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Food Security Sustainability: A Synthesis of the Current Concepts and Empirical Approaches for Meeting SDGs

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Abstract: Currently, food security is becoming a fundamental problem in the global macroeconomic dynamics for policymakers and governments in developing countries. Globally, food security offers challenges both from achieving Sustainable Development Goals (SDGs) targets and the welfare perspective of many poor households. As a result, this study is guided by Neo Malthusian and Access theories to investigate Food Security Sustainability: a Synthesis of the Current Concepts and Empirical Approaches for Meeting SDGs in Nigeria using ARDL and ECM techniques. The ARDL revealed that agricultural value-added and GDP positively affect food security for commercial agrarian investments in Nigeria. However, internal displacement, population growth, food inflation, and exchange rate volatility negatively affect sustainable food security in Nigeria. The model's coefficient of ECM_{t-1} also shows negative (−0.0130 approximately) and statistically significant (0.0000) at 1%. Thus, the speed of adjustment requires 1.3% annually for the long-run equilibrium convergence to be restored. The study concludes that the SDGs targets for poverty and hunger reduction, mainly for food security sustainability alongside small producers by the year 2030, can be rarely achieved because the convergence to equilibrium is more than nine years. An active value-addition strategy for sustainable food security and the provision of humanitarian interventions are recommended.

Keywords: food security; food insecurity; cointegration; SDGs; sustainability; ARDL; Nigeria

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1. Introduction

Global access to food and, in particular, developing countries like Nigeria has become an alarming concern since the emergence of the noble coronavirus pandemic (i.e., COVID-19). This is because of a great shortage of food supply chains and a significant loss of jobs. Low employment as a nexus to a decrease in income can influence the health and well-being of society, and this is a considerable targeting criterion. In addition, the economic, social, and environmental sustainability of food value chains (FCVs) is an increasingly alarming challenge globally [1]. Thus, the food security pillars are categorized according to four key dimensions: availability, access, utilization, and stability [2]. For instance, Nicholson et al. [3] discussed the common indicators of the food security pillars and their use in agricultural systems models.

Food security is described as the "availability at all times of adequate world food supplies of basic foodstuffs to sustain a steady expansion of food consumption", which first appeared at the 1974 World Food Summit [4], but it has since evolved. In 1996, the Food and Agriculture Organization (FAO) declaration on world food security during the world food summit in Rome further defined it as "a state when all people, at all times, have physical and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life". Moreover, the FAO defines sustainable food systems "as the set of farms and enterprises and their successive coordinated value-adding activities that produce particular agricultural raw materials and

process them into particular food products that are sold to final consumers and disposed of after use, in a way that is profitable across the board, has broad benefits for society and does not deplete natural resources permanently [5]". The FAO reported the global State of Food Insecurity, including the social access to food, and not just physical and economic access, in its definition of food security. Social access to food describes one's ability to obtain nourishment in socially acceptable ways, such as going to a supermarket to buy groceries rather than stealing food, scavenging for it, or relying on emergency food supplies for nourishment [6,7].

According to the United States Department of Agriculture (USDA), food insecurity exists on a spectrum, with households experiencing high, marginal, low, and extremely low food security [4]. Food security and hunger may not always intersect, but they are related; if people are food insecure for months at a time, they may very well experience a substantial drop in food intake that leads to hunger. In general, agricultural system model analyses more commonly employ availability indicators but would provide improved guidance for research and programmatic efforts with a focus on indicators of food access [8]. People in food-insecure households have common features. The USDA found that 98% of people in these households expressed their concerns that food ran out even before they could afford to obtain more for further consumption and about 96%, [9] reported lacking money for balanced meals, and 47% [10] reported weight loss because they couldn't afford food. Food insecurity differs from hunger, the physiological process that occurs when an individual cannot afford to eat an adequate amount of food that would cater to their basic nutritional need for a prolonged period. Nigeria is no exception, with a population of over 190 million, and the economy's Gross Domestic Product (GDP) is projected to be $500 billion, with an annual growth rate of around 3%. The revenue from crude oil and gas accounts for about 80% of the country's total earnings federal ministry of agriculture and rural development (FMARD, 2018) cited in [11]. Despite the monocultural characteristics of the oil sector in Nigeria, the agricultural sector dominates the major source of livelihood for most people in Nigeria, with about 70% of the population engaged in agriculture at a subsistence level, and it recently contributed 22.35% of the total GDP between January and March 2021 [12].

Although facilities (i.e., Anchor Borrowers' Programme (ABP) and training program) have been provided through the Central Bank of Nigeria (CBN), the agricultural productivity has been very low due to high postharvest losses and waste with an average of 1.2 metric tons of cereals/ha. In addition, an old-fashioned land tenure system that limits land accessibility with about 1.8 ha/farming household, a very low level of irrigation development with less than 1% of cropped land under irrigation, inadequate use and implementation of technologies, research, and development findings, respectively. Overall, the inadequate access to finance, fertilizer, storage facilities, violent conflicts, and markets have restrained the sector's full potentials over the years [7,13]. The ABP, for instance, works as a partnership between CBN, private sector organizations, and state governments to offer farm facilities including input materials in cash and in-kind directed to farmers at the small-scale level to improve the agricultural productivities given the growing demand and under production challenges in the economy. The ABP is designed to oblige the farmers to deliver their farm produce at the harvest to the anchor, equivalent to the amount the anchor paid in their accounts.

The ABP program report argues that a collective sum of more than $150 million was distributed to over 250,000 smallholder farmers who cultivated approximately 300,000 ha of farmland for cassava, soybeans, maize, wheat, cotton, and rice. As this is a continuing program of agricultural activity, agricultural inputs demands are expected to grow rapidly [14]. Due to the uncertain nature of the agricultural harvest and commodities, the welfare and livelihood of the citizens who largely rely on them is also an alarming concern. As a result, the citizens' financial stability becomes a primary concern if social conflict, terrorism, and theft are to be evaded [15]. According to the USDA. Economic Research Service, Nigeria has a population of 19.9 million people who are food insecure, which is greater than the population of seven West African countries altogether [16]. According to the FAO

cadre Harmonized Analysis Report, 2018, over 1.7 million people are now food insecure. Furthermore, about 2.7 million people in Adamawa, Borno, and Yobe in the northeastern region are expected to suffer extreme food insecurity [10]. Worthy of note is that the agricultural commodity markets volatility and persistence can determine the macroeconomic policy effect, particularly those aimed at stabilizing the Nigerian economy. Ignoring the market's return and volatility transmission leads to a failure to consider the effect of the stated policy [17]. However, the impact of value-added agricultural production, internally displaced persons (IDP's), per capita GDP, exchange rate policy/fluctuation, population growth, food inflation on sustainable food security for the Sustainable Development Goals (SDGs) for poverty and hunger reduction, particularly when intended for food security sustainability alongside small producers by the year 2030 have not been investigated in the literature related to Nigeria to the best of researcher's knowledge, although most Nigerian communities depend on agricultural-related productions. This study seeks to fill this gap in the literature. Second, this study provides hints for spillover effects of conflicts in zones that are not actively in conflict areas to help in planning and executing operative humanitarian, rehabilitation, and resettlement programs. Another contribution for this study stem from a theoretical framework in which the Neo Malthusian and Access theories guide the investigation. Accordingly, the Neo Malthusian theory believed that population growth has the ability to increase more than the global society's ability to produce food to meet its consumption need. While the theory of Access offers distinction between right to have access to resources and ability to benefit from the accessed resources. This contribution is seldom considered in the previous studies and this study seeks to fill this gap as well. Finally, the study enables the research and analysis of food security and conflict status in a Nigerian context to be known and predicted and the relevant authorities and institutions to regulate and design productive approaches affecting food security capacity.

We organized the rest of this study according to 6 sections. Section 1 offers a general overview and the distribution of food insecurity in global and Nigeria, respectively. The literature review is uniquely categorized and discussed in Section 2. The categorization of the literature has not been investigated by the previous studies in Nigeria because we discussed it based on the sustainability pillars: economic, politics and society, environment, natural resources, and food production. Understanding these pillars will help us to meet our current food consumption needs without compromising the abilities of future generations to meet their food necessities. Materials and methods are discussed in Section 3, and Section 4 presents the empirical results of the study. Finally, Section 5 examines the discussion. Section 6 provides the conclusion, policy recommendations, limitations, and areas for further research.

Distribution of Food Insecurity in Nigeria

The survival of the citizens largely depends on agricultural sources of income, but social unrest, terrorism, and economic fluctuations have challenged food security sustainability in the country [18]. Figure 1 shows the prevalence of severe food insecurity in Nigeria between 2014 and 2019, which increased with population growth. As it can be seen from Figure 1, demand for food increased by 0.9% throughout the 2014–2019 period. Figure 2, presents the Food Insecurity Experience Scale's (FIES) regional prevalence of food insecurity in Nigeria, with Borno excluded in the estimate of the study. It demonstrates that food insecurity is more prevalent in southern Nigeria. Figure 3 presents the Famine Early Warning System Network's (FEWS NET) current food security outcome, which countered the FIES analysis. The FEWS outlook demonstrates that outside of the north, in much of the rest of the country, the agricultural season is progressing favorably with average and above-average harvests. Therefore, households in these areas will have access to food and income and will remain in minimal acute food insecurity. Inside the north and areas affected by crisis and conflicts between farmers and pastoralists among other unrest are facing greater difficulty in accessing food and income and will be stressed, famine or

require emergencies, Figure 4 illustrates that the incidence of moderate and severe food insecurity as per the FIES analysis rose in 2020.

As shown in Figure 1, the prevalence of acute food insecurity in Nigeria between 2014 and 2019 has increased with a share of population growth. For instance, there is a strong relation between severe demand for food and a percentage of population by 0.9% throughout the 2014–2019 period. The implications for future trends of population growth could offer Nigeria a huge demographic benefit in food production and significant growth in national markets. However, ignoring these opportunities will be challenging the food sustainability target in Nigeria.

As shown in Figure 2, FIES illustrates that the regional comparison of the prevalence of elements of food insecurity in Nigeria between the north and the south is contained in all of the FIES' 8 constituent questions. On a regional scale level, food insecurity is more prevalent in southern Nigeria for all of the 8 FIES questions. For instance, 84% are worried about food availability, 83% suffer health issues due to insufficient food, 83% have few foods, 71% skipped meals, 75% became ateless, 60% ranout of food, 58% are hungry when asked, and 8% witnessed the wholeday without food in the south East. South-South and Southwest have been relatively more food secured than the South East. On the one hand, the North West region is more food secure than the rest of the regions in Nigeria, according to FIES analysis.

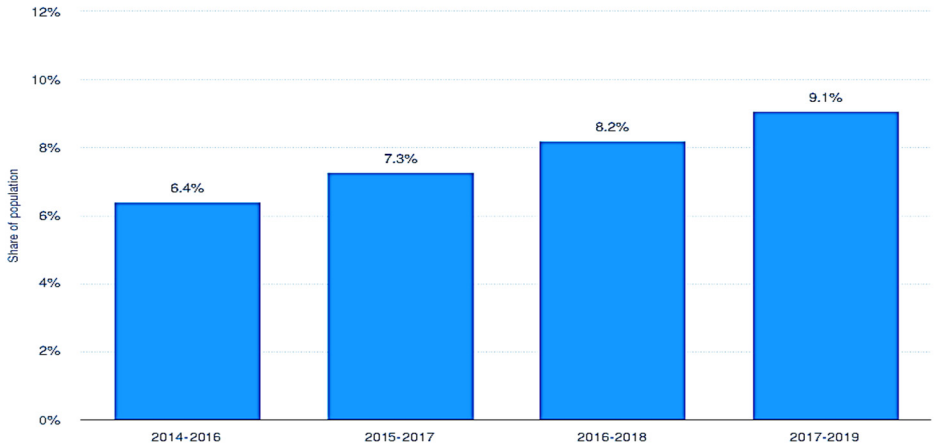

Figure 1. Prevalence of severe food insecurity in Nigeria: Source: FAO and https://businessday.ng. (accessed on 20 June 2021).

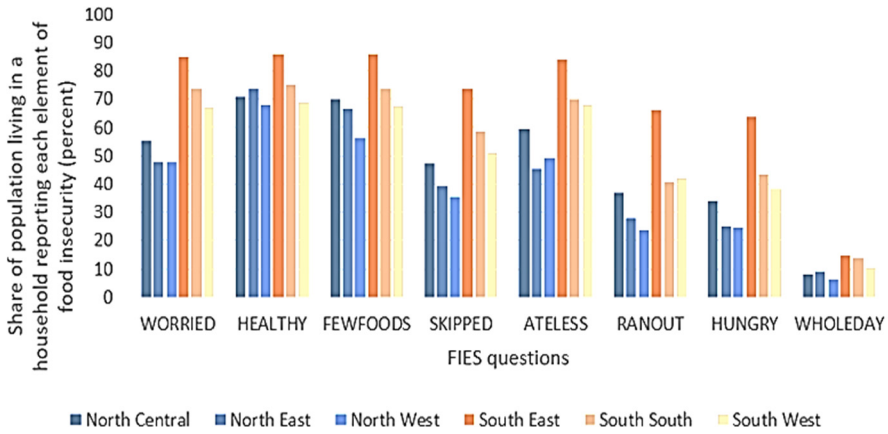

Figure 2. FIES regional prevalence of food insecurity in Nigeria with Borno excluded in the estimate (Source: https://blogs.worldbank.org/opendata/how-should-we-measure-food-security-during-crises-case-nigeria) (accessed on 22 June 2021).

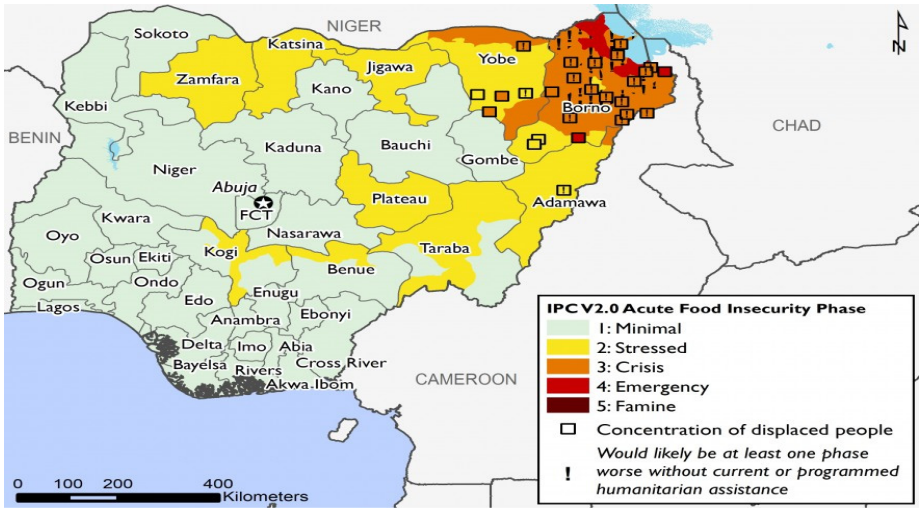

Figure 3. Food security outcomes across Nigeria as of June 2018 (Source: https://fews.net/west-africa/nigeria/food-security-outlook/june-2018) (accessed on 23 June 2021).

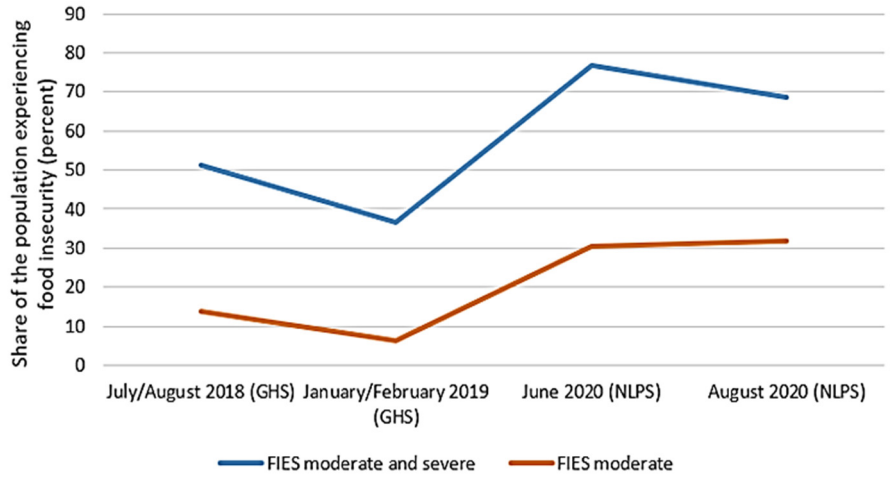

Figure 4. Incidence of moderate and severe food insecurity as per the FIES analysis in 2020. General Households Survey (GHS): National Longitudinal Phone Survey (NLPS). (Source: https://blogs.worldbank.org) (accessed on 22 June 2021).

As shown in Figure 3, Phase 1 shows that most households outside of the northeast have access to food and income as a result of average and above-average agricultural harvests, and they are experiencing only minimal acute food insecurity. Phase 2: Areas most affected by farmer-pastoralist conflict will face more significant challenges in obtaining basic requirements and will be stressed. Food emergency is required in most areas of Borno, northern Adamawa, and eastern Yobe in Phases 3 and 4, due to the prevailing crisis and inability to get humanitarian assistance.

As shown in Figure 4, The incidence of moderate and severe food insecurity as per the FIES analysis in 2020 had risen from 38% to 78% and 69% while moderate food insecurity from 7% to 31% and 32% between January 2019 and August 2020.

2. Literature Review

This section presents the empirical works done by various experts on related topics, and it is categorized based on the sustainability pillars: economic, politics, and society; environment, natural resources, and food production. Understanding these pillars will help us to meet our current food consumption without compromising the abilities of future generations to meet their food necessities. Furthermore, we examine two of the most recent

theories related to sustainable food security: Neo Malthusian and access theory. These theories offer a basis for investigating food security for poverty and hunger reduction, particularly when intended for food security sustainability alongside small producer farmers by the year 2030. Concentrating on population growth dynamics and other dynamic challenges to food security sustainability such as food prices, violent conflict among other challenges, these perspective look at the society's effort to maintain a sustainable society.

2.1. Economic Perspectives of Food Security

The COVID-19 pandemic is bound to result in one of the most devastating economic recessions in decades the world over. The fact is that the world economy is potentially needing additional years to return to pre-COVID-19 stages [19]. Over the last three decades, most economies have implemented significant trade policy reforms to reduce tariff and non-tariff barriers, which have contributed to global trade growth [20]. The justifications for the trade reforms include increasing efficiency in output growth and resource allocation, which alleviate poverty and enhance the availability of food that can be consumed locally [21,22]. For instance, in the countries whose local food production is restrained by agro, climatic, and other factors, the global market can supply their national food demand [23]. The four pillars of FAO (i.e., food availability, access, utilization, and stability) offer a complete framework for analyzing food security, particularly the demand-side effect on labor, household production, and trade related to food [24]. As a result, openness to trade permits and opens access to developed markets, technological transfers, specializations, knowledge spillovers, export revenue generation, and economies of scale [25]. Therefore, an extensive number of studies limited their scopes on globalization, trade liberalization, and particular aspect of development which include poverty and growth dimensions resulting in inconclusive findings [9]. Although poverty is a considerable element of societal wellbeing, the aspect of food security-insecurity is highly associated with the basic needs of society, and it has captivated the interest of researchers in the most recent decades, the world over [26]. Food security and insecurity along with poverty remain pressing concerns globally, not just because of their distressing prevalence but because they are dynamic and stochastic. Many of the world's poorest communities are also those most threatened by poverty, climate, conflict, disease, and other shocks [27]. Improvement in trade openness is associated with improved national food availability and, consequently, food security. However, both in terms of policy and research perspectives, poverty receives more attention than sustainable food security the world over [28,29].

2.2. Political and Societal Conflict Perspectives

Food security sustainability does not only suffer economic challenges but also social problems related to political and societal issues. For instance, the most detrimental shock to the land under cultivation in most developing economies is the prevalence of armed conflict [30]. The fact is that conflicts compel significant changes in the utilization of land in various ways, such as abandoning the agricultural land due to internal displacement [31]. The underutilization of land, loss of labor, and other inputs reduce investments into irrigation infrastructure because of doubts about the potential loss of capital in the conflict-affected regions [30,32]. Despite laws enacted by the government to conserve forests, forest conservation is further forfeited because of occupation by non-state actors [33,34]. The Northeastern states in Nigeria have been dealing with the unprecedented challenges of IDPs who deplete the states' budgets, infrastructure, and resources since their predominance in 2009 [21,35]. For instance, a vast area of land has been under-cultivated and harvested due to violent attacks and related doubts in the Northeastern region in Nigeria [35]. Another claimed factor is the high cost of essential commodities [36], given that 70% of the IDPs depend on farming as the primary means of livelihood [10]. For instance, 19,000 rice farmers near the Sahel dumped their fertile rice fields unharvested in 2009 for fear of violent attacks [36].

The effect of abandonment is intensified in the whole northern region because both the food selling and transporting population are displaced [18]. The crisis in Nigeria highlights the need for engagement because northern Nigeria is the primary source of food production in Nigeria.

As shown in Figure 5, a close comparison of how food insecurity and civil insecurity are related. The violence that emerged and confined to a small area has suddenly grown into one of the most horrible and trending humanitarian crises. For a long time, the food and nutrition crises in the country's northeast were mostly overlooked by the south, and Boko haram was considered a northern Nigerian problem. However, the entire country became mindful of the Boko haram when the vulnerability of suicide attacks struck significant cities, including the country's capital, Abuja. It is indeed a threat that neither Africa nor the rest of the world can accept.

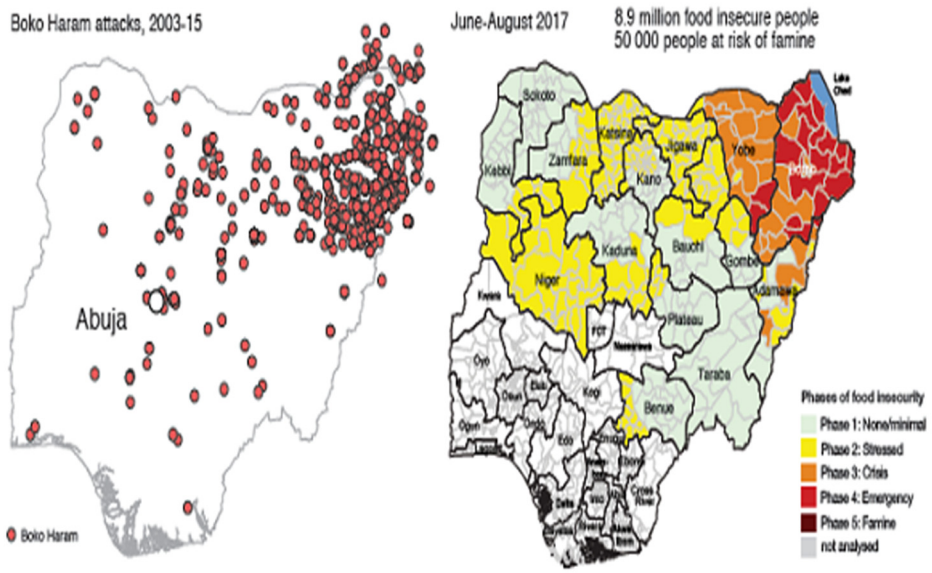

Figure 5. Relationship between Civil Insecurity and Food Insecurity (source: https://www.oecd.org/development/) (accessed on 23 June 2021).

As shown in Figure 6, which is adapted from a business day, assessment data from the Institute for Economics and Peace's (IEP) 2021 Economic Value of Peace report. The economic impact of violence in Nigeria has cost the country billions of dollars. For instance, Figure 6, illustrates that restraining violence is costly, costing Nigeria $1.34 trillion in 13 years (i.e., 2007–2019).

2.3. Environment, Natural Resources, and Food Production

Poor soil fertility is a major issue limiting agricultural output in Sub-Saharan Africa from an agronomic perspective [26,37]. Agricultural production is nutrient-limited, even in the dry savannas of the Sahel [23]. Mineral fertilizers are required because of the significant limitations of nutrients in African farming systems [26,38]. Similarly, it is well acknowledged that merely utilizing mineral fertilizers to manage soils while ignoring the need to maintain soil organic matter cannot support agricultural output. This has given rise to the integrated soil fertility management (ISFM) paradigm, which acknowledges the need for effective nutrient recycling and the use of crop wastes and organic manures, as well as the use of mineral fertilizers [25]. The ISFM also believes that excellent crop types and agronomic management are critical for enhanced production and effective use of nutrients. Intercropping and rotations with grain legumes are important parts of ISFM because their symbiotic relationship with rhizobia allows them to absorb atmospheric nitrogen [10,25]. Legumes also provide the ability to diversify cropping systems as well as intensify them,

providing additional advantages in terms of human nutrition, pest and disease control, and increasing the yields of other crops in the cycle [39].

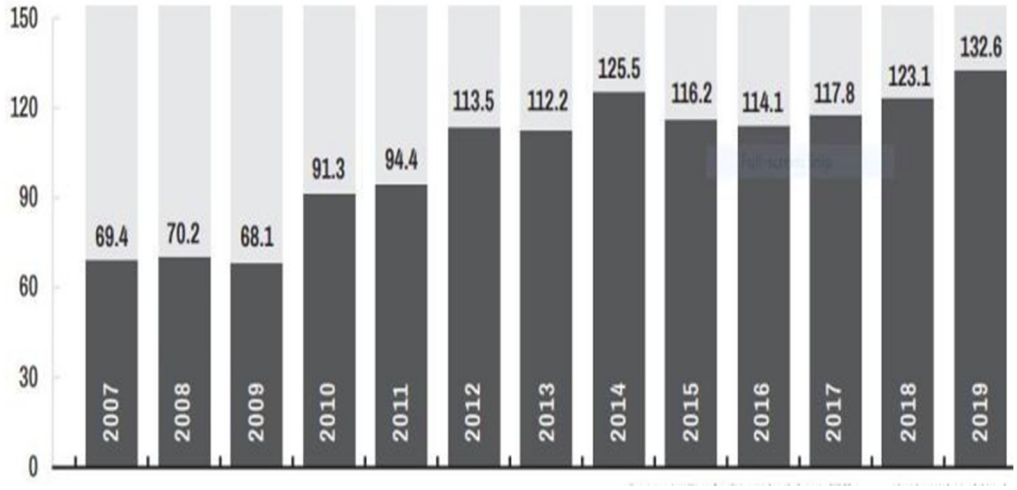

Figure 6. The economic impact of violence in Nigeria in billions of dollars ($, billion) (Source: Institute for economics and peace (IEP) and https://businessday.ng) (accessed on 18 June 2021).

In Africa, smallholding farmers dominate the production process of commodities in Sub-Saharan Africa [40]. The various farming systems are associated with the cultural identities, soils, and climatic nature of these farmers in addition to high population density, inadequate capital, and continuous pressure on land give rise to small farms [35,41]. By investigating 17 Sub-Saharan Africa economies across 93 locations in 13,000 households, it was found that an outrageous 37% of the households were food insecure and even if all their incomes are transformed into calories, they cannot achieve food security [42].

As shown in Figure 7. The recent challenges facing food sustainability in Nigeria, particularly with the growing population and under-production challenges without strategic food reserve in terms of emergencies, are exposed. This has triggered the smuggling of food items in considerable quantities to meet the growing demands of the increasing population.

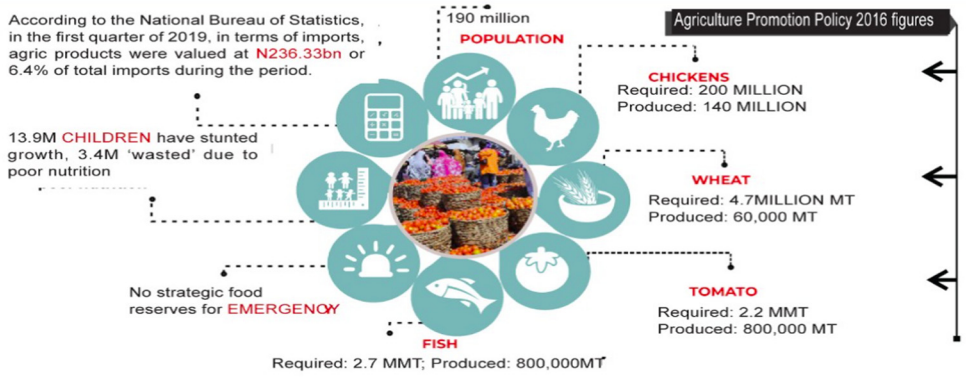

Figure 7. Statistics of underproduction challenges facing food sustainability in Nigeria (source; https://businessday.ng) (accessed on 20 June 2021).

2.4. Neo Malthusian Theory and Theory of Access Connection to Food Security

Currently, population growth and productivity are long term challenges associated with food scarcity the world over. Therefore, employing Neo Malthusian and Access theories and their perspectives is a significant contribution to build further synthesis on global food security challenges particularly the case of Nigeria where population growth, violent conflict food prices among other challenges have become threat to food security

sustainability. Thus, food security sustainability can be achieved ultimately through a sustainable society that meet their current food consumption without compromising the abilities of their future generations to meet their food necessities.

The Neo Malthusian theory [43,44] extended the classical hypothesis developed by [45] that population growth will grow more than the agricultural production. Therefore, the society is going to fail in its ability to address hunger challenges. In this case, Neo Malthusian have a pessimistic perspective on agricultural production because they assert that the society cannot meet its ability to produce subsistence for its inhabitants. Although, some societal shifts are put in place (i.e., in existence), for example, the fertility statistics in most developed economies have significantly reduced to a barest minimum level with the Green Revolution having a significant impact above expectation [46]. Similarly, [47] assert that increase in food supply is associated with population growth. Although, the developed economies have strongly addressed their fertility issues and [48] assertions have robust biological basis, these remedies are yet to be realized in continent like Africa, particularly Nigeria where population size has continued to increase despite declining food production in the country as projected by Neo Malthusian theory. Currently, Nigeria is among the first 20 economies with the highest population growth rate [49]. Thus, the most pressing challenge to food sustainability is shortage in food availability, worsened by challenges of access and utilization of food items intensified by the increasing scarcity. Food availability is significant for conserving resources to maintain sustainable methods of food production and economic development [50].

The theory of Access hypothesizes that "access" must be understood beyond the classical concept of "the right to benefit from things" but to the notion of "the ability to derive benefits from things. The theory stresses the fact that individuals may have the right to access certain resources. However, they may not certainly have the ability to benefit productively from the use of such resources because of inadequate knowledge, capital, market connections, technology, identity, access to authority, access to labour and social relations [51].

However, we incorporate this theory due to its inclusive basis for investigating the significance of access in addressing household food security issues through right to access private property (i.e., bundle of rights) and bundle of powers to access resources. The bundles of right covers all forms of formal and informal rules or norms. However, bundle of power intercedes in analogous to right-based access mechanism to figure how resources users gain control and eventually claim benefits [52]. For example, accessing land and water for irrigation are the most significant resource in agricultural production. Therefore, having access to production can improve productivity and sustainable livelihoods of smallholder farmers which can inevitably help to achieve food security sustainability [53]. However, inadequate access to productive resources can certainly expose the smallholder farmers to food insecurity and become vulnerable to unsustainable livelihoods [54].

Previous studies have failed to incorporate the full prospect of Neo Malthusian and Access theories complementary application since resourceful smallholder farmers that have access to production can positively induce increase in productivity, sustainable livelihood of the smallholder farmers and food security sustainability.

Although these two theories are not identical, but are more connected than studies have acknowledged thus far. However, the method we employed in this investigation are able to capture the changes that are essential to the sequential procedures of analysis. Uncovering the trends from a point of global attention to a new and specific point of attention can definitely offers an idea of how food security has been affected by population growth, food prices value addition, GDP per capital, internal displacement and currency fluctuations in Nigeria. Therefore, problems associated with food security distribution should be addressed with immediate effect. Based on the foregoing theories, this study seeks to test the following hypothesis;

Hypothesis 1 (H1). *Increase in value addition, GDP per capital, population growth, food prices, internal displacement and currency depreciation have significant impact on food availability, access, utilization and stability.*

3. Materials and Methods

In this study, we investigate Food Security Sustainability: a Synthesis of the current Concepts and Empirical Approaches for Meeting SDGs in Nigeria using an Autoregressive Distributive Lag (ARDL) model. The ARDL is utilize along with ECM technique to assess both the long run and short-run relationship obtainable between variables and to appraise and compare the FIES and FEWS analysis with the empirical results obtained in this study to offer a standpoint from the current point of attention to a new point of attention on the issues related to food security sustainability and food insecurity challenges in Nigeria. The ARDL technique is applied within the framework of various series regardless of the order of integration and could also generate a variety of optimal lags besides multiple variables provided that none of the variables is integrated of order I(2) [55]. The method has major advantages over other techniques such as least-squares methods, cointegration technique, VECM technique, and VAR technique. For instance, with the same technique, one can estimate both short and long-run parameters with a self-defined lag length structure. In addition, the problem of endogeneity is solved through the ARDL technique [56]. Meeting the requirements for estimating the ARDL technique along with EC, The ARDL technique is implemented due to variables' stationarity order of I(0) and I(1). Therefore, Figure 8 below, presents the map of Nigeria as the study area.

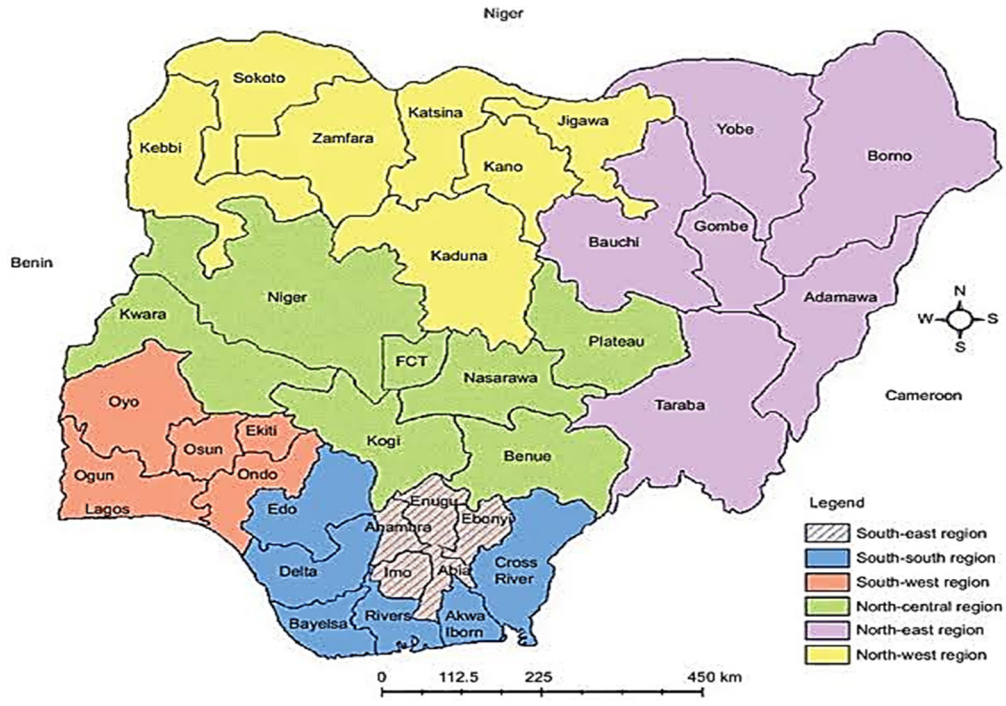

Figure 8. Map of Nigeria as the area of a study showing 36 states, including the federal capital. (Source: https://images.app.goo.gl/ejp7ReDPuMbvoQ2z6) (accessed on 8 May 2021).

As shown in Figure 8. The map of Nigeria shows the 36 states including the federal capital territory Abuja (i.e., FCT). Therefore, the legend shows the six geopolitical zones namely; South-east region, South-south region, South-west region, North-central region, North-east region and North-west region. Thus, the decision to choose Nigeria as a case study is well justified due to the dimensions of extreme poverty, increase in population growth and the volume of IDPs compared with the rest of the world following United Nations (UN) and Statista country growth classification.

3.1. Model Specification and Data Description

The study employed annual time series data covering 1981 to 2019 obtained from the World Development Indicators Database, and the long run econometric model of this study is specified as below:

$$LFPI = \alpha + \beta_1 LAFVA_{it} + \beta_2 LIDP_{it} + \beta_3 LGDPpc_{it} + \beta_4 LPOPtl_{it} + \beta_5 LREER_{it} + \beta_6 LINFcp_{it} + \varepsilon_{it} \quad (1)$$

where *LFPI* is the food production index (2004–2006 = 100) which includes nutritional edible food crops as a proxy for sustainable food security in Nigeria. *LAFVA* is the agricultural value-added including hunting, fishing, and forestry that correspond to International Standard Industrial Classification (ISIC) from divisions 1–5 and measured as a percentage of GDP *LIDP* is the internally displaced persons associated with violence, disaster, and other ethnic and religious conflicts measured based on the number of cases in Nigeria over time. *LGDPpc* is G.D.P. per capita. GDP is divided by the midyear population measured in constant local currency units. *POPtl* is the population total regardless of citizenship or legal status measured as a midyear estimate. REER is the real effective exchange rate index (2010 = 100) measured by the national currency value against several weighted average foreign currencies. We included the exchange rate due to its importance in influencing economic activities in Nigeria. Nigeria is arguably a net importer of food items. Therefore, the exchange rate is expected to affect economic activities, particularly when food prices are unfavorable. INFcp is the inflation rate based on consumer prices measured based on annual percentage. The i and t subscripts represent economy-specific and t time horizons, respectively. To directly interpret elasticities, minimize the effects of serial correlation, heteroscedasticity amongst other spurious regression issues in the data, all the variables have been logged linearized. Accordingly, the α represents the intercept parameter while β_1, β_2, β_3, β_4, β_5, and β_6 will provide us the long-run elasticities of *LFPI* with respect to *LAFVA*, *LIDP*, *LGDPpc*, *LPOPtl*, *LREER*, and *LINFcp*, respectively. The E_t is the error term and should exhibit normal, identical, and independent distribution around zero mean and constant variance (i.e., NIID ~(0,1)). Figure 9, presents the time series plot of the total macroeconomic indicators of food security sustainability.

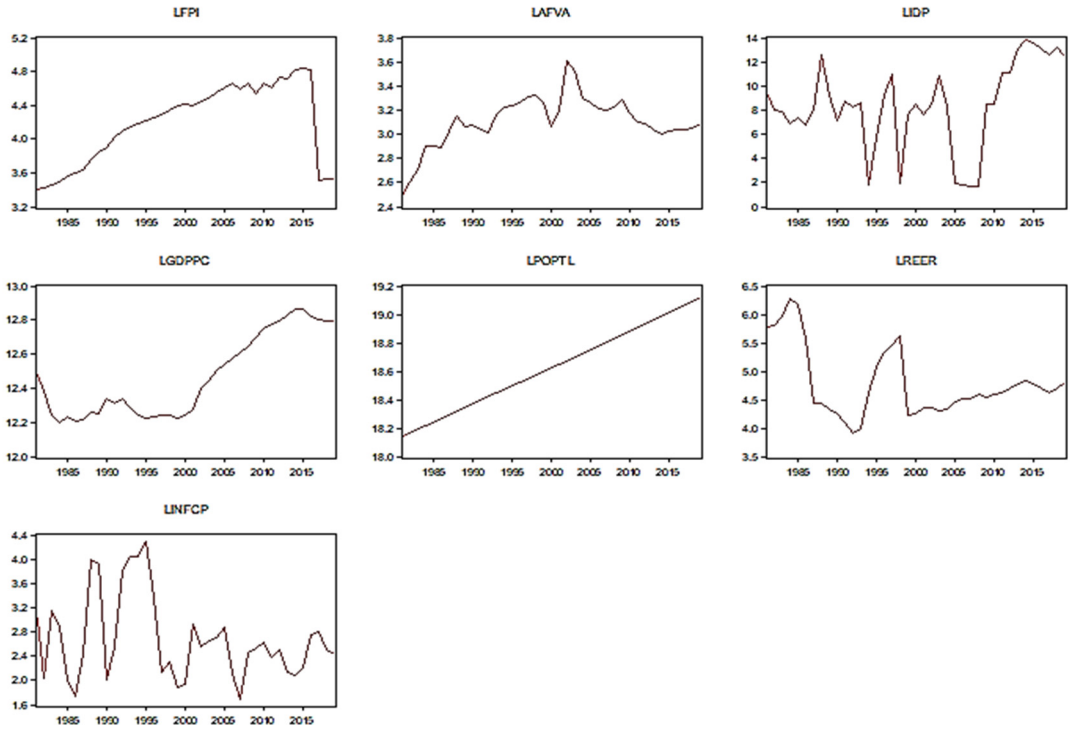

Figure 9. Shows a time series plot of the total macroeconomic indicators as drivers of food security sustainability from 1981 to 2019 (Source: authors' computation based on research data).

The Agricultural season and Rainfall performance in both the northern and southern parts of Nigeria are represented in Figure 10.

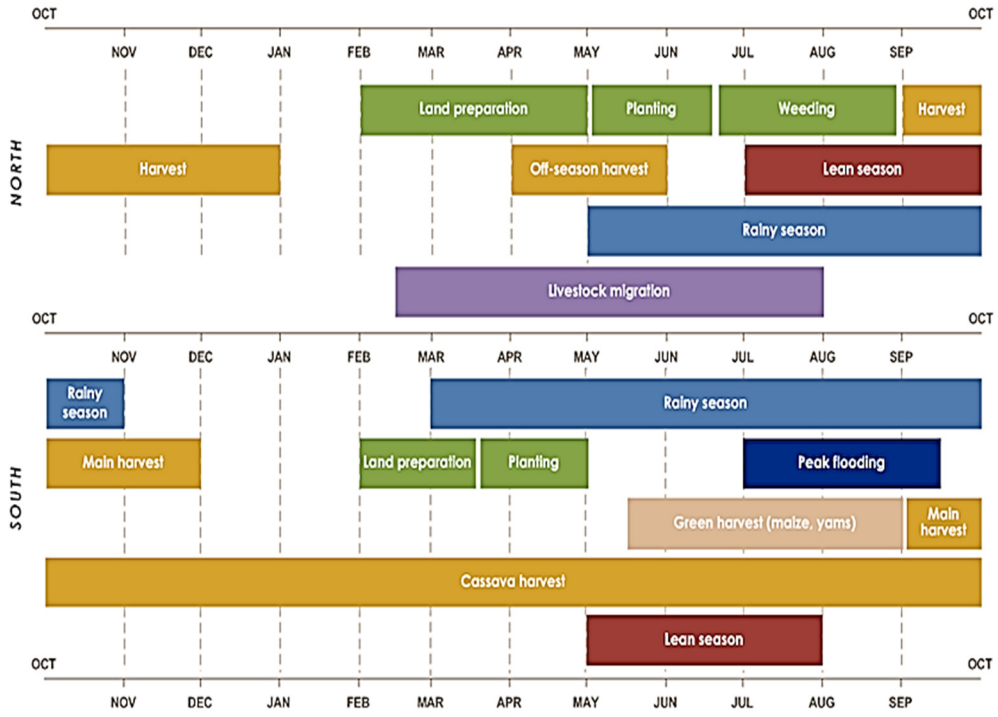

Figure 10. Agricultural season and Rainfall performance in northern and southern Nigeria (Source: https://fews.net/west-africa/nigeria) (accessed on 23 June 2021).

As shown in Figure 10, the current situation and development of the agricultural season, which have seen near average rainfall over much of the country so far. The rainy season starts in March in the south and may in the north as is customary. However, certain central and northern areas may have one to three weeks delays at the start of the season. However, the ongoing insecurity, particularly in most northern states, is again restricting many from accessing land or participates fully in cultivation. The kidnapping in the northern region of Nigeria also continues. Farmers who formally relied on agriculture for a living are finding it difficult to return to farming. In the worst affected communities, where agricultural constraints are the most severe extreme levels of acute food insecurity are likely if displace persons are cut off due to a change in hostilities and emergency aid is discontinued.

3.2. Estimation Techniques

To carry out this investigation, the study performed a unit root test to determine the order and long-run relationship of the variables in the model using Augmented Dicky Fuller (ADF), Phillip Perron (PP.) Tests and Johansen Co-integration test, respectively. When using non-stationary variables in a typical time series model, there is always the risk of producing misleading findings unless the variables share a common trend (i.e., are cointegrated) which describes their long-run relationship. This study used a multivariate cointegration test to assess whether the variables share one or more cointegrating associations. Accordingly, the stationarity property has been ascertained at the mixed other of 1(0) and 1(1). In this study, we employed trace statistics and maximum eigenvalue statistics.

$$\lambda_{\text{trace}} = -T \sum_{i=r+1}^{n} log\left(1-\hat{\lambda}_i\right) \; r = 0, 1, 2 \ldots, n-1 \tag{2}$$

where: the alternative hypothesis is that the variables of interest have more than *r* cointegrating relations.

The null hypothesis (i.e., H0) of at most *r* cointegration relationships specified by maximum eigenvalue statistic can be estimated as follows:

$$\lambda_{\max} = Tlog(1 - \hat{\lambda}_{i+1}) \; r = 0, 1, 2 \ldots, n-1 \tag{3}$$

The alternative hypothesis (i.e., H1): there are *r* + 1 cointegration relationships among the variable of interest.

Given that, it is possible to have up to r linearly independent cointegration relationships (where $r \leq k - 1$) in every system of variables for both trace and maximum eigenvalue tests. The asymptotic distribution, like the univariate Dickey-Fuller test for unit roots, is non-standard and depends on the deterministic components included (i.e., constant and trend). From the unit root test and cointegration results, the necessary condition for estimating the ARDL bound technique is met since the variables are integrated of order I(0) and I(1). This means the variables have a long-run relationship and our findings are trustable in the long run. The ARDL technique in this study is derived as given below;

$$\begin{aligned} LFPI_t = \alpha_0 + \sum_{i=1}^{m} \alpha_{1i} LFPI_{t-i} + \sum_{i=0}^{n} \alpha_{21i} LAFVA_{t-i} + \sum_{i=0}^{l} \alpha_{31i} LIDP_{t-i} + \sum_{i=0}^{l} \alpha_{41i} LGDPpc_{t-i} + \sum_{i=0}^{l} \alpha_{51i} LPOPtl_{t-i} \\ + \sum_{i=0}^{i} \alpha_{61i} LREER_{t-i} + \sum_{i=0}^{l} \alpha_{71i} LINFcp_{t-i} + \varepsilon_{it} \end{aligned} \tag{4}$$

In Equation (4), where the α indicates the coefficient matrixes of the explanatory variables in the study, m, n, l indicates the maximum number of optimal lags length of the variables included in the model coefficients. ε_{it} indicates the error term.

Accordingly, we specify Equation (5) to test and confirm the presence of cointegration among the variables in the study as given below:

$$\begin{aligned} \Delta LFPI_t = \alpha_0 + \sum_{i=1}^{m} \alpha_{1i} \Delta LFPI_{t-i} + 0 \sum_{i=0}^{n} \alpha_{21i} \Delta LAFVA_{t-i} + \sum_{i=0}^{l} \alpha_{31i} \Delta LIDP_{t-i} + \sum_{i=0}^{l} \alpha_{41i} \Delta LGDPpc_{t-i} + \sum_{i=0}^{l} \alpha_{51i} \Delta LPOPtl_{t-i} \\ + \sum_{i=0}^{i} \alpha_{61i} \Delta LREER_{t-i} + \sum_{i=0}^{l} \alpha_{71i} \Delta LINFcp_{t-i} + \alpha_8 LFPI_{t-i} + \alpha_9 LAFVA_{t-i} + \alpha_{10} LIDP_{t-i} \\ + \alpha_{11} LGDPpc_{t-i} + \alpha_{12} LPOPtl_{t-i} + \alpha_{13} LREER_{t-i} + \alpha_{14} LINFcp_{t-i} + \varepsilon_{1t} \end{aligned} \tag{5}$$

From Equation (5), the null hypothesis; $H_0 : \alpha_8 =, \alpha_9 =, \alpha_{10} =, \alpha_{11} =, \alpha_{12} =, \alpha_{13} =, \alpha_{14} = 0$ (no cointegration) while the hypothesis $H_1 : \alpha_8 \neq, \alpha_9 \neq, \alpha_{10} \neq, \alpha_{11} \neq, \alpha_{12} \neq, \alpha_{13} \neq, \alpha_{14} \neq 0$ (cointegration). To determine the influence of the results and by comparing the calculated F-statistics value to both the lower bound I(0) and upper bound I(1) critical values, [57] recommends that the null hypothesis of no cointegration is rejected if the computed value of the test statistics is larger than the upper bound I(1) critical value. In this study, a cointegrating relation exists among the variables of interest.

To evaluate the outcome from the short-run dynamics, the following error correction model is estimated;

$$\begin{aligned} LFPI_t = \alpha_0 + \sum_{i=1}^{m} \alpha_{1i} LFPI_{t-i} + \sum_{i=0}^{n} \alpha_{21i} LAFVA_{t-i} + \sum_{i=0}^{l} \alpha_{31i} LIDP_{t-i} + \sum_{i=0}^{l} \alpha_{41i} LGDPpc_{t-i} + \sum_{i=0}^{l} \alpha_{51i} LPOPtl_{t-i} \\ + \sum_{i=0}^{i} \alpha_{61i} LREER_{t-i} + \sum_{i=0}^{l} \alpha_{71i} LINFcp_{t-i} + \alpha_8 ECM_{t-1} + \varepsilon_{2t} \end{aligned} \tag{6}$$

where, α_8, represents the speed of adjustment coefficient and the short-run correction to equilibrium. The coefficient should be negative and statistically significant so that the system can converge to equilibrium in the subsequent period.

4. Results

Given the dimension of the sample data in this study, the lag order was limited to a maximum of 2 lag using Schwarz-Bayes Criterion (SBC). The study scrutinized the structural breaks utilizing the cumulative sum of squares to ascertain the stability of the parameters in the estimated model which is exhibited in Figure 11 which follows Adedoyin et al. [58]. Hence, we identified the ARDL technique (1, 0,0,1,0,0,0) as the most appropriate as dictated by the data. We performed both ADF and PP unit root tests and all the variables (i.e., *LFPI*, *LAFVA*, *LIDP*, *LGDPpc*, *LPOPtl*, *LREER*) are non-stationary at level except for *LINFcp* which has been found to reject the null hypothesis of non-stationary at the

level. Accordingly, the rest of the variables became stationary when converted into the first difference based on 1% and 5% level of significance and the hypothesis of nonstationary is reject for both as shown in Table 1. This made it appropriate to estimate the ARDL model. Therefore, the empirical results such as coefficients, test statistics, and probabilities will be approximated to 2 decimal points following [18].

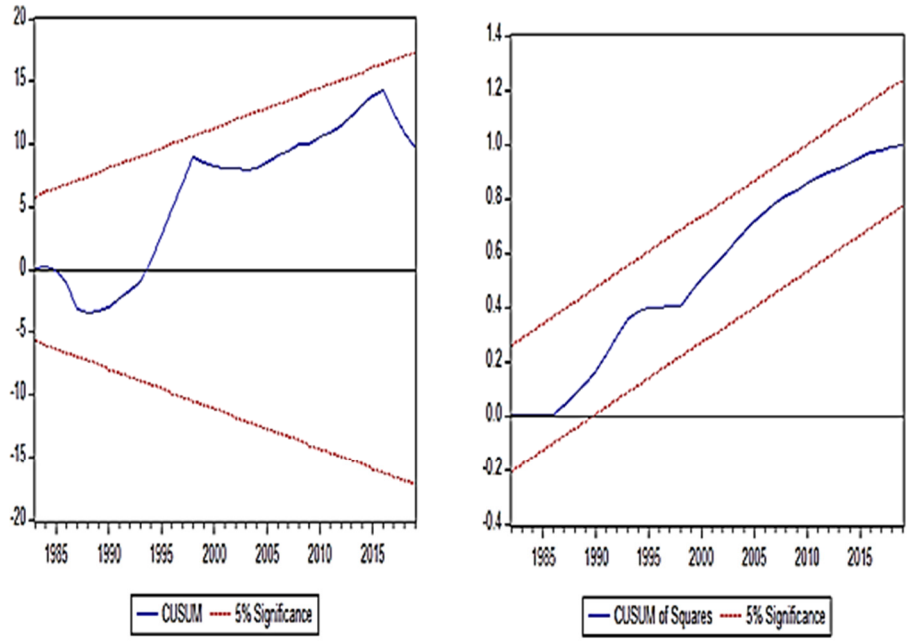

Figure 11. The ARDL Cusum and Cusum of Squares Showing 5% significance level boundaries Plots. (Source: authors' computation based on research data).

Table 1. Unit root test.

	ADF		PP	
Variables	**Test-Statistics**	**Test Statistics**	**Test-Statistics**	**Test Statistics**
(1981–2019)	**level**	**First Difference**	**Level**	**First Difference**
LFPI	−3.53	−5.00 *	−0.82	−6.41 *
LAFVA	−1.94	−7.23 *	−2.18	−8.07 *
LIDP	−1.89	−6.09 *	−1.90	−6.10 *
LGDPpc	−1.47	−3.54 **	−2.93	−3.54 **
LPOPtl	−1.72	14.28 **	−1.84	−5.42 **
LREER	−3.14	−4.74 *	−2.18	−4.29 *
LINFcp	−4.29 **	−6.26 **	−2.87 **	−10.61 **

*, ** show stationarity based on 1% and 5% levels of significance respectively.

4.1. Descriptive Statistics

A descriptive statistical analysis is performed and presented in Table 2, to better understand the dynamics of the total LFPI in the economy. The average growth rate of the LFPI based on historical trends in the Nigerian economy is around 4.43 percent, with maximum and minimum values of 4.83 percent and 3.51 percent, respectively. The maximum growth rate may be considered the initial effect of 1987, structural adjustment program (SAP), and a domestic violence-free economy. This is further ascertained by the long-run positive impact of GDPpc. The economy grows from its lowest point of negative growth to its highest point in 2002, possibly as a result of the positive impact of the democratic government's pursuit of private-sector-led development following the fall of the military regime, as well as the phenomenal rise in oil prices, which has a significant impact on growth. The annual fluctuation rate from 2.99% to 3.28% (*LAFVA*), 8.51% to 13.79% (*LIDP*), 12.69% to 12.86% (*LGDPpc*), 18.85% to 19.11% (*LPOPtl*), 4.52% to 4.82% (*LREER*) and 2.08% to 2.80% (*LINFcp*) established a fairly symmetrical data set across all observations with skewness of zero were realized

with exception of *LFPI*, *LAFVA* and *LIDP* that have a decline skewness of −1.12%, 1.58% and −1.27% respectively. This could be attributed to internally displaced persons resulted from domestic political crises and terrorist activities, which affect the agricultural value-added and food security in Nigeria. Given the 1.56 percent standard deviation, it is possible to conclude that the series has significant dispersion, which is confirmed by the average value of the kurtosis measure of 2.54, confirming that actual LFPI growth is platykurtic. Global Food Security Index identifies Nigeria as the 94th to 100th largest economy globally. However, it has the largest economy with the highest population growth in Africa.

Table 2. Descriptive statistic.

Variables	*LFPI*	*LAFVA*	*LIDP*	*LGDPpc*	*LPOPTL*	*LREER*	*LINFcp*
Mean	4.43	3.07	12.18	12.80	19.11	4.70	2.46
Median	4.65	3.05	12.82	12.80	19.00	4.71	2.48
Maximum	4.83	3.28	13.79	12.86	19.12	4.82	2.80
Minimum	3.52	2.99	8.52	12.70	18.85	4.53	2.09
Std. Dev.	0.49	0.06	1.57	0.04	0.08	0.08	0.21
Skewness	−1.12	1.59	−1.27	−0.42	−0.15	−0.28	−0.33
Kurtosis	2.54	5.11	3.45	3.02	1.76	1.96	2.18
Observation	39	39	39	39	39	39	39

4.2. Johansen Cointegration Test

Table 3 shows that the trace, as well as the Eigen-value, revealed unique cointegration equations at a 5% (0.05) significance level. While the null hypothesis states that there is no long-run relationship among the variables of interest, the (*) represents a rejection of the null hypothesis of no cointegration at the 5% significance level and the implication for this is, the null hypothesis of no cointegration is rejected. This shows the implication for the existence of a long-run relationship among the variables up to the third null hypothesis. By implication, this food security sustainability can converged to its long-run equilibrium condition after some shock in the system.

Table 3. Johansen Cointegration Test.

H_0: No. of CE (s)	Eigen-Value	Trace Stat.	Prob *	Max-Stat.	Prob *
None *	0.77	178.26	0.00 *	54.03	0.00 *
At most 1 *	0.71	124.24	0.00 *	45.61	0.01 *
At most 2 *	0.62	78.63	0.00 *	35.95	0.03 *
At most 3	0.42	42.67	0.14	19.99	0.34
At most 4	0.32	22.68	0.26	14.39	0.33
At most 5	0.20	8.29	0.44	8.13	0.37
At most 6	0.00	0.16	0.69	0.16	0.69

* represents Significance level rejecting the null hypothesis of no cointegration.

Since the conditions necessary for implementing the ARDL bounds test are ascertained [59], Table 4, presents the results of the ARDL Bounds tests approach. Furthermore, as shown in Table 4, the calculated value of F- statistics of 6.38 is higher than the corresponding upper bound table value which is 3.99. Thus, the null hypothesis of no cointegration is rejected and the study concludes that there is the existence of cointegration relationship among *LFPI* and *LAFVA*, *LIDP*, *LGDPpc*, *LPOPtl*, *LREER*, and *LINFcp*. By implication, the agricultural food value-added, internally displaced persons, GDP per capita, population growth, real effective exchange rate, and food inflation have long-run effects on food security sustainability in Nigeria during the study period.

Table 4. ARDL Bound Test Results.

K	F. Statistics	1% Critical Values	
6	6.38	I (0)	I (1)
		2.88	3.99

The results of the effect of *LAFVA*, *LIDP*, *LGDPpc*, *LPOPtl*, *LREER* and *LINFcp* on the LFPI in the short and long run are statistically significant as shown in Table 5. Also, Table 5, shows null hypotheses of the ECM results, and short-run dynamics of no short-run and long-run relationships are rejected. Therefore, the results show that our model's coefficient of ECM_{t-1} is negative (−0.0130 approximately) and statistically significant (0.0000) at 1%. Therefore, *LAFVA*, *LIDP*, *LGDPpc*, *LPOPtl*, *LREER*, and *LINFcp* are significant predictors of LFPI in both the short-run and the long-run analysis coefficients. As a result, the convergence of the disequilibrium to the long-run equilibrium requires 1.3% annually. This is a relatively sluggish adjustment. Although the growth in the food production index is sluggish, by implication, this indicates that the deviation in food security sustainability (LFPI) in Nigeria can adjust to its long-run equilibrium relations after some shocks from the *LAFVA*, *LIDP*, *LGDPpc*, and *LPOPtl*, *LREER* and *LINFcp*. By implication, the result revealed that it would take more than nine years on average for the long-run equilibrium to be fully restored. This means that *LAFVA*, *LIDP*, *LGDPpc*, and *LPOPtl*, *LREER*, and *LINFcp* in Nigeria have not only some beneficial information limited in their lags but also some beneficial information that can predict sustainable food security-insecurity in Nigeria. The contribution of this result revealed that Nigeria's food security sustainability can be determined by the increase in value-added production strategies, effective conflict management, and resolution strategies. The SDGs target for zero hunger and food security sustainability alongside small producers by the year 2030 can be rarely achieved. The finding from our result makes some sense at least because they are in line with the findings of the National Bureau of Statistics, FIES, FEWS, OECD, and World Bank in terms of underproduction challenges and food emergencies in Nigeria. See Figures 1–7. Besides the findings from these institutions, there is also the existence of developing nature of the country and in a particular system of agricultural food production alongside none mechanized farming operating in the country are constraining the ability of the agricultural sector is playing a vital role in the sustainable food security process in Nigeria.

The results of the diagnostics test for the study model are presented in Table 6. As shown in Table 6, the model residuals are homoskedastic and serially uncorrelated. By implication, the null hypothesis of the existence of heteroskedasticity and serial correlation is rejected. In addition, the functional form of the model is correctly specified and its errors are normally distributed. On a final note, the coefficients of the model are also stable. However, the null hypothesis of specification bias, the absence of normal distribution of the model around zero mean, and constant variance and instability of the model are rejected.

Table 5. ARDL (1, 0, 0, 1, 0, 0, 0) Estimates of Short run and Long-run Coefficients.

Short Term Coefficient and Error Correction Model				
Variables	**Coefficient**	**Std. Error**	**T−Statistics**	**Probability**
$\Delta LFPI\ (-1)$	−0.01	0.13	−0.11	0.91
$\Delta LAFVA$	0.44 *	0.10	4.227688	0.00
$\Delta LIDP$	−0.10 **	0.04	−2.26	0.02
$\Delta LGDP._{PC}$	19.68 *	2.37	8.31	0.00
$LGDP._{PC(-1)}$	0.00 *	0.00	3.45	0.00
$POP._{tl}$	−60.00 *	2.34	−25.66	0.00
$\Delta LREER$	11.12 *	0.55	20.24	0.00
$\Delta LINF_{cp}$	−1.13 *	0.14	−8.34	0.00
$E.C.T._{t-1}$	−0.013 *	0.001	−7.365	0.000
Long-Term Coefficients				
Variables	**Coefficient**	**Std. Error**	**T−Statistics**	**Probability**
$LFPI\ (-1)$	0.78 *	0.12	6.24	0.00
$LAFVA$	0.36 *	0.10	3.59	0.00
$LIDP$	0.01 *	0.00	2.72	0.00
$LGDP._{PC}$	0.00	0.00	1.57	0.13
$LGDP._{PC(-1)}$	0.43 *	0.13	3.26	0.00
$POP._{tl}$	−0.40 *	0.11	−3.48	0.00
$LREER$	0.15 *	0.05	2.85	0.00
$LINF._{cp}$	−1.05 *	0.16	−6.42	0.00
C	−6.24 **	2.65	−2.36	0.02

*, ** show stationarity based on 1% and 5% levels of significance respectively.

Table 6. The ARDL diagnostic checks results.

Test	**Calculated Statistic**	**Probability**
B-G-LM Test	0.59	0.54
B-P-G- Test	0.17	0.17
Jarque-	1.22	0.54
Ramsey RESET Test	0.12	0.12
Coefficient Stability Tests:		
Cusum: Stable ^ Cusum(Q): Stable ^		

^ shows significance based on 5% and greater than 5% significance level respectively.

To confirm the significance of the associated parameter for the explanatory variable in the model, the Wald test discussed by [59] was employed. The decision is that, if the Wald test is significant for a specific independent variable or a set of independent variables, we may infer that the parameters related with the variables are none zero, and the variables are to be added to the model by rejecting the null hypothesis of equals to zero. However, if the Wald tests results of the variables are not significant, variables are to be removed from the model and we do not reject the null hypothesis of non-zero. Finally, the result of the joint Wald test of coefficient restriction is presented in Table 7.

Table 7. ARDL Wald test coefficient restriction.

T-Statistics	Value	Df	Probability
F-Statistics	123.34	(6113)	0.00
Chi-square		6	0.00

H_0 = C (2) = C (3) = C (4) = C (5) = C (6) = C (7) = 0.

As shown in Table 7, the result in Table 7 as shown by the computed F-statistics, which is 123.34 and the corresponding probability value of 0.00 approximately, left us with a decision to retain all our variables in the model because the parameters related to these variables are none zero.

As shown in Figure 11, the cusum and cusum of squares stability tests have been carried out to further inspect and ascertain the model. However, the left-hand panel is the cusum test while the right hand is the cusum of squares test. The two red lines indicate the 5% significance bounds. The blue lines from each panel (i.e., left and right panels) indicate cumulative sum and cumulative sum of squares' stability of parameters. When the lines fall within the two boundaries at 5% level of significance, they are considered stable while it is considered coefficient instability if the lines diverge the significance boundaries. Yet, the study scrutinized the structural breaks by means of the cumulative sum of squares to ascertain the stability of the parameters, which follows Adedoyin et al. [58]. The outcome of the estimated parameters shows that the test statistic is within the 5% significance level. Over time, the result confirms the stability of the estimated coefficients as recommended, see Brown, Durbin, and Evans, 1975 [60].

5. Discussion

Food security continues to play a significant role in the global macroeconomic dynamics of many countries. For policymakers and governments in developing and particularly in low-income countries, food security offers even further challenges both from the perspective of achieving SDGs targets and the welfare perspective of the many poor households in the global economies as documented in the literature. For instance, COVID-19 has continued to pose serious economic [19] and welfare challenges to households in Sub-Saharan Africa [16,23]. By implication, this is an alarming aspect for the prospect of sustainable development of food security in Nigeria. We examine first the findings from the recent concepts. The study finds that food security has extensively been associated with increasing food availability and access for a population. Thus, we argue that it is an essential means of achieving the SDGs for poverty and hunger reduction, particularly when focused on small farmers. The physical, political, economic, and social settings, in which a family lives, however, have influenced the riskiness of specific social unrest. For example, rural economies in agrarian regions in Nigeria are more prone to shocks because of conflicts and overall insecurity and this has been imposing a fastening restraint on the long-run growth of agricultural production and domestic income ever since the emergence of unprecedented insecurity in Nigeria [18]. Agriculture is vital to rural economies, and improvement in agricultural productivity can result in economic development or poverty alleviation because livelihoods are so important to food security and sustainability. However, this will only work in settings where people have access to their land. How well these people adapt to a certain threat is largely determined by the strength and diversity of their livelihood. The survival of the citizens largely depends on agricultural sources of income but social unrest, terrorism, and economic fluctuations have challenged food security sustainability in Nigeria [18].

The findings from our results make some sense at least because they are in line with the recent concepts of the National Bureau of Statistics, FIES, FEWS, OECD, and World Bank in terms of underproduction challenges and food emergencies in Nigeria, e.g., see Figures 1–7. For instance, Figure 1 exhibits the prevalence of food insecurity in Nigeria between 2014 and 2019, which increased with population growth in the country over time, where demand for food rose to 9.1 percent between 2017–2019. Figure 2 demonstrates FIES analysis that food insecurity is more prevalent in southern Nigeria on account that northern Nigeria has been the food basket of Nigeria, but in Figure 3, FEWS outcome countered the FIES analysis because outside of northern Nigeria, in much of the rest of the country, the agricultural season is progressing favorably with average and above-average harvests. Therefore, households in these areas will have access to food and income and will remain in minimal acute food insecurity while inside the north and areas affected by crisis and conflicts between farmers and pastoralists, among other social unrest are facing greater difficulty in accessing foods and income and will be stressed, famine or require emergencies, Figure 4 illustrates that the incidence of moderate and severe food insecurity as per the FIES analysis rose in 2020 which justifies the FEWS analysis.

Besides the findings from these institutions, there is also the existence of developing characteristics of Nigeria as an African country. In specific terms, it is argued that the system of agricultural food production alongside none mechanized farming operating in the country is constraining the ability of the agricultural sector is playing a vital role in the sustainable food security process in Nigeria [7].

Next, we examine the empirical approaches. The discussion starts from Figure 2, because it gave us a road map to proceed with the subsequent analyses. The findings revealed unique cointegration equations at a 5% (0.05) significance level, and the implication for this is, the null hypothesis of no cointegration is rejected. This shows the implication for the existence of long-run relationship among the *LAFVA*, *LIDP*, *LGDPpc*, and *LPOPtl*, *LREER*, and *LINFcp* up to the third null hypothesis for both Trace and the Max Eigen-value cointegration results. This result is in line with the findings of [61]. The long-run relationship among *LAFVA*, *LIDP*, *LGDPpc*, *and LPOPtl*, *LREER*, and *LINFcp* can be explained as follows. First, the increase in value-added agricultural production and per capita GDP could positively enhance the goal for sustainable food security. Second, pressure from increasing internally displaced persons, exchange rate volatilities, population growth, and food inflation could ultimately affect the goal of achieving sustainable food security. For example, previous studies found that forced displacement and increase in population have an inverse relationship with agricultural food production [18]. Similarly, food inflation reduces the availability and access to food, particularly at the local level. Thurs, our results are in line with the findings of [17,62], who find that increase in output and economic performance increase food security while exchange rate volatility, increase in population, and forces displacement are related to an increase in food insecurity in the long run. Next, we examine the ARDL Bounds test findings (e.g., see Figure 3). The findings reveal that the calculated value of F- statistics of 6.38 is greater than the corresponding upper bound table value which is 3.99. The null hypothesis of no cointegration is rejected. Thus, the computed F-statistics 123.3378(0.0000) of the joint Wald test left us with a decision to retain all our variables in the model because the parameters associated with these variables are not zero. As shown by the F- statistics, the implication for this is, the *LAFVA*, *LIDP*, *LGDPpc*, and *LPOPtl*, *LREER*, and *LINFcp* are bound together because of equilibrium forces towards a long-run relationship [57,58]. These indicators provide information related to the food security or insecurity and hunger relation in the long run. For instance, a previous study has shown that food security and hunger may not always be linked, but they are related; if people are food insecure for months at a time, they may very well experience a substantial drop in food intake that leads to hunger. In general, agricultural system model analyses more commonly employ availability indicators but would provide improved guidance for research and programmatic efforts with a focus on indicators of food access [8]. Next, we examine Figure 4, the estimates of *LAFVA*, *LIDP*, *LGDPpc*, and *LPOPtl*, *LREER*, and *LINFcp* on the LFPI in the short and long run are statistically significant after the robustness checks, and diagnostic tests have been satisfied. The findings show that the model's coefficient of ECMt-1 is negative (−0.0130 approximately) and statistically significant (0.0000) at 1 percent. As a result, the convergence of the disequilibrium to the long-run equilibrium requires, on average, 1.3% annually. This is a relatively sluggish adjustment, and it indicates that it will take more than 9 years on average for the long-run equilibrium to be fully restored. This result is supported by the United Nations SDGs' target which requires developing countries to achieve at least 7% annual growth to meet the catch-up growth process gap between the developed and developing economies but the 7% target is still out of reach [63,64]. Going by these findings, there is high evidence to believe that accomplishing the SDGs target by the year 2030 for poverty and hunger reduction, particularly when intended for food security sustainability alongside small producers by the year, 2030 can be rarely achieved. This finding has not been investigated by the previous studies. Next, the findings from Figures 5, 6 and 11, left us to retain all our variables because the model residuals are homoskedastic and serially uncorrelated. In addition, the functional form of the model is correctly specified, and its errors are normally distributed. On a final note, the coefficients of the model are also stable. To confirm the significance of the associated parameter for the explanatory variable in the model, the Wald test was employed, and the decision was to retain our variables. The study scrutinized the structural breaks by means of the cumulative sum of squares to ascertain the stability of the parameters in the estimated model, which is exhibited in Figure 11, which follows Adedoyin et al. [58], that the test statistic for the estimated parameters should be within the significant bounds of the 95% confidence interval and this was confirmed. Over time, Figure 11, also confirmed the stability of the estimated coefficients as recommended, see Brown, Durbin, and Evans, 1975 [60].

6. Conclusions

In this study, an ARDL model has been applied to investigate Food Security Sustainability: a Synthesis of the current Concepts and Empirical Approaches for Meeting SDGs in Nigeria using annual data from 1981 to 2019. The following conclusions are drawn from the research findings: Firstly, a long-run cointegration relationship exists between agricultural food value-added production, internally displaced persons, GDP per capita, population growth exchange rate fluctuations, and food inflation. Secondly, while improvement in agricultural value-added production and GDP per capita promote food security sustainability in both the short and long run, increase in population growth, exchange rate fluctuations, and food inflation negate the sustainability of food security in Nigeria. The results also show that the model's lagged coefficient of the error correction term is negative and statistically significant at 1%. Thus, the speed of adjustment requires 1.3% annually for the convergence to the long-run equilibrium to be met. Although the study finds that Nigeria's geography is largely favorable for commercial agricultural investments and projects because agricultural value-added and per capita GDP revealed positive effects as drivers for sustainable food security, the results of our findings based on the current concepts and empirical approaches for meeting SDGs revealed that, on average, domestic violence and insecurity, population growth, food inflation, and exchange rate depreciation remain the key factors determining persistent food insecurity in Nigeria. Since our results are robust and the value addition, GDP per capital, population growth, food prices, internal displacement and currency depreciation have been found to have significant impact on food availability, access, utilization, stability and overall food security sustainability in Nigeria, the study concludes that Nigeria cannot accomplish the SDGs for poverty and hunger reduction, particularly when intended for food security sustainability alongside small producers by the year 2030 because the convergence to the long-run equilibrium is sluggish (1.3% approximately) and will take more than nine years.

6.1. Policy Implications

By implication, our results are robust because they reject the null hypothesis of the none significant and accept the alternative hypothesis of significant impact of value addition, GDP per capital, population growth, food prices, internal displacement and currency depreciation on food availability, access, utilization, stability and overall food security sustainability in Nigeria.

However, the managerial implications for the long-run association among the considered variables have been mixed. The fact is that value-added agricultural production revealed significant managerial prospects and opportunities that can transform Nigeria's agricultural sector into a competitive sector particularly when the value-added production is integrated into current Global Value Chains (GVCs) world markets since each economy retains some value and benefits associated with the consumption of the final product. Yet, improvement in welfare which is measured by the GDP per capita, can boost economic activities, economic performance and make food available and accessible for sustainable food security in Nigeria. Worthy of note is that the prevalence of food insecurity can be minimized in the economy through food storage policy directed at small scale food storage operations by farmers who grow crops and processors among others. Furthermore, for the managerial contributions of the study in terms of the generalization of the findings are unique and this study argues that food security dynamics, changing industry accompanied with consumer and global dynamics present opportunities for innovation to managerial settings, the entire agriculture and food ecosystem is facing an important shift that is reforming the future of food security sustainability from farmers who grow crops, from producers to suppliers and processors to retailers and consumers. This is seldom considered by the previous studies. For example, the food system can be basically shifted from a commodity-based, built-for-scale industry to a modified and global value-added supply chains. Therefore, farmers and producers may be confronted with increased participation burden across the global value chains since consumer demands and under productions imposed serious challenges to farmers and industrial producers to feed the Nigerian market in ways that are transparent, safe and sustainable. By implications, firms can claim some value and benefits in the final products although they may need assurances on the value creation, profit enhancement, transparent operations and corporate social responsibility that induce positive transformation in food and agriculture before taking risk efforts that help in achieving the future of food sustainability in Nigeria by 2030.

Since our study is guided by Neo Malthusian and Access theories the Neo Malthusian theory believed that population growth has the ability to increase more than the global society's ability to produce food to meet its consumption need. While the theory of Access offers distinction between right to have access to resources and ability to benefit from the accessed resources. This contribution

is seldom considered in the previous studies and this study addressed this gap. Theoretically, depreciation of domestic currency due to fluctuations in exchange rates can increase the external trade competitiveness of a domestic export since foreigners find our export cheaper while our industrial sectors find their exports dearer and this can lead to higher prices in the economy, particularly the population growth and violent conflict revealed some pressing challenges to food production due to increasing demand in the economy. Therefore, the availability, access, utilization, and stability of food security can be affected which have been adequately captured the two theories incorporated in this study.

It is quite surprising that empirical evidence for food security sustainability: a synthesis of the current concepts and empirical approaches for meeting Nigeria's SDGs target for reducing poverty and hunger, especially when aimed at food security sustainability alongside small producers by the year 2030, is not only deficient in the literature, but in Sub-Saharan Africa (SSA) where poverty levels are prevalent, and the consumption basket dominated by food is yet to be fully explored. Therefore, this study has filled this gap by providing recent and empirical evidence within the context of Nigeria. The country is sustainable food security targeting economy.

Based on the objective of the study, the study recommends that policymakers and relevant stakeholders design agricultural value addition production strategies, conflict management, and resolution strategies, identify the vulnerable people affected by the crisis, and provide humanitarian food security interventions to confront the next emergency. An inclusive policy framework which includes various sectors and action areas such as funding programs should implemented to minimize the challenges of food insecurity and help in reducing poverty and hunger in Nigeria.

6.2. Limitations

Against this background, this study is limited in terms of qualitative data that could be used primarily to directly engage with the households to offer policy inferences. As a result, we employed a hybrid of recent concepts with available secondary data for the empirical study. A broad data collection such as panel or cross-sectional data, would have supported further inclusive justification of the food security sustainability development from the commencing to the conclusion periods. Although the model of the study considered variables along with white noise (E_t, (i.e., to capture the effect of other variables not included in the model)) from the literature to ensure reliability of the research, it is possible to have deviation in other variables not included in the model such as food quality, undernourishment and coping strategy index such as income expansion and consumption changes which would have contributed to enriching the research findings.

However, future studies should employ micro qualitative data to fill this gap. In addition, future studies should concentrate on agricultural value addition because of its significance in the food security sustainability process. Furthermore, new studies should also focus on investigating on the agricultural value addition into the competitive Global Value Chains (GVCs) world. This can open up opportunities for discussions and for industrial sectors to retain some value and benefits in the final products in the GVCs market. However, food health effects [65] should be investigated to incorporate SDGs' good health and wellbeing targets.

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References

1. Petit, G.; Yannou-Le Bris, G.; Eckert, C.; Liu, Y. Facilitating Aligned Co-Decisions for More Sustainable Food Value Chains. *Sustainability* **2021**, *13*, 6551. [CrossRef]

2. Schleifer, P.; Sun, Y. Reviewing the impact of sustainability certification on food security in developing countries. *Glob. Food Secur.* **2020**, *24*, 100337. [CrossRef]
3. Nicholson, C.F.; Stephens, E.C.; Kopainsky, B.; Thornton, P.K.; Jones, A.D.; Parsons, D.; Garrett, J. Food security outcomes in agricultural systems models: Case examples and priority information needs. *Agric. Syst.* **2021**, *188*, 103030. [CrossRef]
4. USDA Definitions of Food Security. Available online: https://www.ers.usda.gov/topics/food-nutrition-assistance/food-security-in-the-us/definitions-of-food-security.aspx (accessed on 8 April 2021).
5. Neven, D. *Developing Sustainable Food Value Chains, Guiding Principles*; FAO: Roma, Italy, 2014; Available online: http://www.fao.org/3/i3953e/i3953e.pdf (accessed on 1 May 2021).
6. Food and Agricultural Organization of the United Nation. Trade Reforms and Food Security: Conceptualizing the Linkages. 30 December 2003. Available online: http://www.fao.org/3/y4671e/y4671e00.htm (accessed on 1 May 2021).
7. Nicholson, C.F.; Stephens, E.; Jones, A.D.; Kopainsky, B.; Parsons, D.; Garrett, J. Setting Priorities to Address the Research Gaps between Agricultural Systems Analysis and Food Security Outcomes in Low- and Middle-Income Countries. 2019. Available online: https://bora.uib.no/bora-xmlui/handle/1956/22090 (accessed on 1 May 2021).
8. Anderson, K. Krueger, Schiff, and Valdés Revisited: Agricultural Price and Trade Policy Reform in Developing Countries since 1960. *Appl. Econ. Perspect. Policy* **2010**, *32*, 195–231. [CrossRef]
9. Haruna, A. FAO Distributes Seeds, Fertiliser to Farmers Displaced by Boko Haram. Available online: https://www.premiumtimesng.com/regional/nnorth-east/273955-fao-distributes-seeds-fertiliser-to-farmers-displaced-by-boko-haram.html (accessed on 26 June 2021).
10. Muyanga, M.; Jayne, T.S. Effects of rising rural population density on smallholder agriculture in Kenya. *Food Policy* **2014**, *48*, 98–113. [CrossRef]
11. Fasanya, I.O.; Odudu, T.F. Modeling return and volatility spillovers among food prices in Nigeria. *J. Agric. Food Res.* **2020**, *2*, 100029. [CrossRef]
12. Food and Agricultural Organization of the United Nation. FAO Nigeria Agriculture at a Glance. Available online: http://www.fao.org/nigeria/fao-in-nigeria/nigeria-at-a-glance/en/ (accessed on 15 July 2021).
13. FAO Food and Agriculture Organization of the United Nations. Northeastern Nigeria—Situation Report December 2018: FAO in Emergencies. Available online: http://www.fao.org/emergencies/resources/documents/resources%20detail/en/c/1174427/ (accessed on 28 July 2021).
14. CBN. Anchor Borrowers Programme Guidelines. Development Finance Department Central Bank of Nigeria. Available online: https://www.cbn.gov.ng/out/2017/dfd/anchor%20borrowers%20programme%20guidelines%20-dec%20%202016.pdf (accessed on 25 June 2021).
15. Christensen, C. Progress and Challenges in Global Food Security. Available online: https://www.ers.usda.gov/amber-waves/2018/januaryfebruary/progress-and-challenges-in-global-food-security/ (accessed on 18 March 2021).
16. Nechifor, V.; Ramos, M.P.; Ferrari, E.; Laichena, J.; Kihiu, E.; Omanyo, D.; Musamali, R.; Kiriga, B. Food security and welfare changes under COVID-19 in Sub-Saharan Africa: Impacts and responses in Kenya. *Glob. Food Secur.* **2021**, *28*, 100514. [CrossRef] [PubMed]
17. Putra, A.W.; Supriatna, J.; Koestoer, R.H.; Soesilo, T.E.B. Differences in Local Rice Price Volatility, Climate, and Macroeconomic Determinants in the Indonesian Market. *Sustainability* **2021**, *13*, 4465. [CrossRef]
18. George, J.; Adelaja, A. Forced Displacement and Agriculture: Implications for Host Communities. *Sustainability* **2021**, *13*, 5728. [CrossRef]
19. Arias, M.A.; Ibáñez, A.M.; Zambrano, A. Agricultural production amid conflict: Separating the effects of conflict into shocks and uncertainty. *World Dev.* **2019**, *119*, 165–184. [CrossRef]
20. Olper, A.; Curzi, D.; Swinnen, J. Trade liberalization and child mortality: A Synthetic Control Method. *World Dev.* **2018**, *110*, 394–410. [CrossRef]
21. Dorosh, P.A.; Rashid, S.; van Asselt, J. Enhancing food security in South Sudan: The role of markets and regional trade. *Agric. Econ.* **2016**, *47*, 697–707. [CrossRef]
22. Tinta, A.A.; Sarpong, D.B.; Ouedraogo, I.M.; Al Hassan, R.; Mensah-Bonsu, A.; Ebo Onumah, E.; Yildiz, F. The effect of integration, global value chains and international trade on economic growth and food security in ECOWAS. *Cogent Food Agric.* **2018**, *4*, 1465327. [CrossRef]
23. Devereux, S.; Bene, C.; Hoddinott, J. Conceptualising COVID-19's impacts on household food security. *Food Secur.* **2020**, *12*, 769–772. [CrossRef]
24. Vanlauwe, B.; Bationo, A.; Chianu, J.; Giller, K.E.; Merckx, R.; Mokwunye, U.; Ohiokpehai, O.; Pypers, P.; Tabo, R.; Shepherd, K.D.; et al. Integrated soil fertility management: Operational definition and consequences for implementation and dissemination. *Outlook Agric.* **2010**, *39*, 17–24. [CrossRef]
25. Sanchez, P.A. Soil fertility and hunger in Africa. *Science* **2002**, *295*, 2019–2020. Available online: http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.362.6021&rep=rep1&type=pdf (accessed on 18 March 2021). [CrossRef] [PubMed]
26. Upton, J.; Constenla-Villoslada, S.; Barrett, C. *Caveat Utilitor: A Comparative Assessment of Resilience Measurement Approaches*; Cornell University working paper; Cornell University: Ithaca, NY, USA, 2020; Available online: http://barrett.dyson.cornell.edu/files/papers/Resilience%20measurement%20May%202020%20submitted%20with%20appendix.pdf (accessed on 19 March 2021).

27. Revoredo-Giha, C.L. Food Security Indicators, Measurement, and the Impact of Trade Openness. *Eur. Rev. Agric. Econ.* **2009**, *36*, 284–286. [CrossRef]
28. Wichern, J.; van Heerwaarden, J.; de Bruin, S.; Descheemaeker, K.; van Asten, P.J.A.; Giller, K.E.; van Wijk, M.T. Using household survey data to identify large-scale food security patterns across Uganda. *PLoS ONE* **2018**, *13*, e0208714. [CrossRef]
29. Eklund, L.; Degerald, M.; Brandt, M.; Prishchepov, A.V.; Pilesjö, P. How conflict affects land use: Agricultural activity in areas seized by the Islamic State. *Environ. Res. Lett.* **2017**, *12*, 054004. [CrossRef]
30. Gorsevski, V.; Kasischke, E.; Dempewolf, J.; Loboda, T.; Grossmann, F. Analysis of the Impacts of armed conflict on the Eastern Afromontane forest region on the South Sudan—Uganda border using multitemporal Landsat imagery. *Remote Sens. Environ.* **2012**, *118*, 10–20. [CrossRef]
31. Bozzoli, C.; Brück, T. Agriculture, Poverty, and Postwar Reconstruction: Micro-Level Evidence from Northern Mozambique. *J. Peace Res.* **2009**, *46*, 377–397. [CrossRef]
32. Hecht, S.B.; Kandel, S.; Gomes, I.; Cuellar, N.; Rosa, H. Globalization, Forest Resurgence, and Environmental Politics in El Salvador. *World Dev.* **2006**, *34*, 308–323. [CrossRef]
33. Ordway, E.M. Political shifts and changing forests: Effects of armed conflict on forest conservation in Rwanda. *Glob. Ecol. Conserv.* **2015**, *3*, 448–460. [CrossRef]
34. Kah, H.K. 'Boko Haram is losing, but so is food production': Conflict and food insecurity in Nigeria and Cameroon. *Afr. Dev.* **2017**, *42*, 177–196. Available online: https://www.jstor.org/stable/90018140 (accessed on 18 March 2021).
35. Awodola, B.; Oboshi, A. Terrorism in Northern Nigeria: A Threat to Food Security in Maiduguri. *Mediterr. J. Soc. Sci.* **2015**, *6*, 11. [CrossRef]
36. CBC NEWS. Islamic Militants Drive 19,000 Rice Farmers off Land in Northeast Nigeria. Available online: https://www.cbsnews.com/news/islamic-militants-drive-19000-rice-farmers-off-land-in-northeast-nigeria/ (accessed on 26 April 2021).
37. Sanchez, P.A.; Swaminathan, M.S. Cutting world hunger in half. *Science* **2005**, *307*, 357–359. Available online: http://www.jstor.com/stable/3840037?seq=1&cid=pdf (accessed on 18 March 2021). [CrossRef]
38. SSSA. Replenishing Soil Fertility in Africa. *Soil Sci. Soc. Am.* **1997**, *51*, 111–149. [CrossRef]
39. Franke, A.C.; van den Brand, G.J.; Vanlauwe, B.; Giller, K.E. Sustainable intensification through rotations with grain legumes in Sub-Saharan Africa: A review. *Agric. Ecosyst. Environ.* **2018**, *261*, 172–185. [CrossRef] [PubMed]
40. Dixon, J.A.; Gibbon, D.P.; Gulliver, A. *Farming Systems and Poverty: Improving Farmers' Livelihoods in a Changing World*; Food & Agriculture Organization: Rome, Italy, 2001; Available online: http://www.fao.org/3/ac349e/ac349e.pdf (accessed on 18 March 2021).
41. Minot, N. Food price volatility in sub-Saharan Africa: Has it really increased? *Food Policy* **2014**, *45*, 45–56. [CrossRef]
42. Frelat, R.; Lopez-Ridaura, S.; Giller, K.E.; Herrero, M.; Douxchamps, S.; Andersson Djurfeldt, A.; Erenstein, O.; Henderson, B.; Kassie, M.; Paul, B.K.; et al. Drivers of household food availability in sub-Saharan Africa based on big data from small farms. *Proc. Natl. Acad. Sci. USA* **2016**, *113*, 458–463. [CrossRef]
43. Ehrlich, P.R.; Ehrlich, A.H. *The Population Explosion*; Simon and Schuster: New York, NY, USA, 1990.
44. Ophuls, W.; Boyan, A.S., Jr. *Ecology and the Politics of Scarcity Revisited*; W.H. Freeman: New York, NY, USA, 1992.
45. Malthus, T.R. *An Essay on the Principle of Population*; John Murray: London, UK, 1826.
46. Ehrlich, P. The Population Bomb: Revisited. *Electron. J. Sustain. Dev.* **2009**, *1*, 63–71.
47. Quinn, D. *The Story of B*; Bantam Books: New York, NY, USA, 1997.
48. Hopfenberg, R. Human carrying capacity is determined by food availability. *Popul. Environ.* **2003**, *25*, 109–117. [CrossRef]
49. The 20 Countries with the Highest Population Growth Rate in 2021. Available online: https://www.statista.com/statistics/264687/countries-with-the-highest-population-growth-rate/ (accessed on 6 October 2021).
50. Scanlan, S.J. Food availability and access in lesser-industrialized societies: A test and interpretation of neo-Malthusian and Techno ecological theories. In *Sociological Forum.*; Springer: New York, NY, USA, 2021; Volume 16, pp. 231–262. [CrossRef]
51. Ribot, J.C.; Peluso, N.L. A Theory of Access. *Rural Sociol.* **2003**, *68*, 153–181. [CrossRef]
52. Mutea, E.; Rist, S.; Jacobi, J. Applying the theory of access to food security among smallholder family farmers around North-West Mount Kenya. *Sustainability* **2020**, *12*, 1751. [CrossRef]
53. Liniger, H.; Studer, R.M.; Hauert, C.; Gurtner, M. Sustainable Land Management in Practice Guidelines and Best Practices for Sub-Saharan Africa; Terr Africa, World Overview of Conservation Approaches and Technologies (WOCAT) and Food and Agriculture Organization of the United Nations (FAO). 2011. Available online: http://www.fao.org/3/i1861e/i1861e00.pdf (accessed on 5 October 2021).
54. McKay, B.; Colque, G. Bolivia's Soy Complex: The Development of 'Productive Exclusion'. *J. Peasant Stud.* **2016**, *43*, 583–610. [CrossRef]
55. Faisal, F.; Tursoy, T.; Ercantan, O. The relationship between energy consumption and economic growth: Evidence from non-Granger causality test. *Procedia Comput. Sci.* **2017**, *120*, 671–675. [CrossRef]
56. Rauf, A.; Zhang, J.; Li, J.; Amin, W. Structural changes, energy consumption and carbon emissions in China: Empirical evidence from ARDL bound testing model. *Struct. Chang. Econ. Dyn.* **2018**, *47*, 194–206. [CrossRef]
57. Pesaran, M.H.; Shin, Y.; Smith, R.J. Bounds testing approaches to the analysis of level relationships. *J. Appl. Econom.* **2001**, *16*, 289–326. [CrossRef]

58. Adedoyin, F.F.; Ozturk, I.; Bekun, F.V.; Agboola, P.O.; Agboola, M.O. Renewable and non-renewable energy policy simulations for abating emissions in a complex economy: Evidence from the novel dynamic ARDL. *Renew. Energy* **2021**, *177*, 1408–1420. [CrossRef]
59. Pesaran, M.H.; Shin, Y.; Smith, R.J. *Testing for the'Existence of a Long-Run Relationship'*; Faculty of Economics, University of Cambridge: Cambridge, UK, 1996; Available online: https://ideas.repec.org/p/cam/camdae/9622.html (accessed on 8 April 2021).
60. Brown, R.L.; Durbin, J.; Evans, J.M. Techniques for testing the constancy of regression relationships over time. *J. R. Stat. Soc. Ser. B* **1975**, *37*, 149–163. Available online: http://www.jstor.org/stable/2984889 (accessed on 8 April 2021). [CrossRef]
61. Kong, Q.; Peng, D.; Ni, Y.; Jiang, X.; Wang, Z. Trade openness and economic growth quality of China: Empirical analysis using ARDL model. *Financ. Res. Lett.* **2021**, *38*, 101488. [CrossRef]
62. Applanaidu, S.D.; Bakar, N.A.A.; Baharudin, A.H. An Econometric Analysis of Food Security and Related Macroeconomic Variables in Malaysia: A Vector Autoregressive Approach (VAR). *UMK Procedia* **2014**, *1*, 93–102. [CrossRef]
63. UN. Promote Sustained, Inclusive and Sustainable Economic Growth, Full and Productive Employment and Decent Work for All. Available online: https://unstats.un.org/sdgs/report/2019/goal-08/ (accessed on 9 August 2021).

64. Cafiero, C.; Viviani, S.; Nord, M. Food security measurement in a global context: The food insecurity experience scale. *Measurement* **2018**, *116*, 146–152. [CrossRef]
65. Zeng, Y.; Pu, X.; Du, J.; Yang, X.; Li, X.; Mandal, M.S.N.; Yang, T.; Yang, J. Molecular Mechanism of Functional Ingredients in Barley to Combat Human Chronic Diseases. *Oxid. Med. Cell. Longev.* **2020**, *2020*, 3836172. [CrossRef] [PubMed]