Food Security, Institutional Framework and Technology: Examining the Nexus in Nigeria using ARDL Approach

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Abstract

In this paper, we examined the level of technology and how investment in agricultural science and technology can improve technical know-how in Nigeria with a view to achieving food security. Growth in agricultural science and technology is deemed essential for increasing agricultural output; reduce the vulnerability of rural poverty and in turn, food security. Food security and growth in agricultural output depends on technological usages, which enhances the productive capacity of the agricultural sector. The indicators of food security utilised in this study include: dietary energy supply, average value of food production, prevalence of food inadequacy, among others. The results from econometric analysis based on Auto-Regressive Distributed Lag (ARDL) showed, inter alia, that in Nigeria, there is a high level of food insecurity as a result of low attention on food production occasioned by the pervasive influence of oil that become the major export product. Hence, policy to turn around the trend is recommended in this study.

Keywords: *Agricultural transformation; Food Access; Food Availability; Food security; Technological utilisation; Institutions*

1. INTRODUCTION

The problem of food scarcity is not only limited to the emerging markets, but it is a problem faced by developed countries as well. The proportion of the prevalence of malnutrition and people who suffer from food insecurity are found in rural areas of the emerging markets [34]. For a county to be food sufficient, such a country needs to make food available, provide easy access to food at any given time, and provides households or families with the ability to afford staple food [1]. It is increasingly obvious that technological investment in agriculture has a very pivotal role to play to ensure that food is available globally, also serves as a major source of income which enhances households' purchasing power to buy food that has a high rate of nutritional status [2]. Saying that Nigeria is highly endowed with abundant resources is stating the obvious; hence, it is rather paradoxical that the country Nigeria is one of the largest food importers in Africa [3].

The abundance of the country's resources and continued economic growth notwithstanding, the issue of undernourishment is still on the increase and has, on the average, increased in recent times by 2% [4]Approximately, 70% of the Nigerian population lives below the poverty line (living on less than US$1.25 per day) [3]. In 2012, the Global Hunger Index (GHI) ranking, Nigeria was ranked 40th out of 79 and 156th out of 187 on the 2011 Human Development Index (HDI) by United Nations Development Programme [5]. The agricultural sector remains an important sector of the Nigerian economy as it employs more 70% of the country's total labour force, especially in the rural areas where most of the farmers live and contributes to about two-fifth to the country's Gross Domestic Products-GDP [6]

Nigeria, which was previously known to be among the world's largest producers of agricultural products which includes: groundnut, cocoa, yam, cassava and other major food crops, is now said to be food-insecure relying solely on imported food to meet a number of her nutrient needs and increasing domestic food requirement, among others [7] Investment on agricultural sector which can be done in form of research and innovations pose a huge multiplier effects in ameliorating poverty through direct impact on producer incomes, indirect impact on consumer welfare by the reduction of food prices, impact on employment and wage rate [8]. It has been observed that in developing countries, increase in agriculture yields by just one percent has the capacity of reducing the average number of individuals who are undernourished by 0.82, which are those living below 1.25 USD per day as specified by the United Nations [9]

Many farmers in Nigeria are faced with harsh agroecology which is characterised by low soil fertility, recurrent droughts and/or floods, and increasingly unpredictable weather patterns associated with climate change. Vulnerability to shocks is compounded by technological deficits (roads and transport networks, telecommunications, potable water and irrigation) which make farming activities tedious and unattractive to young individuals or youths [10]

The aftermath is low production, reduced supply of food (food insecurity). Other factors that are militating against food availability include: poor infrastructure and ineffective policies and weak institutional framework. Supports can be provided which can be in form of giving free seeds and fertilizer distribution to low or middle-income farmers in post-shocks (post-disaster and post-drought) conditions in a way of recovering quick form shocks and of restarting agricultural production and food security [10].

Households that have the financial wherewithal to evade poverty (relative and extreme) seldom experience or suffer chronic hunger; while households that are poor not only experience or suffer the most from unceasing hunger, but are also the section of the population who are most at risk during food deficiencies and famines [2].The major crops like cocoa, yam, rice, maize among others are currently grown in Nigeria, and are intended to be major raw materials for food industries to enable them to produce stable food that will help feed the ever teeming Nigerian population [8].

Government programmes, policies and schemes and her methods of investment provide an enabling avenue for agricultural sector advancement and Investment in agricultural technology which is been observed over time to be a major player in past agricultural efficiency that ensured food sufficiency, and which is presumed be vibrant in contributing to the realisation world's food security, especially the Goals of the United Nations to eliminate the number of people living in hunger and poverty at all levels by the year 2030 [12].The challenge in agricultural research and development is by keeping previous output accomplishment by enhancing agricultural invention and innovation which can distinguish outputs by value addition by making rural farmers have a meaningful proportion of output gains. Food security can be said to exist when people, especially the low-income group, at all times, have access to adequate enough and staple diet that meets households dietary requirements for a healthy living [2].

In recent times, environmental and economic concern has exacerbated the problem of food insecurity. A feasible result of global warming assumes that major parts of the African continent will experience massive climatic change and this will impose severe consequences for the African continent which have more than 75% of the people that depends on agriculture [4][5].Volatility in food prices alongside with the changes in climate imposes an extra constraint to households such as lowering their purchasing power and to food producers by lowering their productive capacity. A nation that is food insecure goes beyond poverty issues of her criticises; food security can be broader seen and taken as it evolves the general food scheme and impacts on all individuals in some ways: whether families have sufficient food or not [4].Given the above background, this study, therefore, examines how efficient and effective technology can influence the level of food security in Nigeria.

The role of institutional framework in enhancing food security is also investigated in this study. This is given the recent empirical observations that most activities by economic agents can be predicated upon the nature of institutional framework that is operational in the said system [14]The Inadequacy of infrastructure facilities such as roads among others further exacerbates poverty in rural areas by isolating rural farmers from needed inputs and profitable markets [15]On the other hand, the availability of basic amenities especially feeder roads can increase the returns of farmers in rural communities get from their farming endeavours. For instance, it has been noted that in rural Ethiopia, the provision of rural feeder roads has the potential of increasing internal rate of returns by 12 to 15 % [12] Pressure from rising populations is also affecting already declined resources, further threatening food production [16]. Over-farmed land, deforestation, and overgrazing are severe in many parts of the country. The issue of drought has become common in the northern parts of Nigeria, while erosion and flooding is a major problem in the southern part.

The above was one of the main factors that led to the launch of the Agricultural Transformation Agenda (ATA) by the Federal Government of Nigeria (FGN) with a view to revamping the agricultural sector and enhance food security, among others [17][3]. It is believed that any system whose food demand is not sufficiently matched by food supply is said to be food insecure. Meanwhile, Nigeria is one of the food-deficit countries in sub-Saharan Africa (SSA), although it is arguably better in terms of production than the others. It has also not suffered major issue of famine, mass hunger and therefore food crisis [18]. This does not in any way prevent public policy makers from being conscious of avoiding the unbearable impact of food shortages in neighbouring countries which have therefore, made food security become a first order priority of the present Nigerian government [19].

Food Security is one of the major recent threats confronting the world. Food security is interlinked with other current global challenges of economy, weather, and climatic change. The best way of determining the sufficiency is when households, at every given time, are able to afford food; safe, sufficient and energy given food that meets their daily need of food consumption. This connotes enhancing households entitlements to food [36][2]. The economic and environmental concerns in recent years have exacerbated global food security problems. A probable outcome of global warming suggests that a large part of the African continent will become drier and experience massive climatic fluctuations, which would have serious consequences for the region with over 70% of the population being dependent on agriculture [20]

Following this introductory section is a brief literature review and analytical framework as contained in the second section. Sections 3 encapsulate theoretical framework and method of analysis while Section 4 presents and discusses the results for this study. The last section is the conclusion and policy recommendations.

2. Some Insights from the Literature and Analytical Framework

As it has been noted in the preceding section, food security can be said to occur at all level social, and economic assess

to sufficient, safe, nutritious food to meet their lives [2]. For a family, food security simply implies that all members of the family have enough to food to eat when it is needed to enable them continue living in good health [21]. By 2050, global population is expected to rise above 9 billion and this rise in World's population will no doubt increase the demand for food which will be driven by the hiked population and variations in climatic conditions in the coming decades. Technology options that needed especially in agricultural sector to boost the level of food production are many, but transparent evidence-based information has been inconclusive or scarce. In Africa, more than 35% of the total population are undernourished, which is the world's most prevalence 33% [22]

Saying generally that the world is food secure is re-echoing a fundamental truth. This is keen to the fact that the food produce globally is sufficient in meeting the needs of the present world's population. [35], aggress to the above statement and argues that the issue of food security faced globally is not due to the scarcity of food, but it is people's entitlement to food that enhances their access to food which they lack. To the author, the idea of food entitlement posits the issue of insecurity of food and continuous malnutrition are the main determinants of low income elasticity of those who are deprived of the necessary ability both to manufacture food or the fiscal capability required to acquire food in a continuous way [35] [36]. In the same vein, access to food is the main determinant of food security than the availability of food. While [35] pointed out that the problem of food insecurity is transitory and not chronic (this means that it can be controlled per time if food production base can be increased and enhancement of individuals' access to produced food.

In view to fully understand the prevalence of food scarcity, which is measured as the reduction in people's purchasing power and consumption pattern, [35] suggests that the examination of studies should be on the failures in exchange entitlements of individuals who suffer a deficiency of food instead of focusing on the total food availability failures. The author views failure entitlements exchange as the optimum entitlements of food, in which individuals have available food to consume at will, with respect to the price and at any given time irrespective of their location. Hence, insecurity of food and severe undernourishment arises where the people's food entitlement is troubled by numerous socio-economic features. Insecurity as a result of this can be tackled by a way of enhancing people's food privilege or entitlement by building their capacity to manage hunger through increasing their access to food [35]. The food prerogative or entitlement context is necessary due to the fact that it disaggregates the causes why individuals are vulnerable to acute malnutrition and are insecurely food wise [36][38].

However, this does not mean that knowledge of the upcoming coming generation food security should not be considered as a result of unforeseen contingencies stimulated by ever dearth of resources, climatic and weather variation as it will adversely affect food production [15]. Yet, 850 million people remain undernourished globally; the most proportion of the people who lack the adequate and sufficient nutritional diet lives in Sub-Saharan Africa in which one out of every four families battles with severe hunger [15]. In Sub-Saharan Africa, especially in Nigeria, food insecurity has been on the increase which is a source of major concern to the Nigerian and African governments [6].

The institutional framework can be taken as the rule of the game or the regulators of the rule. The institutional framework in the context of food security is said to be in the distribution and access to food by household a community or locality. In this study, the former conceptualisation is followed based on the fact that even the latter (the regulators) require the former (the rules) to effectively function. Thus, institutions are essential for the attainment of food security in any country –Nigeria inclusive. Institutions are government policies and directives towards achieving a particular goal [23]. Stemming from above, government can undertake some policies such as the funding of agricultural policies like the Agricultural Guarantee Scheme Fund (AGSF), provision of agricultural equipment like tractors to the farmers and educating them on how it is used, effective and efficient social protection programmes to build farmers resilient capability in the event of shocks and untold vulnerability.

Strong social protection in the agricultural sector will help protect the farmers for been a victim of those shocks and even if they fall victim, they will the enough capacity to bounce back and little effect on their productive capacity and improved domestic resource mobilisation from the Sector [24]. This will enhance food production and thereby reduce food insecurity in the Country. In Nigeria, with respect to boosting food productivity (Agricultural output), attempt has been made by various government regimes with the aim of enhancing the productive capacity of farmers in order to increase the level of food availability via initiatives inter alia the 1976 agricultural programme; Operation Feed the Nation (OFN) and the Green Revolution, Agricultural Development Project -1974 and Fadama (I- III). However, most of these policies ended up as deadlocks due to inefficient management, the absence of follow up in programme implementation and the paucity of planning [25][26]. It is noted that farmers are vulnerable to shocks and agricultural sector is associated with weather-related risks than any other sector, which are the essential predictors of rural livelihood strategies and are mostly the reason for low yields. Weather-related risks associated with agriculture can be dangerous to farming activities by lowering farmers' even distribution of resources, through the encouragement of events that are associated with low risk but slower the rate of turnover, such risk generate poverty from one generation to another by inducing undernourishment [27]

A country that is food-sufficient is one where food is made as a human right to enhance its access. A Country like Nigeria that is greatly endowed with vast resources, there is indeed a lot of food and it is believed that the issue of hunger results not from the shortage of food but mainly from the misdistribution of food [28]. Allocated according to dietary need, the lactovegetarian the supply of food supply alongside with the production reared animals will support up to 85% of the Nigeria's modern population [8]. Researchers' finds that if poor nations and their citizens had enough purchasing power, more food can be produced: the country Nigeria has unutilised and unharnessed ability for the adequate production of food. Without citizens' purchasing power, food would not be available to the people except given as aids. Thus, it is suggested that for Nigeria that has a growing population, the availability of food just have to be increased more than two-fold to commensurate food requirements and expectation of improved diets of a food sufficient nation and households' income can also influence food security [22]. Put differently, household income can directly affect the level of food security [4]. The Sustainable Development Goals (SDGs) which succeeded the Millennium Development Goals (MDGs) envisaged that by the year 2030 there would be enough food for all (food security, SDG Goal 2). Food insecurity and hunger are forerunners to nutritional, health, human and economic and sustainable development problems of any nation [29]. How far these goes can be realised will be unfolded in the process of time just as the Millennium Development Goals (MDGs) were not adequately attained in Nigeria the dawn of the end period of December 2015 [23]. For instance, in Africa, more than 75 million of the citizens have little or no access to food which is required to meet their daily energy needs [17].

To better situate the key arguments in this study, Figure 2.1 presents the possible outcomes (options) that will emanate from the combination of the level of technology and institutional quality, ceteris paribus. Taking it from the top right in Case I and going in the clockwise direction, it could be observed that high level of food security will be feasible when there is the deployment of a high-level of technology coupled with a strong institutional framework. This is the most desirable quadrant.

<<<<<<<Figure 2.1>>>>>>

However, there could be some constraints ranging from resources (human and material), lack of or inadequate social protection on the agricultural sector, among others. The aforementioned factors will make a country to rather operate at Case II or Case IV. Both cases are somewhat similar as they involve using high technology or strong institutional framework depending on which one is cheaper based on their production possibility frontiers. The outcome of these two cases will be the moderate level of food security. The last case, which is the least desirable, is the situation when there is a low level of technology as well as a weak institutional framework. The end of such combination is food insecurity.

Many countries of the world have invested substantially in technological development to increase food production, process and storage, though limiting the import of 'free' technical know-how accessible via contact from overseas, that is, 'spill-ins'. A thorough technological strategy for innovation (such as: intellectual property rights, biosafety regulations, seed, including input arcade principles) is essential to the functioning of the farming system, which will boost agricultural outputs (yields). Added to the above is the strengthening the households' or farmers' ability to articulate the needfulness of technological research while partaking in the design, testing, and disseminating requisite machinery, which will help make farming operation less tedious for farmers [20]. These suggest that agricultural technology include: the components and processes of agricultural products which will help increase food production and reduce food waste in ensuring food security, to be able to cater for the teeming population. They entail production of plant and animal breeding (including biotechnology), the introduction of new crops, livestock and fisheries, mechanisation, infrastructural development and inputs [27]. This is germane as the population of Nigeria is increasing and the available arable lands are not only not increasing but not fully utilised [10]

It is disheartening to note that more than 45% of world's food is thrown away every year. These poses a great implication on food security, also the lacuna in political will to curb the immense has not been effective [13]. With the aid of technological advancement, this number can be drastically reduced to the lowest minimum. In developed countries, steps are being taken with regards to the application software and web platforms to put the food to good use. The major causes of food insecurity and low agricultural productivity (output) are linked to the inefficient use of technology in production process [16]. Technology is not only needful in production process, but it is also highly required in the areas of processing and storage of food and agricultural products that are perishable

3. Theoretical Framework and Method of Analysis
3.1 Theoretical Framework

This study draws insight from Solow's technological change growth model which provides a useful framework for analysing the need of technology in the agricultural sector for production, processing and storage increase. Solow's theory relates to the explanation of the determinant of growth in the production of outputs including those for the agricultural sector. In this study, we presume that the quantity of agricultural output in an economy is a function of the number of technological inputs applied. In this wise, given detailed data for an economy's sub-sectors, it will be

possible to "explain" (model) the food security by the growth in quantities of food production. Any residual is attributed to "technological change" that is, a shift in the food production not due to technological inputs. Solow's result challenged households who thus had seen savings and capital accumulation as the main determinants of food security.

There are many factors that influence food production, and this number increases as the view is expanded from technological change to include equitable growth and wellbeing. Some of such factors are savings, technological change, innovation systems, human development, economic efficiency, social protection, infrastructural and services, governance and security [30]. Ayinde, Muchie and Olatunji used multi-econometric method to assess food security as affected by technological variations. In their study, the authors assessed the impact of trade liberalisation on the Nigerian food production. It was found that contrary to Akinyele (2009)'s observation that trade openness is highly advantageous, but in Nigeria, the reverse seems to be the case. The study recommended that for the economy to take advantage of trade liberalisation, restriction should be placed on the importation of food, control of food prices and improve local food production.

A research was on the effects of climate change on agricultural productivity in Nigeria; it was found that food productivity is crucial, given its effect in changing livelihood patterns in the country [14].The finding confirmed that the rate in food productivity was higher from 1981 to 1995, which was followed by a lower tecnological rate between 1996 and 2000. Furthermore, there was variation in the trend or pattern of electricity supply.Variation in Electricity was revealed to have adverse effect particularly on storage while rainfall change exerts a positive effect on food productivity. However, previous year rainfall was negatively significant in affecting current years in food productivity. In their study, they found out that in Nigeria, agricultural productivity is critical, given its impact in the changing feeding patterns in the country. Food production will affect food availability, which is an essential 'pillar' of food security.

3.1 Method of Analysis

This study engaged three main approaches of analysis which comprises of: descriptive, empirical and econometric techniques. The descriptive method was employed using tabular representations to show some indicators of food security and technological usage in Nigeria. The empirical method involves the critical review of related literature, while the econometric analysis utilised econometric model that was fitted into data using the approach of Auto Regressive Distributed Lag (ARDL). Co-integration and Vector Error Correction (VEC) techniques were engaged with a view to estimating the long-run relationship between the selected indicators of food security and technology.

The model of the study assumed a functional relationship between indicators of food security and its possible determinants. It hinges on the theoretical underpinning of the

Solow growth model, which has technical progress as basic explanatory variables that could explain production capacity of a country, especially in the agricultural sector. The model also allows the incorporation of other variables, in this case, indicator of technology. Explanatory variable considered essential in the model are: electricity generation and distribution, because it has been noted as a major driver for the processing and storage of food. Other explanatory variables which were considered essential include: institutional framework (i*nstfram*) captured by the average value of two indicators (notably: civil liberty and political rights), growth rate of per capita gross domestic products (*pgdpgr*) and land available for production (*Lucp*).

Generally, institutional framework can influence the level of food security as it has been said that the quality of a country's institution can determine the extent of growth in food production [15]. Thus, food security can be related to the aforementioned explanatory variables, namely: technology, infrastructure captured by Electricity power distribution loss (as a percentage of total power output (*EPDL*), institutional framework.

The model can be simplified implicitly as;

$$Foodsect^K = f(techj, lucp, insfram, epdl, gdpgr) \ldots\ldots\ldots (1)$$

Equation (1) above can be represented in an explicit form as:

$$food\sec_t^K = \alpha_0 + \alpha_1 tech_t^j + \alpha_2 lucp_t + \alpha_3 aveinst_t + \alpha_{4t} epdl_t + \alpha_5 gdpgr_t + e_t \ldots (2)$$

Where:

foodsect$^{K:}$ Indicators of food security. This represents two equations: Average value of food production (*Avfp*) and prevalence of food inadequacy (*pfi*) as indicators to measure food security. Thus, K=1 and 2.

tech: Technology usage in the agriculture is proxied by two indicators, namely: Agricultural Machinery and tractors (*amt*) and agricultural machinery (tractors) per 100 square of arable land (*amtl*)

lucp: land tenure system: the availability of land under food crop production. Arable land helps to increase food production thereby increasing the availability of food [32]

aveinst: Institutional framework indicator. It is measured by taking the average of the two measures of institutions in 2015 Freedom House dataset, namely: political rights and civil liberties. The choice of this source is based on the fact that it covers a long period of time (1978-2015). They measure a broad state of freedom in a country, which is vital for food security. They are reported on a ratio of 1 to7; a rating of 1 indicates the highest degree of freedom and 7 the least degree of freedom. Following the insights from Osabuohien and Ike (2011), this study transformed the data in a way that higher values will mean better institutional quality and as a result the transformed values ranged from 1(worst) to 7 (best). This is to aid interpretation of results. Thus, an average value of 1.0 to 2.5 can be considered not free (weak institutional framework); 3.0 to 5.0, partly-free

(moderate institutional framework); and 5.5 to 7.0, Free (strong institutional framework)

epdl: Electricity power distribution and loss (% of total power output). Power outage affects the processing of agricultural outputs.

gpdpgr: growth rate of per capita gross domestic products

e: the error term that is expected to be *iidN(0, σ2).*

The apriori expectation is that $\alpha_i >$, i =1, 2, 3 & 5 >0, while 4 < 0. Thus, increase in the explanatory variables (except *epdl*) is expected to enhance the rate of food security, *ceteris paribus*.

3.3   Estimation Techniques

To estimate the formulated model, the study used time series data from 1990 to 2014 where there is the availability of data for the variables selected. STATA software (version 13) was used in the estimation process. The estimation used logarithmic transform some of the variables because it brings the variables to a more comparable form and also helps to reduce issue of heteroscedasticity [33]

Thus, the equation can be estimated as:

$$\Delta foodsec^K_{\ t} = \beta_0, + \sum_{t=1}^{n} \beta_1 \Delta techj_{t-1}$$

$$+ \sum_{t=0}^{n} \beta_2 \Delta lucp_{t-1}$$

$$+ \sum_{t=0}^{n} \beta_3 \Delta aveinst_{t-1}$$

$$+ \sum_{t=0}^{n} \beta_4 \Delta epdl_{t-1}$$

$$+ \sum_{t=0}^{n} \beta_5 \Delta pgdpgr_{t-1} + \gamma ECM_{t-1}$$

$$+ \quad e_t - - - - - - - - - - - -(3)$$

Where: Δ represents the difference operator and the ECM_{t-1} is the error correction term. γ shows the speed of adjustment from the short-run to the long-run.

To empirically analyse the dynamic interactions amongst the variables of interest, the model was estimated using Auto Re-Distribution Lag (ARDL) technique. The ARDL can be performed without a consideration of the order of integration of the series. In addition, the ARDL can be carried out with a small sample and, most importantly, it provides an unbiased long-run estimate and valid t-statistics that are applicable even when some of the regressors are endogenous (Olokoyo, Osabuohien & Salami, 2009).

The ARDL representation is shown as:

$$\Delta foodsec^K_{\ t} = \beta_0 + \beta_1 tech^J_{t-1} + \beta_2 \Delta lucp_{t-1}$$

$$+ \beta_3 aveinst_{t-1}$$

$$+ \sum_{t=1}^{n} \boldsymbol{\beta}_4 \Delta epdl_{t-1}$$

$$+ \sum_{t=0}^{n} \beta_5 \Delta pgdpgr_{t-1} + \mu_t - - -(4)$$

In ARDL estimation, it is usually essential to ascertain whether the variables are co-integrated by restricting the coefficients of the lagged level variables to be equal to zero (0). Therefore, the null hypothesis (H_0) of no cointegration is stated as:

H_0: $\beta_1 = \beta_2 = \beta_3 = \beta_4 = \beta_5 = 0$ ---------------------- (5)

Equation above (5) can be tested against the alternative hypothesis of the presence of cointegration among the variables as:

H_1: $\beta_1 \neq \beta_2 \neq \beta3 \neq \beta4 \neq \beta5 \neq 0$ ---------------------- (6)

The above test can be carried out using F-statistics and asymptotic non-standard distribution variables to determine whether variables are stationary at levels or order one [1](0) or 1(1)]. If the calculated F-statistics lies above the upper level, then the null hypothesis are not accepted but are rejected. Cointegration was done prior to the estimation of the Error Correction Mechanism (ECM) by comparing the trace statistics and the maximum Eigen-values against the critical values at a given level of significance (1, 5 or 10%). If the former is greater than the latter, then the null hypothesis is rejected and there is evidence of a long-run relationship among the variables. Variables that are not in rate and index are used in their logarithmic form to bring the variables to a more comparable form and also help to reduce issue of heteroscedasticity [32]

4. Results and Discussion
4.1 Descriptive Analysis

This sub-section presents and discusses data used for analysis of the role of technology on food security in Nigeria. The indicators of food security that are discussed in this sub-section include: average value of food production and prevalence of food inadequacy. While the indicators of Technology are agricultural machinery notably, tractors (*Amt, Amtal*), electricity power distribution and loss (Epdl), growth rate of gross domestic product (*Gdpgr*), and the average value for institutional framework (*aveinst*)) as obtained from World Development Indicators (WDI) of the World Bank, Food and Agriculture Organisation (FAO) and Freedom House. The results from the descriptive analysis are reported in Table 4.1.

<<<<<<<Table 4.1>>>>>>>

Institutional framework in Nigeria in terms of political rights and civil liberties can be considered partly free/moderate. The implication of the above finding is that strong institutional framework tends to boost food security through effective polices while weak institutional framework weakens food security via weak policies. In terms of population, as population increases without a correspondent increase in food production, and this lead to food insecurity. This is because more people tend to chase less food available (over-crowding leading to food competition).

4.2 Econometric Results

This sub-section reports and discusses the empirical results from econometric analyses, notably: cointegration and Vector Error Correction (VEC) technique (Messer and Heywood, 1990). The stationary pre-testing was not carried out given the fact that analysis with Vector Auto-Regressive (VAR) technique does not necessarily require stationary based on the fact that VAR models used variables in their differenced form [21].

From the results in Table 4.2, the null hypothesis is rejected at 5% level. Table 4.1 equally reveals that there are at least three cointegrating equations. This means that the variables are compatible in the long-run. In effect, when there is short-run disturbance there is tendency of the variables to return to equilibrium in the long-run. The implication of this is that institutional framework and electricity power supply are relevant in explaining the variations in food security in the long-run, given the finding that at least one cointegrating equation exists, as shown in Table 4.2

<<<<<<<Table 4.2>>>>>>>

<<<<<<<Table 4.3>>>>>>>

From the cointegrating equations reported in Table 4.3, it is obvious that the chosen explanatory variables are statistically significant in determining the role of technology in food security in Nigeria. The overall statistics in Table 4.4 point to the fact that the regressors are able to account for over 75% variations in food security. Thus, institutional framework together with electricity, machineries, arable land, population, per capita GDP growth rate jointly explains the rate of food security in Nigeria. The variables were significant at varying levels (1, 5 or 10%) and coefficients indicate the levels at which they account for the rate of change in the indicators of food security. the estimates from Vector Error Correction (VEC) techniques are depicted in Table 4.4.

<<<<<<<Table 4.4>>>>>>>

The result above revealed that agricultural machineries (tractors and tractors per 100 sq. km of Arable Land), Power supply (Electricity) (% of output) and Land under Crop Production (hectares of land) exert a positive and significant influence on Average value of food production, except Institutional framework which exerts a negative influence.

From their coefficients, it could be inferred that a proportionate increase in Average Value of Food Production, Agricultural Machinery (tractors), Agricultural Machinery (tractors per 100 sq.km of Arable Land), Electric Power Transmission and Distribution (% of output) Land under Crop Production (hectares of land) will result to about 41%, 30%, 80% and 84% proportionate increase respectively in food security. On the contrary, Institutional frameworks of the country were found to have a negative effect on food security in Nigeria, consequent upon their statistical significant inverse relationship. This implies that a proportionate decrease in Institutional frameworks of the country will bring about 20% decreases in the Country's level of food security.

5. Conclusion and Recommendation

This study was motivated by the need of making contribution to research efforts and increase in the frontiers of knowledge of food security in Nigeria, which has become a challenge, and it the examined the influence of technology on food security in Nigeria using timeseries data (1990-2014). The results from descriptive, statistical and econometric analyses confirm that, *inter alia*, institutional framework and technology are essential in explaining the rate of food security in Nigeria.

It was noted that the availability of arable land was one of the major factors to increase food production to counter the plague of food insecurity for the ever teeming Nigerian population. This is very imperative for Nigeria given her abundant land space, which can be adequately cultivated for food production process through active productive means. Thus, the efforts of reducing the rate of food insecurity are essential in this regards. This can also be achieved, among others, by active interactions between government and farmers, to make contribution to important planning issues that relate to food production in the country and above all, social protection policies should be geared or channelled to agricultural sector to protect farmers who are vulnerable to shocks and avert risks associated with agriculture.

With regard to institutional framework, Nigeria is seen to be rated as the most corrupt country in Africa and third in the world, which was one of the reasons for her low living standard that made it comparable to that of Mexico and Turkey. This means that efforts in reducing corruption in Nigeria cannot be overemphasised in the country's quest for food allocation and the attainment of food security. The strengthening and restructuring of anti-corruption agencies especially Economic and Financial Crimes Commission (EFCC) and Independent Corrupt Practices and other related offences Commission (ICPC) are highly recommended in this drive to build strong institutions.

An important finding from the long-run relationship was that electricity supply is very vital and highly elastic in impacting food security in Nigeria. Thus, it is recommended that there is the urgent need of improving electricity generation, distribution and supply (EGDS) in Nigeria, which can be realised by ensuring a more sincere government commitment

as well as private sector involvement. The issue of privatisation that is currently contemplated may be needful; however, there should be a clear-cut standard on the extent of involvement, which will require a broad based consultation across the range of stakeholders.

In summary, this study submits that there is need to improve the institutional framework of Nigeria, if Nigeria sincerely desires to experience rapid food security as institutions controls all other factors. This can be achieved through the instrumentality of the rule of law and effectiveness of the various agencies of the government to invest massively in agriculture either by channelling social protection programmes to agricultural sector to avert risks associated with the sector, subsidising farmers, providing seedlings at affordable rates, providing fertilizer to them, giving loans to the farmers without interest and educating them. Investment should be made in agricultural research to diverse means of modern farming processes. This is necessary as strong a institutional framework in the country will help in promoting business and economic activities that are relevant components of any meaningful economic transformation. Therefore, the study calls the attention of the managers of the Nigerian Food Security Society (NFSS) and those that believe in the Nigerian project to realise that the issue of fiscal indiscipline that manifests in delayed passage of budget, rising budget deficit, excessive public borrowing, and so on, can mainly be addressed through strong institutional mechanism.
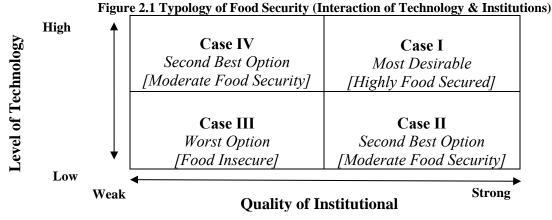
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Figure 2.1 Typology of Food Security (Interaction of Technology & Institutions)

Source: The Authors'

Table 4.1 Summary Statistics of Variables

Variables	Mean	Standard Deviation	Minimum	Maximum
Lavfp	5.3062	0.5822	5.1533	5.4161
Llucp	16.638	0.1627	15.9587	16.7813
Amatl	31.8567	6.8208	20.2357	48.5659
Lamt	2.6006	0.1967	9.5396	10.1186
Pgdpgr	3.0543	6.4919	3.1185	30.3441
Aveinst	3.2400	0.9478	1.0000	4.0000
Ecpdl	27.8666	13.3537	5.8654	43.8374

Source: Authors' Computation

Table 4.2: Cointegration Test

Maximum Rank	Eigen value	Trace Statistics	Critical Value (5%)
0	-	163.4858	94.15
1	0.95647	91.3991	68.52
2	0.87708	43.1869	47.21
3	0.54856	24.8950	29.68
4	0.52212	9.9119	15.41
5	0.25957	0.9997	3.76

Source: Authors' Computation

Table 4.3 Cointegrating Equation

Lavfp	Lamt	Llucp	Gdpgr	Aveinst	Ecpdl
Coef.	-0.242*	0.475*	-0.006*	0.0309*	-0.004*
(P-value)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Lavpf	**Llamtal**	**Llucp**	**Gdpgr**	**Aveinst**	**Ecpdl**
Coef.	-0.019*	3.286*	-.0117*	0.117*	-.0089*
(P-value)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Pfi	**Lamt**	**Llucp**	**Gdpgr**	**Aveinst**	**Ecpdl**
Coef.	91.389*	8.679*	-0.819*	-0.810*	0.689*
(P-value)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Pfi	**Amtal**	**Llucp**	**Gdpgr**	**Aveinst**	**Ecpdl**
Coef.	-3.515*	317.47*	-0.459*	25.932*	-0.275*
(P-value)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)

Note: *, **, *** means significant at 1, 5 & 10%.
The Lag Selection was based on Akaike Information Criterion (AIC),
Schwarz Information Criterion (SIC), and Hannan-Quinn Information Criterion (HQIC).
Source: Authors' Computation

Table 4.4: Estimates from VEC Technique

Regressand ➡ Regressors ⇩	D_Lavfp	D_Lavfp	D_pfi	D_pfi
ECterm	-0.403*	-0.102*	-0.02**	0.003**
	(0.000)	(0.000)	(0.052)	(0.004)
Lavfp(LD)	0.0074	-0.201	0.408	0.066*
	(0.750)	(0.412)	(0.155)	(0.0000)
Lamt(LD)	0.396***	0.0023**	-17.217	-12.457
	(0.093)	(0.042)	(0.1444)	(0.205)
Amatl (LD)	12.324	0.0009	0.2335*	0.0039
	(0.253)	(0.191)	(0.0000)	(0.870)

Llucp(LD)	0.018***	0.122	0.734	0.535
	(0.079)	(0.119)	(0.614)	(0.748)
Gdpgr(LD)	0.00017*	0.008***	0.0199	0.080
	(0.002)	(0.054)	(0.389)	(0.935)
Aveinst(LD)	0.0050**	0.0041	0.066	0.1008
	(0.047)	(0.513)	(0.748)	(0.613)
Ecpd(LD)	-0.05***	-0.001**	-0.023	-0.010
	(0.076)	(0.037)	(0.196)	(0.611)
Adj. R-sq	*0.6557*	*0.4518*	*0.8491*	*0.8297*
AIC	*1.9213*	*14.7888*	*8.1172*	*21.8258*
HQIC	*2.5794*	*15.4469*	*8.7752*	*22.4839*
SBIC	*4.5380*	*17.4054*	*1.7338*	*24.4424*

Notes and Soruce: Same as in Table 4.3