggregate demand. "This would, in turn, lead to

an increase in overall economic activity and a reduction in unemployment" (Investopedia, 2020).

Figure 6. Key Takeaway from the Keynesian economic Theory




*Sources: (Investopedia, 2020, The balance, 2020)*

***Reason for the employment of the theories***

In the search for an appropriate theoretical framework that describes the study, the theory on the conditions for digital transformation of agriculture by Trendov, et al., and the Keynesian economic theory emerged as the most suitable. The theory on the conditions for digital transformation of agriculture by Trendov, et al., simply highlights the conditions that must exist for the use of digital technologies and for the digital transformation of agriculture to occur. This model is appropriate for describing this study because one of the main research objectives is to investigate the extent to which digital technologies can transform the agricultural sector in Nigeria and this theory will provide a pathway for the investigation to be carried out. This provides an overview of the initial part of the thesis topic, '*Technological Transformation of The Agricultural Sector in Nigeria: An Antidote for Economic Recession*'.

Another main objective of this study is to examine the possible impact of a digitalized agricultural sector in revamping the economy of Nigeria, the Keynesian economic theory will serve as a guide for the analysis of this study. The Keynesian economic theory was formulated to have a deeper understanding of economic recession (great depression) and how to mitigate the situation, therefore the Keynesian economic theory is said to be also suitable because it provides a clearer understanding of the latter part of the thesis topic, '*Technological Transformation of The Agricultural Sector in Nigeria: An Antidote for Economic Recession*'.

# 4. Empirical Analysis

## 4.1 Research Method

The research method employed in this study is the exploratory research method. This method best justifies this thesis because the subject matter under investigation has not been comprehensively explored in the past. Also, employing the exploratory research method provides a deeper and concrete understanding of the subject matter which is to investigate the effect of digital technologies on the agricultural sector in Nigeria and to examine the possible impact of a digitalized agricultural sector in revamping the economy of Nigeria, consequently, this thesis opens a pathway for future related research with more tangible analyses. In respect to research design, this thesis adopts a case study research, which made use of the qualitative method of analysis to gain an understanding of the current subject of the thesis. Data used in this thesis was collated from secondary sources such as academic literature, news articles, document analysis and other online journals. This thesis attempts to investigate the extent to which digital technologies can transform the agricultural sector in Nigeria and to examine the possible impact of a digitalized agricultural sector in revamping the economy of Nigeria. In line with this, the main research questions of this thesis will be:

1. To what extent can digital technologies transform the agricultural sector in Nigeria?
2. To what extent can a digitalized agricultural sector serve as a viable tool to lead Nigeria out of the current recession?

The following section seeks to investigate the effect of digital technologies on the agricultural sector in Nigeria by examining the extent to which digital technologies can transform the agricultural sector in Nigeria.

## 4.2 Technological Transformation of the agricultural sector in Nigeria

Conditions for Digital Transformation of Agriculture as the basis for analysis

According to figure 5. Nikola M. Trendov, Samuel Varas, and Meng Zeng provided a two-part condition for the digital transformation of agriculture to occur, namely the basic conditions and the enabling conditions (enablers). Both the basic conditions and enabling conditions are divided into three conditions each. The **basic conditions** include; IT infrastructure and networks in rural areas, educational attainment, digital literacy and employment in rural areas and policies and programmes for enabling digital agriculture while the **enabling conditions** include the use of digital technologies among the rural populations and farmers, digital skills among rural populations and digital agripreneurial and innovative culture. (Trendov, et al., 2019). It is vital to know that the basic conditions and the enabling conditions are in conjunction and the enabling conditions cannot be met without fully achieving the basic conditions.

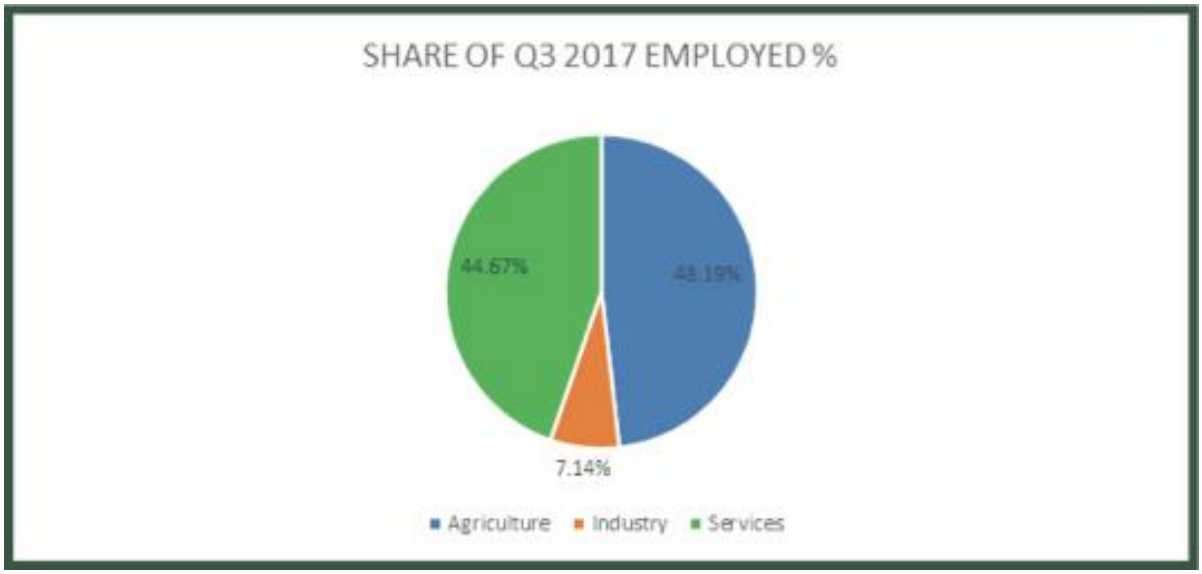
1. IT infrastructure and networks in rural areas

The provision of IT infrastructure and networks in rural areas has been a trend in the growing interest of various developing countries. There has always been a digital divide between the rural and urban areas in developing countries and various ways to close this gap has been embarked upon. In Nigeria, the application of ICT and provision of telecommunication infrastructure in rural communities for connectivity within the community and outside the community has been ongoing especially for agricultural development. Also, Nigeria has made great progress in expanding GSM signal coverage over the years, however, the awareness of telecommunication and networks remains limited. For instance, in a research study carried out on the '*Access and application of information and communication technology (ICT) among farming households of south east Nigeria*' by Ezeh Ann Nnenna, the researcher indicated that the result of the analysis in the study area revealed the availability of numerous ICTs "but the respondents were not fully aware of them" (Nnenna, 2013, p. 609). There is no doubt that there exists a presence of IT infrastructure and networks in rural areas, however, the paramount challenges do not lie in the availability of IT infrastructures and networks but the utilization and accessibility of these ICTs. Besides, most people in rural areas cannot afford the network coverage prices and therefore cannot gain access to the internet. Things are much different in other countries where innovations such as pay as you go plans are established to provide affordable smartphone prices and accessibility to networks in rural areas. This situation can be seen only in urban areas in Nigeria.

2. Educational attainment, digital literacy and employment in rural areas

The utilization of digital technologies demands fundamental literacy as well as digital knowledge and skills. Flowing from the premise of the above conclusion, it has been established that there is a lack of relevant knowledge and digital skills among not only farmers but people in rural areas. In a study carried out in 2019 on '*a GIS-based analysis of geographical accessibility to shared information and communications technology (ICT) infrastructure in a remote region of Nigeria'* in Oyo state by Kayode J. Samuel and Bola Ayeni, the findings of the study shows that the accessibility to shared ICT facilities remain poor in rural areas and a suggestion was made to the government to consider innovative service delivery option to improve shared ICT facilities as well as to promote inclusiveness in the new information society on the part of people living in rural areas in Nigeria (Samuel & Ayeni, 2019). Also, it is no news that the agricultural sector remains the livelihoods in the economy as it is responsible for creating a significant percentage of employment opportunities in Nigeria. The Nigeria Bureau of Statistics report (Q3 2017), on 'labour distribution by sector', shows that the labour market was dominated by the agricultural sector by a large margin. "In 2017 Q3, 48.19% of employment were found in the Agricultural sector, followed by 44.67% in Services, only 7.14% of total workers were working in Industries" (National Bureau of Statistics, 2018).

Figure 7. Labour Distribution by Economic Sector of Q3 2017 (%)




*Source:* (National Bureau of Statistics, 2018)

Therefore, a digital transformation of the sector will significantly not only change the nature of work but the demand for workforce and skills which would create a vast form of employment opportunities that would target youths that are eligible and have adequate digital literacy. This would limit the number of educated graduates which as a result of low employment opportunities that suit their qualifications, have led them down the path of robbery, hired assassins and so on. It will also aid the government's agenda of keeping youths "off the street". (Trendov, et al., 2019).

3. Policies and programmes for enabling digital agriculture

In several countries, government policies and programmes are one of the driving forces of digital transformation. In an article written by Nagy Hanna on '*a role for the state in the digital age*', it points out the significance of the government in creating a digital economy by providing policies that will nurture a "national digital transformation ecosystem and build an innovative and inclusive digital economy" (Hanna, 2018). Essentially the state plays a vital role in ensuring digitalization by establishing various policies that would aid digital transformation as a whole. The creation of these policies by the government in several nations has created an environment for competitive digital markets and e-services. Additionally, there is a "trend towards governments themselves deploying e-services/e-government especially in health, education, environment, and employment" (Trendov, et al., 2019). The formulation, implementation and the management of government policies require a substantial level of administrative innovative capacity and since the Nigerian government suffers from, inconsistency in designing and managing government policies and programmes (see section 2.1, paragraph 4) towards a digital transformation of the agricultural sector, there has been no record of absolute success over the years. In as much as other sectors such as telecommunications thrive, the agricultural sector which is "a major employer in rural areas, lags behind" (Trendov, et al., 2019).

***Discussion***

So far it has been a challenging journey in the process of achieving a digital transformation of the agricultural sector in Nigeria in as much as there is a great clamour for it. The problem does not lie in the realization of the adoption of these digital technologies but the cultural perspective has hindered the acceptance of these digital technologies and as a result, no matter how much the clamour for a technological transformation of the agricultural sector to occur, it would be difficult. In addition, the Nigerian government which would have been the driving force of the

movement lacks the innovative capacity as well as the ability to sustain this new wave of agricultural development.

Digital literacy has always been a key obstacle in the adoption of new digital technologies in the agricultural sector, thereby transforming the sector has been difficult so far. The people that have the skillset and the required digital education and training in rural areas often in most states in Nigeria migrate to urban areas in search of a job that matches their skillset. There is a belief among most educated youths in Nigeria that agriculture in Nigeria has nothing to offer. This is not to say that agriculture is not worthy of an investment of any kind, in reality, Agribusiness in Nigeria has been flourishing in recent times. For instance, top agribusiness companies in Nigeria such as Flour Mills of Nigeria, Olam, Stallion Group, SeedCo Nigeria Limited, etc., which through the manipulation of technology and innovation in their vision to provide a better livelihood for the people in Nigeria has led to an increase in profit (Ignita Tropical Weather Forecasting, 2020). However, most youths don't seem to be interested because agriculture is not yet gaining momentum like other sectors such as fintech. It is going to be challenging for the government to set up an educational platform that would be responsible for training farmers in rural areas. The possibility for this to result into a positive outcome is really thin and given the unsuccessful track record of embarking on vigorous training for farmers, it can be inferred that going down this road can most likely prove to be futile.

According to Trendov, et al, "digitalization of the agricultural sector will significantly alter the nature of work and the demand for laboured skills" (Trendov, et al., 2019), therefore, for a digital transformation to take place in the agricultural sector, there has to be a form of reform that allows for only eligible individuals that fit the technological transformation movement, to head and or be among members of the various departments in not only the agricultural sector but also in the Nigerian government. These individuals in the government and the agricultural sector will be saddled with the responsibility of taking agriculture to the next level in Nigeria by spearheading the digital revolution of the agricultural sector, creation of policies and programmes that would aid and abet the movement, employ other like-minded/educated people that have the desired level of literacy to help implement these policies and manage the adoption of these policies. When all these are put in place, digital technologies will be able to infiltrate the agricultural sector in Nigeria with little or no hitch giving a chance for a transformation to occur.

## 4.3 Agricultural Transformation as an Antidote for Economic Recession in Nigeria

Arriving at a point where we have digitalized agricultural sector simply means that digital technologies have not only impacted the method of production but has also transformed general activities including engagement and interaction within the agricultural sector in Nigeria. In the previous section (see 4.2 in discussion), it was established that the basic conditions for Nigeria to have a digitalized agricultural sector is yet to be achieved. However, in addition to these basic conditions, some sub-conditions emerged during the discussion, specifically targeted towards the nature of the Nigerian economy which includes; a shift in cultural dimension, innovative capacity building on the part of the government and reform that allows for only eligible individuals that fit the technological transformation movement, to head and or be among members of the various departments in not only the agricultural sector but also in the Nigerian government.

In a case where these above conditions are met, there is a possibility that the agricultural sector will not only transform in itself but will aid the Nigerian economy in her quest to become an industrialized nation. Charles Peter Timmer, on the process of agricultural transformation, presented four phases. According to him, agricultural labour productivity increases in each phase of transformation leading to a high level of agricultural surplus. This surplus enables growth in other non-agricultural sectors by "mobilizing labour, savings, and tax revenues from the agricultural sector". This then leads to the integration phase where there is an increase in the significance of non-agricultural sectors, therefore, agricultural development can be said to be linked to the "rest of the economy through improved infrastructure and the development of markets", and in a case where integration results in a positive outcome, then the economy can be said to be industrialized (Timmer, 1998).

Nevertheless, the fundamental question remains, 'to what extent can a digitalized agricultural sector serve as a viable tool to lead Nigeria out of the current recession?'. The National Bureau of Economic Research defines a recession as "a significant decline in economic activity spread across the economy, lasting more than a few months, normally visible in GDP, real income, employment, industrial production and wholesale-retail sales" (NBER, n.d.). The National Bureau of Economic Research (NBER) as a private and non-profit research organization,

focuses on promoting a greater understanding of how the economy operates. NBER spreads its economic research among public policymakers, business professionals and the academic community (Investopedia, 2020). Usually, expansion and growth in any given economy is not always constant. Economic shock could cause major economic disruption, for instance, COVID-19. However, before the recent outbreak, Nigeria experienced deflation in oil price as a result of a large drop in demand. As a result, various scholars, academic researchers and even policymakers in Nigeria are advocating for diversification of the economy towards, most especially the Agriculture sector, as a way out of the current recession. Some are of the opinion that a digital transformation of the agricultural sector can serve as a means to revamp the economy (see 1. Introduction).

Agreeably, agricultural performance has been linked to economic growth over the years (see 2.2 paragraph 4) and the technological transformation of the agricultural sector will yield a positive outcome on the Nigerian economy. The reason is, people such as entrepreneurs, investors, politicians etc. in Nigeria are usually drawn to a new trend or wave and when that happens, they would be looking to invest to a great extent because of the notion that it would thrive since technology is involved. As a result, there would be an increase in economic activity and monetary circulation which would serve as revenue for the government. For instance, the implementation of the "cash-less Nigeria" cash policy by the government in 2012 "to drive development and modernization of our payment system..." among others (Central Bank of Nigeria, n.d.), has increased the significance of the fintech sector in Nigeria. In a report by Mckinsey on '*Harnessing Nigeria's fintech potential,'* it was stated that:

> *"Nigeria is now home to over 200 fintech standalone companies, plus a number of fintech solutions offered by banks and mobile network operators as part of their product portfolio. Between 2014 and 2019, Nigeria's bustling fintech scene raised more than $600 million in funding, attracting 25 percent ($122 million) of the $491.6 million raised by African tech startups in 2019 alone, second only to Kenya, which attracted $149 million"* (Mckinsey & Company, 2020).

Nonetheless, inasmuch as the technological transformation of the agricultural sector in Nigeria may prove to be favourable and lead to an increase in the domestic economic activity in the country, it cannot take the country out of the current recession. Only one sector cannot be responsible for bringing the country out of economic recession and ensuring economic stability.

The Nigerian economy is made up of various sectors and is divided into 3; agricultural sector, industry and services. These sectors have their advantages that can be utilized as a source of revenue. Nigeria is suffering from "Dutch disease" and the reason the deflation in oil price caused a recession is as a result of the lack of diversification which should have happened a long time ago. Now, shifting the focus to another sector in the economy would be unwise, since the reason for the current economic downturn is as a result of running a mono-product economy.

The key takeaway from the Keynesian economic theory is, during an economic recession government should undertake deficit spending to make up for the decline in investment, cut taxes to boost consumer spending to stabilize and increase aggregate demand to boost growth and encourage the increase in economic activities (see figure 6) (Investopedia , 2020). This appears to be a more viable way of combating economic recession without the risks of falling back into the old habit of having an economic system that is dependent on the existence of only one major economic product as an economic sustenance. In addition, still flowing from the premise of the Keynesian economic theory, the focus of the should be on increasing aggregate demand in the economy which would result in the increase in the overall economic activity. The agricultural sector alone cannot be responsible for increasing aggregate demand to the level that is necessary for general economic activity in the whole country to occur, however investing digital technologies in not only the agricultural sector but other sectors that seem to be gaining momentum in Nigeria, such as fintech sector, entertainment sector, solid minerals, etc. would bring about a flow of general economic activity like never before.

The implementation of digital technologies will not only create more profit but bring about added value which increases revenue. For instance, cocoa beans as a raw material are being grown and processed into chocolate in the United States, and it is ranked one of the highest producers of chocolate, generating annual revenue of $20 billion (Investopedia, 2019). However, the largest cocoa production region is located in Africa (Côte d'Ivoire, Ghana, Nigeria and Cameroon) (United Nations, 2008, p. 4). This shows that with proper usage of machinery, Africa can begin to also benefit from the added value of converting raw materials to finished goods. Likewise, according to Statista, Thailand is the leading country among natural rubber producing countries worldwide in 2018 and 2019 (Statista, 2020). Thailand is regarded as the world's central source of rubber and its rubber industry also converts rubber into finished goods. The production process flows from the upstream industry to the

downstream industry. The upstream industry is responsible for planting and harvesting rubber, the midstream is in charge of converting raw rubber into semi-finished goods such as concentrated latex, and the downstream industry has to do with the "production of rubber products such as vehicle tire, gloves, shoes, condoms and elastics" (TCEB, 2019). According to statista, Thailand is also the leading country among natural rubber producing countries worldwide in 2018 and 2019.

However, all economic activities differ from country to country and in distinct cases, the method of production of some certain crops might not permit mechanisation. For example, Switzerland is known for its berry farming and strawberries are the most popular among others. Strawberries are majorly "hand harvested", this means that they are harvested through the means of hand-picking. They are harvested based on their size and colour and put into clamshells, and placed into boxes by workers. A harvest process as unique as this might not be compatible with the implementation of any form of mechanization. Likewise, some food crops that are produced in Nigeria such as plantain and yam cannot permit the use of mechanisation in the harvesting process. However, the conversion of unripe plantain to plantain flour can allow the use of new and improved machinery in the grinding process instead of the local form of blender.

***Discussion***

There exist limited or no way to test the impact of a technological transformation of the agricultural sector on the Nigerian economy and how it can serve as a way out of the current recession. However, through investigation, it can be seen that the agricultural sector alone cannot serve as a viable tool for bringing the country out of the economic recession and sustaining the economic stability in the long-run. Also, the purpose of diversification of the economy is to bring about the opposite of a mono-product economy, therefore, the Nigerian government has to have a robust re-orientation about how the economy works and in as much as a digitalized agricultural sector can create a road map for others to follow, it would be unwise to shift focus back to only the agricultural sector. Where a diversified economy exists, in a situation where a decline in the market price relating to one sector occurs, it would not result in an economic meltdown or recession because the economy is no longer a mono-product economy.

The cause of the current economic recession relates to the decline in overseas investment in oil (market export) at the detriment of Nigeria. A digitalized agricultural sector can bring about an increase in revenue and domestic economic activity, however, it will have little or no effect on the on the market export. In relation to agriculture, Nigeria provides raw materials in exchange for monetary value. In a case where Nigeria is able to utilize digital technologies in converting these raw materials such as rubber for example, it will reduce the importation of these types of finished goods which is better for the economy. Nevertheless, it might not succeed for export purposes. The reason is, various countries already have partnerships with each other on import and export trade and it will be difficult for Nigeria who is relatively new to the mass production of converting raw materials to finished good for export, to penetrate the market. This does not mean that new partnerships cannot be formed, still, it will take a very solid strategy to swerve targeted countries attention from their current partners. Since, the petroleum industry accounts for over 90 percent of all export value, and a decline in oil price can obviously shake up the economy, the Nigerian government should place its focus on trying to find ways to boost internal revenue to reduce the cost and effect of an economic recession.

Consequently, there is a need for rigorous study of the pattern of economic recessions in Nigeria, the events that occur around it and the possibility to limit the chances of an eruption of another wave of economic recession. Since the first recession caused by decline in oil price, the government should have found means to empower and strengthen other sectors in the country to improve internal revenue. Since technology has proven its great benefits, the increase in internal revenue can be done by utilizing new and improved ICTs.

# 5. Summary and Concluding Remarks

In an attempt to contribute to the ongoing discussion on the ways to improve the Nigerian economy and find viable ways to combat the current economic recession caused by the decline in oil price, this thesis focuses on the technological transformation of the agricultural sector in Nigeria with an emphasis on how it can serve as an antidote for economic recession. As a result, this thesis investigates the effect of digital technologies on the agricultural sector in Nigeria and also examines the possible impact of a digitalized agricultural sector in revamping the economy of Nigeria. The above objectives were carried out using the exploratory research method because the subject matter under investigation has not been comprehensively explored

in the past. This thesis also incorporated the case study research design which made use of the qualitative method of analysis to gain a deeper understanding of the current subject matter.
The conceptual frameworks that were integrated into this thesis to serve as a bedrock for analysis are the "Keynesian economic theory" and the "Conditions for digital transformation of agriculture by Nikola M. Trendov, Samuel Varas, and Meng Zeng". These conceptual models are key components of the study because it does not only help understand the study and provide a concrete explanation of the research questions which were to find out the extent to which digital technologies can transform the agricultural sector in Nigeria and to examine the extent to which a digitalized agricultural sector can serve as a viable tool to lead Nigeria out of the current recession. It also provides a roadmap of which analysis can flow through. The results and findings of the analysis of the study show that:

1. It has been a challenging journey in the quest for a digital transformation of the agricultural sector in Nigeria. In as much as there is a great clamour for it. Digital literacy has always been a key obstacle in the adoption of new digital technologies in the agricultural sector. Therefore, this thesis establishes that, for a digital transformation to take place in the agricultural sector, there has to be a form of reform that allows for only eligible individuals that fit the technological transformation movement, to head and or be among members of the various departments in not only the agricultural sector but also in the Nigerian government. In doing so these individuals will spearhead the digital revolution of the agricultural sector and create policies and programmes that will give rise to the movement. When all these are put in place, digital technologies will be able to infiltrate the agricultural sector in Nigeria with little or no hitch giving a chance for a transformation to occur.

2. It is a fact that over the years agricultural performance and development has an impact on the Nigerian economy and various empirical studies have been carried out to prove the positive relationship between agricultural development and the economic growth in Nigeria. In as much as the prospect for technological advancement of the agricultural sector can increase the flow of domestic economic activities in the country, the agricultural sector alone cannot serve as a viable tool for bringing the country out of economic recession and sustaining the economic stability in the long-run. Looking back at the root cause of the recession, it can be seen that the lack of diversification of the

economy is the reason the country is facing the current recession. As a result, this thesis recommends that the Nigerian government have a vigorous re-orientation about how the economy works and instead of focusing attention on only one sector, the strength, capacity, innovation and implementation of digital technologies should be spread among the sectors in Nigeria because where a diversified economy exists, in a situation where a decline in the market price relating to one sector occurs, the country can lean towards other sectors. This way, the situation can be helped and would not result in an economic meltdown or recession.

3. Keynesian economic theory saw the importance of self-sufficiency with an implication that an economy has to take responsibility for its affairs and try to set up a movement in motion that will help in the raining days. This simply means that no country or business can stay in a boom period for a very long time without having a downturn or slump once in a while. Now the level of the impact the decline in general activities will have on the economy solely depends on the strength, capability and capacity of the country/business. Therefore, this thesis suggests that, a thorough study of the pattern of economic recessions in Nigeria, the events that occur around it and the possibility to limit the chances of an eruption of another wave of economic recession. This is where the significance of this thesis lies, which is to create a pathway for future related research with more tangible analyses.

In the introductory part of this paper, this thesis provided scholarly arguments on the subject matter that relates to the technological transformation of the agricultural sector and how it can serve as a viable tool for mitigating various economic concerns. The protagonists of this school of thought backed up their argument with a case study of The Republic of Korea and how technological innovation in their agricultural sector has brought about sustainable economic development. However, The Republic of Korea experienced this massive level of development through the technological advancement of agriculture because the nation has been working towards industrialization and the structural transformation that occurred made the industrialization process rapid making them one of the largest industrialized economies in the world. However, Nigeria has a mixed economic system, it is both traditional and semi-industrialized. Therefore, what worked for The Republic of Korea seems unlikely to work for The Federal Republic of Nigeria. We have to look inward to find solutions just like they did instead of trying to directly reproduce the actions of The Republic of Korea.

# References


A., A. C. L. & Asadu, A. N., 2015. Analytical Overview of Agricultural Conditions in Nigeria. *Journal of Tropical Agriculture, Food, Environment and Extension,* XIV(1), pp. 1-17.

Adekoya, F., 2019. *The Guardian.* [Online] Available at: https://guardian.ng/business-services/despite-growth-manufacturing-sectors-contributions-to-gdp-remain-static/ [Accessed 9 September 2020].

Agbata, C. F., 2019. *Transforming Nigeria's agriculture sector with technology.* [Online] Available at: https://punchng.com/transforming-nigerias-agriculture-sector-with-technology/ [Accessed 10 September 2020].

Akeredolu, F., 2017. *Investment Opportunities in the Sesame Seed market in Nigeria.* [Online] Available at: https://medium.com/@Feranmi/opportunities-in-the-sesame-seed market-in-nigeria7b8e12db370d#:~:text=You%20can%20find%20this%20seed,%2C%20Taraba%2C%20Yo e%20and%20Abuja. [Accessed 15 October 2020].

Blandford, D., n.d. *The Contribution of Agriculture to Green Growth.* [Online] Available at: https://www.oecd.org/greengrowth/sustainable-agriculture/48258861.pdf [Accessed 18 December 2020].

Carsten, P. & Eboh, C., 2020. *Nigeria proposes steep basic healthcare budget cuts despite coronavirus.* [Online] Available at: https://www.reuters.com/article/health-coronavirus-nigeria/nigeria-proposes-steep-basic-healthcare-budget-cuts-despite-coronavirus-idINL8N2DI3QF [Accessed 1 October 2020].

Central Bank Of Nigeria, 2019. *Central Bank of Nigeria Annual Report 2019,* Abuja: Central Bank of Nigeria (CBN).

Central Bank of Nigeria, n.d. *Cash-less Nigeria.* [Online] Available at: https://www.cbn.gov.ng/cashless/ [Accessed 04 November 2020].

Central Intelligence Agency, 2019. *The CIA Fact Book 2019-2020.* New York: Skyhorse Publishing.

Chukwuma, O. M., 2018. Diversification of Nigeria's Economy through Agriculture and Solid Minerals in the Face of Dwindling Economy. *International Journal of Advance Research and Innovation ,* VI(3), pp. 147-151.

Dalum Hjallse Debate Club, 2018. *Keynes in main Points.* [Online] Available at: https://www.dandebat.dk/eng-keynes.htm#National [Accessed 1 December 2020].

Ekekwe, N., 2017. *How Digital Technology Is Changing Farming in Africa.* [Online] Available at: https://hbr.org/2017/05/how-digital-technology-is-changing-farming-in-africa [Accessed 10 September 2020].

Evbuomwan, G. O., 2017. *DIVERSIFICATION OF THE NIGERIAN ECONOMY.* [Online] Availableat:https://www.researchgate.net/publication/321057632_DIVERSIFICATION_OF_THE_NIGERIAN_ECONOMY [Accessed 28 September 2020].

FAO , 2006. *Other rapidly growing Asian economies Republic of Korea, Thailand and Viet Nam,* Bangkok: RAP PUBLICATION.

Hanna, N., 2018. A role for the state in the digital age. *Journal of Innovation and Entrepreneurship,* VII(5), pp. https://doi.org/10.1186/s13731-018-0086-3.

Ibrahim, A. M., 2018. Ginger Farming Practice in Jaba Region, Kaduna State, Nigeria. *Dutse Journal of Pure and Applied Sciences (DUJOPAS),* Iv(2), pp. 155-168.

Ignita Tropical Weather Forecasting, 2020. *Top 10 Agribusiness Companies in Nigeria.* [Online] Available at: https://www.ignitia.se/post/top-10-agribusiness-companies-in-nigeria [Accessed November 2020].

Investopedia , 2020. *Keynesian Economics.* [Online] Available at: https://www.investopedia.com/terms/k/keynesianeconomics.asp [Accessed 19 October 2020].

Investopedia, 2019. *The 4 Countries That Produce the Most Chocolate.* [Online] Available at: https://www.investopedia.com/articles/investing/093015/4-countries-produce-most-chocolate.asp [Accessed 24 November 2020].

Investopedia, 2020. *National Bureau of Economic Research (NBER).* [Online] Available at: https://www.investopedia.com/terms/n/nber.asp [Accessed 4 November 2020].

Izuchukwu, O.-O., 2011. Analysis of the Contribution of Agricultural Sector on the Nigerian Economic Development. *World Review of Business Research,* I(1), pp. 191-200.

J., S. O., A., A. O., O., A. M. & Adeyinka, O.-B., 2015. Diversification of the Nigerian Economy towards a Sustainable Growth and Economic Development. *International Journal of Finance & Economics,* III(2), pp. 107-114.

Johnson, D. G., 1991. *World Agriculture in Disarray.* 2nd Edition ed. Chicago: Macmillian for the Trade policy research center, London.

Mckinsey & Company, 2020. *Harnessing Nigeria's fintech potential.* [Online] Available at: https://www.mckinsey.com/featured-insights/middle-east-and-africa/harnessing-nigerias-fintech-potential [Accessed 4 November 2020].

Nairametrics, 2019. *Nigeria's top 10 agricultural exports hit N152 billion in half-year 2019.* [Online] Available at: https://nairametrics.com/2019/09/25/nigerias-top-10-agricultural-exports-hit-n152-billion-in-half-year-2019/ [Accessed 15 October 2020].

National Bureau of Statistics, 2018. *Labour Force Statistics Vol. 2: Employment by Sector Report (Q3 2017),* s.l.: s.n.

National Bureau of Statistics, 2020. *Foreign Trade in Goods Statistics (Q2 2020).* [Online] Available at: https://nigerianstat.gov.ng/elibrary?queries[search]=foreign%20trade [Accessed 1 October 2020].

National Planning Commission, 2011. *The Transformation Agenda 2011-2015 Summary of Federal Government's Key Priority Policies, Programmes and Projects.* [Online] Available at: https://nairametrics.com/wp-content/uploads/2013/03/Transformation-agenda-2011-2015.pdf [Accessed 1 October 2020].

NBER, n.d. *Business Cycle Dating.* [Online] Available at: https://www.nber.org/research/business-cycle-dating [Accessed 4 November 2020].

Nigerian Index, 2019. *The Six Geopolitical Zones in Nigeria and the States that make them up.* [Online] Available at: https://www.nigerianindex.com/the-six-geopolitical-zones-in-nigeria-and-the-states-that-make-them-up/ [Accessed 15 October 2020].

Nnenna, E. A., 2013. Access and application of information and communication technology (ICT) among farming households of south east Nigeria. *AGRICULTURE AND BIOLOGY JOURNAL OF NORTH AMERICA,* IV(6), pp. 605-616.

Ogunsolu, O., 2018. *Agricultural Performance and Nigerian Economy: An Antidote for Economic Recession (1981-2016),* Kwara: Unpublished essay.

Ojo, O., 2016. *Technology as a key to agriculture's success in Nigeria.* [Online] Available at: https://africanharvesters.com/2016/11/07/technology-as-a-key-to-agricultures-success-in-nigeria/ [Accessed 10 September 2020].

Olabanji, E., Adebisi, F., Ese, U. & Emmanuel, O., 2017. Agricultural Output and Economic Growth in Nigeria. *Journal of African Research in Business & Technology,* 2017(Article ID 516093), pp. 1-11.

Olorunfemi, O. O. & Cajetan, A., 2017. *Agricultural diversification as antidote to economic recession in Nigeria: Product option.* Ibadan, NAAE, pp. 84-89.

Omorogiuwa, O., Zivkovic, J. & Ademoh, F., 2014. The Role of Agriculture in the Economic development of Nigeria. *European Scientific Journal,* February X(4), pp. 133-147.

Pinto, B., 1987. Nigeria During and After the Oil Boom: A Policy Comparison with Indonesia. *The World Bank Economic Review,* I(3), pp. 419-445.

Premium Times, 2019. *Why Nigeria cannot export animal products – Expert.* [Online] Available at: https://www.premiumtimesng.com/agriculture/agric-news/323093-why-nigeria-cannot-export-animal-products-expert.html [Accessed 15 October 2020].

Proshare, 2017. *Reviving the Cocoa Industry in Nigeria.* [Online]
Available at: https://www.proshareng.com/news/Agriculture/Reviving-the-Cocoa-Industry-in-Nigeria/37675# [Accessed 15 October 2020].

Samuel, K. J. & Ayeni, B., 2019. A GIS-based analysis of geographical accessibility to shared information and communications technology (ICT) infrastructure in a remote region of Nigeria. *African Journal of Science, Technology, Innovation and Development,* XI(1), pp. 121-129.

Solsten, E. & Meditz, S. W., 1988. *Finland: A Country Study*, Washington: GPO for the Library of Congress,.

Statista, 2020. *Leading natural rubber producing countries worldwide in 2018 and 2019.* [Online] Available at: https://www.statista.com/statistics/275397/caoutchouc-production-in-leading-countries/ [Accessed 24 November 2020].

TCEB, 2019. *Tire and Rubber Industry of Thailand.* [Online]
Available at: https://intelligence.businesseventsthailand.com/en/industry/tire-and-rubber [Accessed 24 November 2020].

The balance, 2020. *Keynesian Economics Theory- How it works with examples.* [Online]
Available at: https://www.thebalance.com/keynesian-economics-theory-definition-4159776#criticism [Accessed 20 October 2020].

The World Bank, 2020. *Nigeria's Economy Faces Worst Recession in Four Decades, says New World Bank Report.* [Online] Available at: https://www.worldbank.org/en/news/press-release/2020/06/25/nigerias-economy-faces-worst-recession-in-four-decades-says-new-world-bank-report [Accessed 1 October 2020].

Timmer, C. P., 1998. The Agricultural Transformation. In: H. Cheneo & T. Srinivasan, eds. *Handbook of Development Economics,*. Havard university: Elsevier Science Publishers B.V., pp. 276-338.

Tochukwu, O. M., 2012. *THE IMPACT OF AGRICULTURAL DEVELOPMENT ON NIGERIA ECONOMIC GROWTH (1980-2010).* [Online] Available at :
https://pub.abuad.edu.ng/Open_Access_Research_Projects_of_Universities_-_Batch_1/Computer%20Science/IMPACT%20OF%20AGRICULTURAL%20DEVELOPMENT%20ON%20NIGERIA%20ECONOMIC%20GROWTH%20(1980-2010).pdf [Accessed 5 October 2020].

Tonuchi, J. E. & Onyebuchi, N. A., 2019. Economic diversification in Nigeria: The Role of Agriculture and Manufacturing Sector. *International Journal of Electrical and Computer Engineering,* VII(3), pp. 916-926.

Trendov, N. M., Varas, S. & Zeng, M., 2019. *Digital Technologies in Agriculture and Rural Areas,* Rome: Food and Agriculture Organization of the United Nations.

Ukpe, W., 2020. *No foreign exchange for food and fertilizer importers - Buhari.* [Online]
Available at: https://nairametrics.com/2020/09/11/no-foreign-exchange-for-food-and-fertilizer-importers-buhari/[Accessed 11 October 2020].

United Nations, 2008. *Cocoa Study: Industry Structures and Competition.* s.l., United Nations Conference on Trade and Development, pp. 1-62.

Uzonwanne, M. C., 2019. Basic Economic Problems of an Underdeveloped Economy. In: C. Uzonwanne, ed. *STRUCTURE AND PROBLEMS OF THE NIGERIAN ECONOMY.* Nnamdi Azikiwe University, Awka: ResearchGate, pp. 195-266.

World Population Review, 2020. *Total Population by Country 2020.* [Online] Available at: https://worldpopulationreview.com/countries[Accessed 28 September 2020].

Worldometer, 2020. *African Countries by population (2020).* [Online] Available at: https://www.worldometers.info/population/countries-in-africa-by-population/ [Accessed 28 September 2020].

# Appendix

## Appendix 1. Non-exclusive license

**A non-exclusive licence for reproduction and publication of a graduation thesis[11]**

I **Olamide Ogunsolu** (*author's name*)

1. Grant Tallinn University of Technology free licence (non-exclusive licence) for my thesis

**Technological Transformation of the Agricultural Sector in Nigeria: An Antidote for Economic Recession**
(*title of the graduation thesis*)

Supervised by **Professor Erik S. Reinert, PhD**
(*supervisor's name*)

1.1 to be reproduced for the purposes of preservation and electronic publication of the graduation thesis, incl. to be entered in the digital collection of the library of Tallinn University of Technology until expiry of the term of copyright;

1.2 to be published via the web of Tallinn University of Technology, incl. to be entered in the digital collection of the library of Tallinn University of Technology until expiry of the term of copyright.

2. I am aware that the author also retains the rights specified in clause 1 of the non-exclusive licence.

3. I confirm that granting the non-exclusive licence does not infringe other persons' intellectual property rights, the rights arising from the Personal Data Protection Act or rights arising from other legislation.

---

January 4th 2021 (date)

[1] *The non-exclusive licence is not valid during the validity of access restriction indicated in the student's application for restriction on access to the graduation thesis that has been signed by the school's dean, except in case of the university's right to reproduce the thesis for preservation purposes only. If a graduation thesis is based on the joint creative activity of two or more persons and the co-author(s) has/have not granted, by the set deadline, the student defending his/her graduation thesis consent to reproduce and publish the graduation thesis in compliance with clauses 1.1 and 1.2 of the non-exclusive licence, the non-exclusive license shall not be valid for the period.*