Sapientia Global Journal of Arts, Humanities and Development Studies (SGOJAHDS), Vol.6 No.1 March, 2023; p.g. 21 – 32; ISSN: 2695-2319 (Print); ISSN: 2695-2327 (Online)

THE IMPACT OF CLIMATE CHANGE ON FOOD SUPPLY IN NIGERIA: AN EMPIRICAL ANALYSIS FROM 1980-2020

ATOYEBI, K .O. , DANMOLA RASAQ .A ODUOLA,OLADOTUN KABIR, ANAGUN, A.M. & ALABI, S.A.

Abstract

The aim of the study is to examine the effect of climate change on food supply in Nigeria between 1980- 2020. The study used an ex-post facto research strategy because it examines prior occurrences of an existing state to identify the variables that are related to specific occurrences of carbon dioxide on the food supply. The 2022 World Development Indicator was used to gather an annual series of data for the years 1980-2020. The natural log of food production index was used as a proxy for the availability of food, and the natural logs of carbon dioxide (CO2) emissions from burning fossil fuels, liquid fuel consumption, and solid fuel consumption were used as proxies for the state of the climate. EViews version 9 was used to analyze the study, which used a log-log econometric model. The study conducted a pre-estimation test via descriptive statistics, Augmented Dickey Fuller unit root test to ascertain whether the series is stationary or not. A post-estimation test was conducted through the Auto-Regressive Distributed Lag Bound Co-integration test and the Auto-Regressive Distributed Lag model to test the hypotheses. According to the study, carbon dioxide (CO2) emissions from the burning of fossil fuels have an impact on food production, whereas emissions from the use of liquid and solid fuels have no impact on food production in Nigeria. The study then makes two recommendations: first, given that Nigeria's food supply experiences fewer widespread failures, farmers should be trained to adapt to and mitigate the effects of climate change. Second, the government should frequently disseminate information via radio and television programs.

Keywords: Climate Change, Food Supply, ARDL.

Introduction

The Nigeria food production system account a number of factors which include natural factors, man-made factors and lack of technological advancement (IPCC, 2014; Idumah et al, 2016). As a result of the natural factors entail land and water issues (flood, etc.), climate change factors (temperature, rainfall, relative humidity, carbon emissions, etc.). Having a critical and empirical view on the effect of these climate change factors on food production and supply has gained an intermittent status in local, national, and worldwide discourse. Therefore, the actuality of climate change and the regularity of its unfavorable effects pose grave challenges to human life in various parts of the planet. The unfavorable effects of climate change have prompted widespread worries, initiatives to lessen their effects, and lobbying for policies that would limit human actions that contribute to climate change.

Carbon dioxide levels in the atmosphere are high as a result of human activities like the combustion of fossil fuels like coal and oil (Ani et al, 2022). Additionally, the greenhouse effect has been somewhat exacerbated by the clearance of land for industrial and agricultural purposes. The ozone layer is being destroyed due to the emissions of synthetic chemicals called chlorofluorocarbons, which are of industrial origin and contribute to global warming.

The global temperature and carbon emission fluctuations over time have birth a rise to the contemporary climate change phenomenon likewise causing a trend in the food supply of developing economies. Hence, the effects of climate change in Nigeria as a result of higher greenhouse gas concentrations could be detrimental to ecosystems, communities, agriculture, forestry, and water supplies (Ikpa et al, 2017).

Global warming as a result of climate change is a central issue affecting the provision of food supply and food security in any country (FAO, 2015). Moreover, the report also revealed that agricultural production systems are impacted by climate change in both direct and indirect ways. A change in physical qualities, such as temperature ranges and rainfall patterns, can have direct consequences on certain agricultural production systems. The productivity is impacted by indirect effects when other species, including as pests, disease vectors, pollinators, and invasive species, are altered. These incidental impacts might be very important. Given these interacting characteristics and links, many of which are still unknown, they are far more difficult to assess and project.

The phenomena of climate change are also expected to have a variety of effects on agriculture. For instance, changes in rainfall characteristics at the beginning of the growing season can cause crop planting and replanting to occur in an unusual order, which could result in food shortages due to poor harvests. Early rains may not be sustained, and crops planted at their time may be smothered by heat waves. Farmlands are destroyed by extreme weather conditions including floods and strong winds, which can result in crop loss. Climate change directly affects agricultural product availability through its effects on crop yields, crop pests and diseases, and soil fertility. As a result of the heightened risk that climate change poses to investments in agriculture and other weather-dependent livelihoods, many farmers in the area are now facing greater challenges to their livelihoods and food security.

Owing to the factor that Nigeria is faced with several socio-economic issues which also range from climate change as a results of temperature in the Northern part of the country and prone to in-availability of land in the Southern and Western part of the country; this may result to shortage in the supply of food in the country. As a matter of fact, rainfall, temperature, and relative humidity are three natural climatic factors that heavily influence Nigeria's ability to produce food (Idumah et al, 2016). As such, climate change is said to affect the aspects of food security which include food availability, food accessibility, food use, and food system stability(FAO,2008). The expected effects of climate change include altered levels of purchasing power and market flows, as well as effects on human health, livelihood assets, food production, and distribution systems(The Food and Agriculture Organization of the United Nations, 2015). But amongst all these, the climate change through the natural factors such as flood and drought accounts to affect the nation irrespective of the geo-political zone. Once the flood erupts, it will have an effect on consumer purchasing power and market trends, as well as human health, livelihood assets, food production, and distribution systems. Then their access to food are likely to be the first to be impacted by it. Its effects will be both short-term, brought on by more frequent and intense extreme weather events, and long-term which then establishes food insecurity.

With this, the food supply of a low-income nation like Nigeria is grossly affected by climate change having a direct relationship on the urban settlers via a loss of food insurance and

accessibility (Aliyu and Amadu, 2017). Moreover, Abraham (2012) revealed that carbon dioxide emissions from gaseous fuel (liquid and solid) and consumption of carbon dioxide emission damage is posed to have a negative effect on food production which have a positive influence on the on the supply of food in Nigeria. This also corroborate with the report of the Intergovernmental Panel on Climate Change (IPCC, 2007) in developing economies. It is from this background the study is deliberate to examine the effect of climate change on food supply in Nigeria between 1980 to 2021.As such, to critically examine the effect of climate change on food supply in Nigeria; the study sets to determine the effect of carbon dioxide (CO_2) emissions from fossil fuel, carbon dioxide (CO_2) emissions from liquid fuel consumption, and carbon dioxide (CO_2) emissions from solid fuel consumption on food supply in Nigeria.

Hypotheses

The study adopted the following null hypotheses:

H_{01}: Carbon dioxide (CO_2) emissions from fossil fuel do not have an effect on food supply in Nigeria.

H_{02}: Carbon dioxide (CO_2) emissions from liquid fuel consumption has no impact on food supply in Nigeria.

H_{03}: Carbon dioxide (CO_2) emissions from solid fuel consumption does not influence food supply in Nigeria.

2. Selected Existing Literature

Several studies have captured the empirical and theoretical review for the study. Pickson and Boateng (2022) reviewed to assess the impacts of climate change on food security in 15 selected African countries, namely Algeria, Burkina Faso, Cameroon, Cote d'Ivoire, Egypt, Ghana, Kenya, Mali, Morocco, Nigeria, Sierra Leone, South Africa, The Gambia, Tunisia, and Zambia between 1970-2016. The study used climatic variables (i.e. temperature and rainfall) coupled with other explanatory variables (gross domestic product (GDP) per capita, population growth, and cultivated land under cereal production) using the pooled mean group technique and the Dumitrescu–Hurlin panel. The study revealed that rainfall has a significance effect varied substantially across the 15 countries. Also, they found that there is no robust impact of temperature on food security in the long run, while the short-run results showed that extreme temperatures hinder food security, with varying magnitudes across countries. Lastly, that except rainfall, there is a bidirectional causality between food security and temperature in Africa. In a research by Amoo et al (2022) which captures an integrated assessment tools in support of futuristic climate change towards rice production in Nigeria. They employed an integrated assessment tools, the Lower Benue River Basin in Nigeria's rice agriculture was predicted using various lengths of recorded morpho-climatic data (IAT). The principle component analysis (PCA) method and multivariate inferential regression were used to estimate the basin's hydrological response to the various historical meteorological data available for the last 10, 25, and 35 years, respectively. While the multivariate inferential regression connects the past topography conditions to project the future climate scenario, the PCA separates the physical upper and lower limits of rainfall over the basin to serve as a baseline in quantifying available water and subsequent irrigation schedule planning. The findings indicate that the net irrigation water requirements for the different years' worth of data were 711m^3/ha, 1115m^3/ha, and 1343m^3/ha, respectively. However, the average values for ET_0 and ETc suggest that air temperature is a more important climatic driver than precipitation, regardless of the different years' worth of data. Additionally, the effective

rainfall result demonstrates the precision of the anticipated and investigated CROPWAT 8.0 model with longer lengths of recorded morpho-climatic datasets, supporting future-looking assessments of climatic influences for the development of rice agriculture.

The climatic effect on food security especially in developing nations hypothetically effect hunger like Nigeria. In a study by Ayo et al (2014) reviewed the effect of climate change on crop productivity which could have an impact on the supply of food. The primary effects of the study include a decreased agricultural production, changes in the suitability of the land for crop production, changes in precipitation patterns, potential for longer growing seasons, CO2 fertilization that could increase yields for crops with the physiology to benefit from CO2 enrichment, increased irrigation, planting and harvesting changes, decreased arability, increased pest risk, and potential for nutritional deficiencies in fisheries. According to the authors, in order to build a climate-smart food system that can better resist whatever the climate throws at us, a step change is required. They recommended that since climate-smart food is fundamental priority of all trade, investment, and development programs, it should then be included in developing drought- and heat-tolerant crops or innovative tillage practices that decrease release of carbon from soils. Unarguably, climate change affects food supply through the release of billions on tons of carbon dioxide and other greenhouse gases into the atmosphere. Hence, the study reviews the study of Okoli and Ifeakor (2014) on an overview of climate change and food security in Nigeria. The study reveals that low agricultural output, a rise in agricultural pests and illnesses, hunger and malnutrition, and in certain cases, mortality are all consequences of climate change. The use of more effective crop varieties, better irrigation and watershed management, effective use of climate data and forecasts, through early warning systems, altering planting dates, and incorporating irrigation into current rain-fed systems are just a few of the adaptation strategies that are covered.

The study reviews the anthropogenic global warming theory otherwise denoted as AGW theory was developed in the late 1800s as reported by Scientist. The theory which postulates that human-produced (anthropogenic) changes in atmospheric greenhouse gases would likely cause climate change, as changes in these gases have been the case every time in the geologic past. The theory was developed by Bert Bolin, a Swedish meteorologist, who put out the cause-and-effect relationship between rising CO_2, rising temperatures worldwide, melting glaciers, and rising sea levels. The theory states that human activity is causing the Earth to warm, and as a result, people will eventually wipe off the world. The AGW theory has influenced almost every aspect of contemporary life.

2.2. Food Production Data

Table 2.1

Tones produced in	YEAR			
	1980	2000	2016	2020
Maize	612,000	4,107,000	764,678	615,312
Millet	2,824,000	5,814,000	1,468,668	968,000
Guinea corn	3,690,000	7,711,000	6,939,335	4,313,226
Yam	5,250,000	26,210,000	44,409,615	33,415,610
Cassava	11,500,000	32,697,000	57,134,478	58,132,470

Rice paddy	1,090,000	3,298,000	6,070,813	7,512,802
Melon seed	94,000	345,000	569,398	525,392
Cocoyam	208,000	3,886,000	3,175,842	3,123, 802
Sesame seed	15,000	72,000	460,988	461,929

Source: FAO, 2021.

Trend in food production value in metric tons of some selected food items in Nigeria (1980-2020).

It can be deduced that there were fluctuations in the value of those selected food items as a result of climate change during the period of consideration.

3. Methodology

The study adopted an ex-post facto research design. The design was employed due to the fact that it involves and establishes the factors that are associated with certain occurrences of carbon dioxide on food supply by analyzing past events of an existing condition. The data used for the study were sourced from the World Bank Development Indication. An annual time series data over the period of 1980 to 2021 using the natural log of food production index as proxy for food supply, carbon dioxide (CO_2) emissions from fossil fuel, the natural log of carbon dioxide (CO_2) emissions from liquid fuel consumption, and also the natural log of carbon dioxide (CO_2) emissions from solid fuel consumption were used as proxy variables for climate change to form an econometric model. The study adopted the use of log-log econometric model and were analyzed with the aid of EViews version 9. Hence, to the best of the researcher's knowledge, several studies has not captured an econometric model that suits the interest of the study based on the variables.

4. Empirical Results and Interpretation

Table 4.1: Descriptive Statistics

Variables	**Mean**	**Std. Dev.**	**Jarque-Bera**	**Sum Sq. Dev.**
LogFS	1.738182	0.203769	3.496084	1.494784
CO_2FF	1.550122	1.004536	9.737268	36.32731
LogCO_2LFC	4.062050	0.289055	1.092944	3.007899
LogCO_2SFC	1.909416	0.443924	2.548495	7.094476

Source: Author's compilation usingEViews9

Table 1 above shows the descriptive statistics of the variables having the mean for food supply as 1.738, carbon dioxide (CO_2) emissions from fossil fuel as 1.550, carbon dioxide (CO_2) emissions from liquid fuel consumption as 4.062, and carbon dioxide (CO_2) emissions from solid fuel consumption as 1.909. Also, the standard deviation revealed that food supply, carbon dioxide (CO_2) emissions from fossil fuel, carbon dioxide (CO_2) emissions from liquid fuel consumption, and carbon dioxide (CO_2) emissions from liquid fuel consumption as 0.203;1.004;0.289, and 0.443; and its Jarque-Bera coefficients as 3.496; 9.737; 1.092, and 2.548 respectively. The sum of squared deviation for food supply, carbon dioxide (CO_2) emissions from liquid fuel consumption, and carbon dioxide (CO_2) emissions from solid fuel

consumption were low while the carbon dioxide (CO_2) emissions from fossil fuel were reported high.

The Augmented Dickey-Fuller unit root test were employed to examine the time series properties of the variables in the study. This was done in order to avoid spurious regression, and on the advantage of including lagged terms of the dependent variables in order avoid the problem of autocorrelation.

Table 4.2: ADF Unit Root Test

Variables	t-Statistics	5% level Critical value	Prob.*	Order of Integration	Max. Lag Length
LogFS	-21.94834	-2.941145	0.0001	I(2)	9
CO_2FF	-5.903266	-2.938987	0.0000	I(1)	9
LogCO_2LFC	-13.85014	-2.948404	0.0000	I(1)	9
LogCO_2SFC	-7.382712	-2.951125	0.0000	I(1)	9

Note: *Lag Length based on SIC. Probability based on MacKinnon (1996) one-sided p-values for ADF test. *Prob. is significant at 5 percent.*

Source: Author's compilation using EViews9

The ADF null hypothesis suggests that $\delta=0$, and the alternative hypothesis suggests the $\delta<0$; the null hypothesis is rejected if the series is stationary, and the alternative hypothesis prevails if the series has a unit root. The Augmented Dickey-Fuller unit root test as shown in table 3 indicate that variables for carbon dioxide (CO_2) emissions from fossil fuel, carbon dioxide (CO_2) emissions from liquid fuel consumption, and carbon dioxide (CO_2) emissions from solid fuel consumption are stationary at first difference; ***I(1)***, while the variable for food supply is stationary at second difference; ***I(2)***. Therefore, there is need to test for the Auto-Regressive Distributed Lag bound co-integration test.

Table 4.3: Bounds Co-Integration Test

F-Statistic	K	I(0) Bound at 5% Critical	I(1) Bound at 5% Critical
1.539388	3	3.23	4.35

Source: Author's compilation via EViews9

From the ARDL bounds co-integration test above, it was shown that the **F-statistic** is reported to be **1.539388**. Moreover, the study adopts a 5 percent level of significance lower and upper bound which shows that its lower bound value;***I(0)***bound is **3.23**, while its upper bound; ***I(1)***bound is **4.35**. Then, the decision criteria for bound test states that if the F-statistic is greater than the critical value for the upper bound ***I(1)*** at 5 percent level of significance, then, we conclude that there is co-integration (i.e. there is a long-run relationship). And, if the F-statistic is less than the critical value for the lower bound ***I(0)*** at 5 percent level of significance, then, we conclude that there is no co-integration (i.e. there is a short-run relationship). Therefore, since the results in table 4 shows that the F-statistic is less than the critical value for the lower bound;***I(0)*** at 5 percent level of significance, we conclude that there is no co-integration and that there is a short-run relationship between the food supply, carbon dioxide (CO_2) emissions from fossil fuel, carbon dioxide (CO_2) emissions from liquid fuel consumption, and carbon

dioxide (CO_2) emissions from solid fuel consumption. Thus, we accept the null hypothesis, and reject the alternate hypothesis. This means that the model used for the study is stable and is at equilibrium. The association between the dependent and independent variables were established using the short-run Auto-Regressive Distributed Lag (ARDL) model. The model can take into account a variable ideal number of lags to seizure series generation techniques from general to specific modeling, as noted by Pesaran et al. (2001), which is one of the benefits that led to the selection of the ARDL model for the current investigation (Laurenceson and Chai, 2003). The ARDL model also permits the use of unique optimal delays inside the model (Nkoro and Uko, 2016). The ARDL model is also suitable for variables with varying orders of integration, and it only requires one equation to analyze long-term relationships. The ARDL model used for the study can be expressed in equation 4:

$$\mathrm{LogFS}_t = \varphi_1 \mathrm{LogFS}_{t-1} + \beta_1 \mathrm{COFF}_t + \beta_2 \mathrm{COFF}_{t-1} + \beta_3 \mathrm{LogLFC}_t + \beta_4 \mathrm{LogLFC}_{t-1} + \beta_5 \mathrm{LogSFC}_t + \beta_6 \mathrm{LogSFC}_{t-1} + \varepsilon_t \quad \ldots\ldots\ldots (4)$$

The ARDL model adopted for the study used the Akaike Info Criterion using the automatic selection of 4 maximum dependent lags and a 4 automatic dynamic regressors. Hence, the selected model for the study is the lagged four period (i.e, ARDL: 4, 4, 4, 4). The short-run Auto-Regressive Distributed Lag guides the variables (food supply, carbon dioxide (CO_2) emissions from fossil fuel, carbon dioxide (CO_2) emissions from liquid fuel consumption, and carbon dioxide (CO_2) emissions from solid fuel consumption) of the model to maintain equilibrium in the model. This means each of the variables were automatically lagged four times. As such, using the version 9 of the Eviews, the results of the short-run Auto-Regressive Distributed Lag model is shown below.

Table 4.4: ARDL Model Results

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
LogFS(-1)	0.718727	0.244175	2.943495	0.0114
LogFS(-2)	0.661423	0.216452	3.055747	0.0092
LogFS(-3)	-0.544095	0.223769	-2.431506	0.0302
LogFS(-4)	0.203136	0.175836	1.155259	0.2688
CO_2FF	0.007926	0.008489	0.933733	0.3675
CO_2FF(-1)	0.000385	0.011592	0.033230	0.9740
CO_2FF(-2)	-0.022943	0.010990	-2.087639	0.0571
CO_2FF(-3)	0.040991	0.010558	3.882525	0.0019
CO_2FF(-4)	-0.014453	0.009170	-1.576006	0.1390
LogCO_2LFC	0.201361	0.092657	2.173195	0.0488*
LogCO_2LFC(-1)	-0.247419	0.108241	-2.285818	0.0397
LogCO_2LFC(-2)	0.157218	0.112507	1.397404	0.1857
LogCO_2LFC(-3)	-0.107026	0.067693	-1.581039	0.1379
LogCO_2LFC(-4)	-0.051580	0.048708	-1.058955	0.3089
LogCO_2SFC	0.021558	0.015683	1.374651	0.1925
LogCO_2SFC(-1)	0.041692	0.015744	2.648132	0.0201
LogCO_2SFC(-2)	-0.051650	0.019057	-2.710254	0.0178
LogCO_2SFC(-3)	0.071373	0.016589	4.302334	0.0009
LogCO_2SFC(-4)	-0.043148	0.018511	-2.330984	0.0365

C	0.044050	0.175301	0.251284	0.8055
R-squared	0.997372		**Adjusted R-squared**	0.993531
F-statistic	259.6830		**Durbin-Watson stat**	1.993825
SSR	0.002469		**F-statistic Prob.**	0.000000*

Note:*Prob. is significant at 5 percent.*

Source: Author's compilation via EViews9

The ARDL short-run result shows that if carbon dioxide (CO_2) emissions from fossil fuel is increased by one percent, then food supply will be increased by 0.7 percent in the short-run. Its corresponding probability value is not significant at 5 percent level of significance. Also, if carbon dioxide (CO_2) emissions from liquid fuel consumption is increased by one percent, food consumption increased by 20.1 percent while its corresponding probability value is significant at 5 percent level of significance in short-run. Consequently, if carbon dioxide (CO_2) emissions from solid fuel consumption is increased by one percent, then food supply will be increased by 2.1 percent, and its corresponding probability is not significant at 5 percent level of significant in the short-run.

The ARDL model is then estimated below:

$$\begin{aligned}\mathrm{LogFS}_t = {} & \varphi_1\mathrm{LogFS}_{t-1} + \varphi_2\mathrm{LogFS}_{t-2} + \varphi_3\mathrm{LogFS}_{t-3} + \varphi_4\mathrm{LogFS}_{t-4} + \beta_{11}\mathrm{COFF}_t + \beta_{12}\mathrm{COFF}_{t-1} \\ & + \beta_{13}\mathrm{COFF}_{t-2} + \beta_{14}\mathrm{COFF}_{t-3} + \beta_{15}\mathrm{COFF}_{t-4} + \beta_{21}\mathrm{LogLFC}_t + \beta_{22}\mathrm{LogLFC}_{t-1} \\ & + \beta_{23}\mathrm{LogLFC}_{t-2} + \beta_{24}\mathrm{LogLFC}_{t-3} + \beta_{25}\mathrm{LogLFC}_{t-4} + \beta_{31}\mathrm{LogSFC}_t \\ & + \beta_{32}\mathrm{LogSFC}_{t-1} + \beta_{33}\mathrm{LogSFC}_{t-2} + \beta_{34}\mathrm{LogSFC}_{t-3} + \beta_{35}\mathrm{LogSFC}_{t-4} + \varepsilon_t\end{aligned} \quad \text{…….. (5)}$$

$$\begin{aligned}\mathrm{LogFS}_t = {} & 0.718\mathrm{LogFS}_{t-1} + 0.661\mathrm{LogFS}_{t-2} - 0.544\mathrm{LogFS}_{t-3} + 0.203\mathrm{LogFS}_{t-4} + 0.007\mathrm{COFF}_t \\ & + 0.0003\mathrm{COFF}_{t-1} - 0.022\mathrm{COFF}_{t-2} + 0.040\mathrm{COFF}_{t-3} - 0.014\mathrm{COFF}_{t-4} \\ & + 0.201\mathrm{LogLFC}_t - 0.247\mathrm{LogLFC}_{t-1} + 0.157\mathrm{LogLFC}_{t-2} - 0.107\mathrm{LogLFC}_{t-3} \\ & - 0.051\mathrm{LogLFC}_{t-4} + 0.021\mathrm{LogSFC}_t + 0.041\mathrm{LogSFC}_{t-1} - 0.051\mathrm{LogSFC}_{t-2} \\ & + 0.071\mathrm{LogSFC}_{t-3} - 0.0043\mathrm{LogSFC}_{t-4} + \varepsilon_t\end{aligned} \quad \text{…….. (6)}$$

Therefore, the Akaike Information Criteria of the top 20 ARDL models adopted for the study reveals that the best or appropriate model to be used for the study in Fig. I (see Appendix) is the 4, 3, 3, and 3 model which tends to be the lowest model on the graph.Hence, from the (4, 3, 3, 3) Akaike Information Criteria above, it can be expressed below as:

$$\begin{aligned}\mathrm{LogFS}_t = {} & \varphi_1\mathrm{LogFS}_{t-1} + \varphi_2\mathrm{LogFS}_{t-2} + \varphi_3\mathrm{LogFS}_{t-3} + \varphi_4\mathrm{LogFS}_{t-4} + \beta_{14}\mathrm{COFF}_{t-3} \\ & + \beta_{24}\mathrm{LogLFC}_{t-3} + \beta_{34}\mathrm{LogSFC}_{t-3} + \varepsilon_t\end{aligned} \quad \text{…….. (7)}$$

$$\begin{aligned}\mathrm{LogFS}_t = {} & 0.718\mathrm{LogFS}_{t-1} + 0.661\mathrm{LogFS}_{t-2} - 0.544\mathrm{LogFS}_{t-3} + 0.203\mathrm{LogFS}_{t-4} \\ & + 0.040\mathrm{COFF}_{t-3} - 0.107\mathrm{LogLFC}_{t-3} + 0.071\mathrm{LogSFC}_{t-3} + \varepsilon_t\end{aligned} \quad \text{…….. (8)}$$

From the best fit model of the (4, 3, 3, 3) ARDL model in equation (8), the result shows that if carbon dioxide (CO_2) emissions from fossil fuel is increased by one percent, then food supply will be increased by 4 percent. Its corresponding probability value (0.0019) is significant at 5 percent level of significance which shows that the null hypothesis for hypothesis one is rejected. Also, if carbon dioxide (CO_2) emissions from liquid fuel consumption is increased by

one percent, food supply will be decreased by 10.7 percent while its corresponding probability value is not significant at 5 percent level of significance in short-run. This shows that the null hypothesis for hypothesis two is rejected. Thus, if carbon dioxide (CO_2) emissions from solid fuel consumption is increased by one percent, then food supply will be increased by 7.13 percent, and its corresponding probability is significant at 5 percent level of significant in the short-run. This shows that the null hypothesis for hypothesis three is accepted.

Furthermore, the result shows that the R-squared is 0.997372 (99.7 percent) which reports that the model is best fit for the study and that the R-squared percent explains the variability in the dependent variable; food supply. This shows that food supply has a relative high explanatory power in the model. The probability of the F-Statistic from the model reveals to be 0.000000 which indicates to be less than 5 percent level of significance. Hence, the study rejects the null hypotheses and accept the alternate hypotheses also concluding that the model is statistically significant. However, the probability of the ARDL model normality test reports to be greater than 0.05 significance level, which means that the data used in analyzing the ARDL model has a normal distribution as shown in Fig. II below (see Appendix).

4.2. Discussion of Findings

The study is aimed to examine the effect of climate change on food supply in Nigeria between 1980 to 2020. To achieve the foregoing, carbon dioxide (CO_2) emissions from fossil fuel does not have an effect on food supply in Nigeria which shows that the null hypothesis one is rejected having one percent increase yielding a four percent increase in food supply. This shows that the probability value for hypothesis one is rejected which yields to be significant. This result does not corroborate with the findings of Abraham (2012), and Tagwi (2022). Also, hypothesis two shows to be accepted which reveals that carbon dioxide (CO_2) emissions from liquid fuel consumption has an effect on food supply in Nigeria between the period of the study. As such, the result is in consistency with the findings of Abraham (2012), and Ogundipe (2020).

Conclusively, the study shows that carbon dioxide (CO_2) emissions from solid fuel consumption has effect on food supply in Nigeria having its corresponding probability to be significant which means that the null hypothesis for hypothesis three is accepted. The result shows to be stable with the finding of FAO (2017), and Tunde et al (2022).

5. Conclusion

Evaluation of the impacts of climate change is essential to developing adaptation and mitigation strategies. However, comprehension of the impact pathways is just as important for developing effective policy measures that will mitigate the effects of climate change. It's crucial to examine further data on the effects of climate change. Data on average mean temperature trends over time, as well as information on drought and flooding and how they affect food crops, are crucial for influencing policy, for example. Most Nigerian governments, according to Enete et al. (2011), already have institutions tasked with handling environmental issues, such as climate change, and they frequently disseminate information via radio and television shows. While up to 30 percent of individuals surveyed claimed to have heard about climate change on television or the radio, some respondents claimed they paid little attention to these media because doing some of the remedies suggested by the material would involve additional costs.

It is more difficult for farmers to adapt when there is a lack of reliable data and timely information. Based on the results, the study shows that the nation's food supply will experience fewer widespread failures if farmers are also given the knowledge and training they need to adapt to and mitigate the effects of climate change.

References

Abraham, T.W. (2012). Climate Change and Food Supply in Nigeria. *Nigerian Journal of Economic and Social Studies, 54*(2): 209-232.

Aliyu, A.A. and Amadu, L. (2017). Urbanization, cities, and health: The challenges to Nigeria: A review. *Ann Afr Med, 16*(4): 149-158.

Amoo, O.T., Ojugbele, H.O., Abayomi, A., Singh, P.K. and Nakin, M.D.V. (2022). Integrated Assessment Tools in Support of Futuristic Climate Change Towards Rice Production in Nigeria. In: Leal Filho, W., Djekic, I., Smetana, S., Kovaleva, M. *Handbook of Climate Change Across the Food Supply Chain. Climate Change Management (eds).* Springer, Cham. https://doi.org/10.1007/978-3-030-87934-1_5

Ani, K.J., Anyika, V.O. and Mutambara, E. (2022). The impact of climate change on food and human security in Nigeria. *International Journal of Climate Change Strategies and Management, 14*(2): 148-167.

Ayo, J.A., Omosebi, M.O. and Suleiman, A. (2014). Effect of climate change on food security in Nigeria. *Journal of Environmental Science, Computer Science and Engineering & Technology, 3*(4): 1763-1778.

Ejemejoyovwi, J., Obindah, G. and Doyah, T. (2018). Carbon Dioxide Emissions and Crop Production: Findings a Sustainable Balance. *International Journal of Energy Economics and Policy, 8*(4): 303-309.

Enete, A.A., Madu, I.I., Mojekwu, J.C., Onyekuru, A., Onwubuya, E.A. and Eze, F. (2011). Indigenous Agricultural Adaptation to Climate Change: Study of Southeast Nigeria. *Africa Technology Policy Studies Network, 6*: 11–17.

Food and Agriculture Organization of the United Nations. (2008). Climate Change and Food Security: A Framework Document. *Interdepartmental Working Group on Climate Change.* Retrieved from https://www.fao.org/3/k2595e/k2595e00.pdf accessed on 15-10-2022.

Food and Agriculture Organization of the United Nations. (2015). Climate change and food security: Risks and Responses. Technical report: 1-122. Retrieved from https://www.fao.org/3/i5188e/I5188E.pdf accessed on 14-10-2022.

Food and Agriculture Organization of the United Nations. (2017). Global database of GHG emissions related to feed crops: Methodology. Version 1. *Livestock Environmental Assessment and Performance Partnership*. FAO, Rome, Italy

Idumah, F.O., Mangodo, C., Ighodaro, U.B. and Owombo, P.T. (2016). Climate Change and Food Production in Nigeria: Implication for Food Security in Nigeria. *Journal of Agricultural Science, 8*(2): 74-83.

Ikpa, E., Sawa, B.A., and Ejeh, U.L. (2017). Evidence of Climate Change and Adaptation Strategies among Grain Farmers in Sokoto State, Nigeria. *IOSR Journal of Environmental Science, Toxicology and Food Technology, 11*(3): 1-7.

Intergovernmental Panel on Climate Change (IPCC). (2007). Intergovernmental panel on Climate Change.*Fourth Assessment Report, Climate Change*. Cambridge University Press.

Intergovernmental Panel on Climate Change (IPCC). (2014). Global climate change impacts in the United States.*Fifth assessment report of the United States Global Change Research programme*, Cambridge University Press.

Laurenceson, James, and Joseph C. H. Chai. 2003. *Financial Reform and Economic Development in China*. Cheltenham: Edward Elgar Publishing Ltd.

Nkoro, E. and Uko, A.K. (2016). Autoregressive Distributed Lag (ARDL) cointegration technique: Application and interpretation. *Journal of Statistical and Econometric Methods*, 5: 63–91.

Ogundipe, A.A., Okwara, C. and Ogundipe, O.M. (2020). CO2 Emissions and Environmental Implications in Nigeria. *International Journal of Energy Economics and Policy, 10*(3): 317-324.

Okoli, J.N. and Ifeakor, A.C. (2014). An Overview of Climate Change and Food Security: Adaptation Strategies and Mitigation Measures in Nigeria. *Journal of Education and Practice, 5*(32): 13-19.

Pesaran, H.M., Yongcheol, S. and Richard, S.J. (2001). Bounds testing approaches to the analysis of level relationships. *Journal of Applied Econometrics,* 16: 289–326

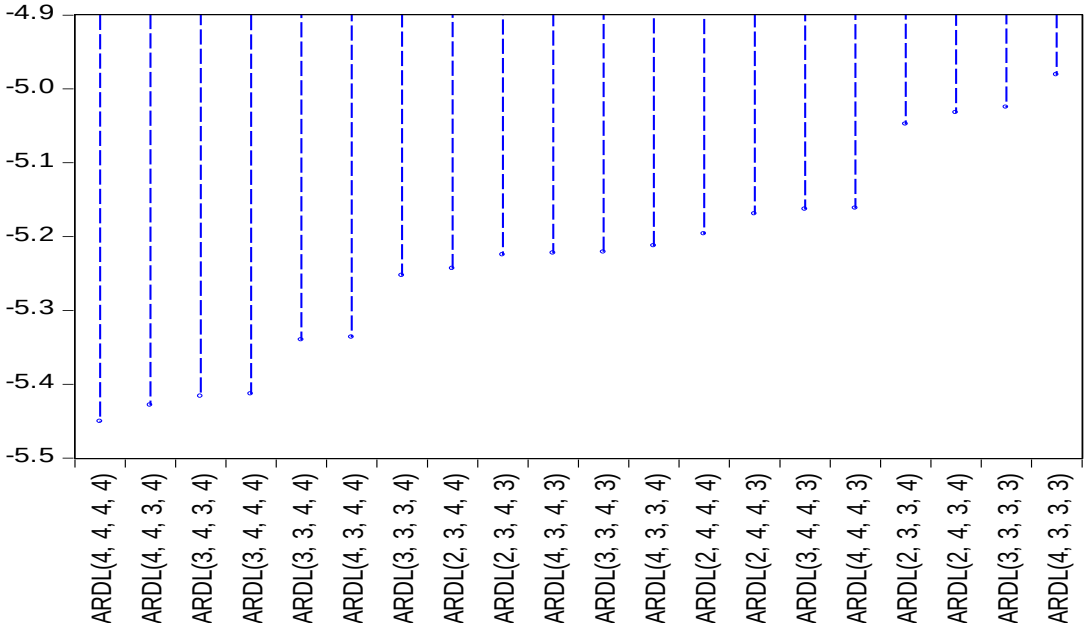
Pickson, R.B. and Boateng, E. (2022). Climate change: a friend or foe to food security in Africa?. *Environ Dev Sustain, 24*, 4387–4412.https://doi.org/10.1007/s10668-021-01621-8

Tagwi, A. (2022). The Impacts of Climate Change, Carbon Dioxide Emissions (CO2) and Renewable Energy Consumption on Agricultural Economic Growth in South Africa: ARDL Approach. *Sustainability*, *14*: 1-25. https://doi.org/10.3390/su142416468

Tunde, O.L., Adewole, O.O., Alobid, M., Szucs, I. and Kassouri, Y. (2022). Sources and Sectoral Trend Analysis of CO_2 Emissions Data in Nigeria Using a Modified Mann-Kendall and Change Point Detection Approaches. *Energies,* 15: 766. https://doi.org/10.3390/en15030766

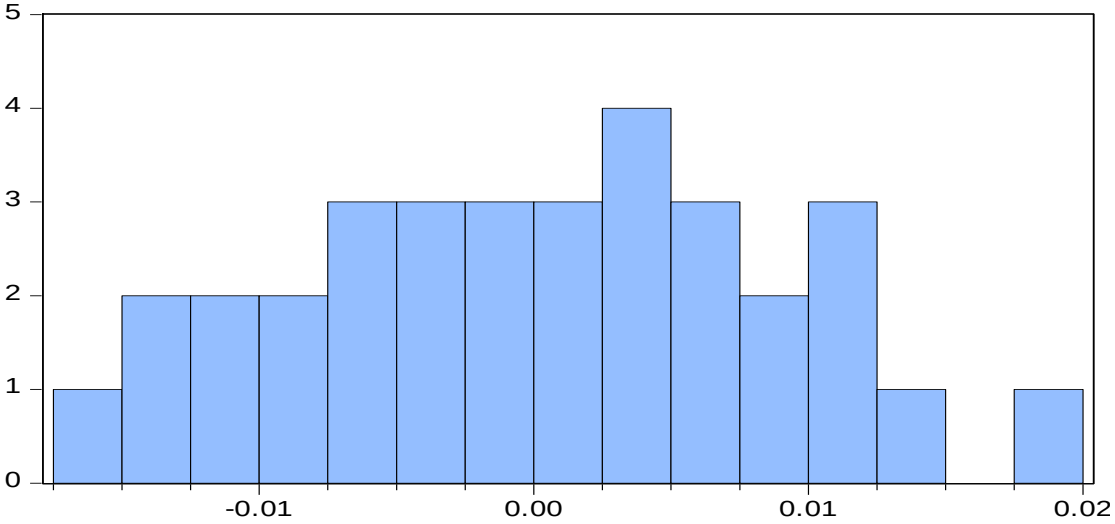
APPENDIX

Fig. I: Akaike Information Criteria (top 20 models)



Source: EViews9

Fig. II: Histogram-Normality Test



Source: EViews9