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The impact of population growth on food production in Nigeria: An empirical analysis

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Abstract

This study investigated the impact of population growth on food production in Nigeria. The study used secondary data spanning from 1980 to 2020 on food production, urban population, rural population, carbon dioxide emissions, government spending on agriculture, arable land, and agricultural. These data were analyzed using Autoregressive Distributed Lag (ARDL). The results revealed that urban population had a significant negative effect on food production in Nigeria for the period under study, among others. Based on the findings, it was recommended specifically that since population increases impacts negatively on food production, there is need to check population increases through measures like family planning, delayed marriages etc.

Keywords: food production; urban population; rural population; environmental quality; ARDL.

Introduction

Nigeria is the utmost populated nation in Africa and the 7th utmost populated country in the world. Nigeria is amongst the fastest growing population in the world with an average of 2.70% annual population growth rate. It might become the third most populous country after India and China with a population of around 400 million people by 2050 (UN, 2014). Its population growth (annual %) was reported at 2.543% in 2020, according to the World Bank collection of development indicators (2020). According to the Census Bureau of the United States, the population of Nigeria will surpass that of the United States in 2047, when the population of Nigeria will reach 379.25 million. The idea that a nation's population growth may have significant effects on individuals' access to food and other resources is not new and was indeed postulated by Malthus as far back as the 1800s. According to statistics from the UN Population Division (2010), by 2050, population growth will result in a doubling of the global demand for food. In sub-Saharan Africa, even if fertility rates were to decline from their current levels, the population of the region is projected to double, with attendant implications for food security. According to the Food and Agricultural Organization (FAO) (2021), the world food demand is expected to grow by 60 percent by 2050. There is therefore the tendency for the earth's population to outgrow the capacity to feed it. This idea was first expressed by Malthus (1798), in his principles of population growth. Malthus

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observed that the population was increasing at a geometrical rate while resources grew at an arithmetic rate. He, therefore, posited that unless checked by a reduction in population growth or some voluntary moral restraints in terms of birth control, there are tendencies that the population will outstrip the food supply; a phenomenon which was later termed by modern Economists as 'Malthusian population trap' (Todaro & Smith, 2012). This rapid population growth raises critical concerns about the nation's ability to sustainably provide sufficient food for its people.

To forestall this imminent Malthusian trap, the Federal Government of Nigeria through her Agricultural Transformation Agenda (ATA) instituted in 2011 appeared to be committed to increasing the availability of food in the Nation. This was also recently supported by international research bodies such as International Institute for Tropical Agriculture (IITA) as well as private agricultural service providers such as Syngentia who signed a 3-year partnership agreement with IITA to increase food output in the Country (IITA, 2014). While appraising the Agricultural Transformation Action Plan (as contained in the ATA), has announced an increase in the production of 5 key commodities: rice, cassava, sorghum, cocoa, and cotton production. Furthermore, two key objectives of the Nigerian national agricultural policy are to increase food production and attain food security (Akano, Oderinde, & Omotayo, 2023). Despite the robustness of this policy framework, population growth can be a major threat to the achievement of the objectives if not properly checked. In fact, on average, Nigeria is yet to achieve self-sufficiency in aggregate food production; a phenomenon which some Neo-Malthusian researchers have attributed to the increasing population figures.

The demand for food will increase as the population grows and put more pressure on natural resources and food production (Owoo, 2021). Thus, advancement headed for food production and nourishment goals necessitates that food is accessible, available, and adequate amount and excellence to safeguard decent nutritious products. An appropriate diet contributes to human growth; it supports individuals to comprehend their full potential and income improvement (FOA, 2010, 2012, and 2014). The quality and quantity of food that a human population can obtain from its resources will be determined by the internal food prices mechanism, which is mostly determined by food accessibility and availability as well the aggregate nourishment demand (Atkin, 2013).Hunger reduction requires an integrated approach which includes public and private investments to raise agricultural productivity (FAO, 2014; Ogunniyi et al., 2017; Ogunniyi et al., 2018).The consequence of hunger and malnutrition are perceived to be a major threat to social peace in Africa (Ogunniyi et al., 2016). These challenges underscore the importance of examining how rapid population growth affects food availability and broader socio-economic development.

This study is apt because rapid population growth especially in countries with poorly developed agricultural sectors results in food shortages, and food price inflation, and causes income strain by increasing government recurrent and social expenditure as substantial resources have to be devoted to providing basic food and other needs for the populace with little or nothing earmarked for capital development. It puts pressure on existing infrastructure such as schools, hospitals, roads, etc., migration surfaces, urbanization blossoms, environmental degradation worsens, and overall economic growth is retarded. The implications of this population explosion are grave. Outside the social problem that comes with it, there is the likelihood that the country may not be able to produce enough food to feed all its inhabitants. Meanwhile, the international community through the Sustainable Development Goals (SDGs) commits to ending poverty and achieving zero hunger by 2030. However, the extent to which that is achievable in Nigeria judging by the fact that this is just twelve years away is a matter for further research. This is obvious because of the rapid growth in population, subsistence farming, rudimentary technologies in agriculture and production, and massive urbanization putting intense pressure on food production.

Apart from the population growth rate and other macroeconomic variables, international tensions and concerns recently are intensifying over what impact the climate condition will have on the environment and agricultural produce. The changing environmental problems have sharpened our awareness of the danger posed to the food and agricultural sector of Nigeria. These problems include soil erosion, tropical deforestation, and desertification. The Nigerian government has been investing in conservation measures such as watershed projects, reforestation schemes, building amelioration components into projects, strengthening environmental institutions and finally introducing appropriate regulatory measures. In the absence of rational and conscious sustainable exploitation of the physical and natural resources, irreplaceable and probably irreversible damage will inevitably result. This will be catastrophic for food production and rural development. Food production is reduced due to the loss of fertile lands and gully erosion, and marine resources, a source of income for some people, are depleted. This further aggravates the poverty level and has impacts on humans, wildlife, animals, plants, and micro-organisms. This also causes some illnesses and untimely deaths associated with it. Hence, attention should be drawn to the consequences of population growth on food production thereby necessitating this research.

Many previous empirical studies, such as those by Osu (2017), Oguntegbe et al. (2018), Gambo and Idris (2018), Akano, Oderinde, and Omotayo (2023), and Onime (2019), have primarily utilized total population growth alongside macroeconomic variables to assess the impact of population growth on food production. However, this study takes a more nuanced approach by examining the effects of disaggregated population growth, specifically, the growth rates of urban and rural populations, on food production in Nigeria. Furthermore, earlier studies have largely overlooked the role of environmental factors in influencing food production. To address this gap, the present research incorporates environmental quality indicators as additional determinants. In line with this, the study aims to: (1) investigate the impact of urban population growth on food production in Nigeria, (2) analyze the influence of rural population growth, and (3) evaluate the effect of environmental quality on food production.

This study is structured into five sections. As section one has already been explored, sections two and three will deal with literature review and research methodology respectively; while sections four and five will take care of data analysis, discussion of findings, and policy recommendations in that order. The findings of this study will contribute knowledge to the general public, academia, and economic planners on the impact and challenges of the rapid population on food production in Nigeria. Also, contribute to the available literature on the current situation of the rapid population growth in food production in Nigeria. The study will also benefit the researchers who will use them for further studies.

Malthusian Theory of Population

The Malthusian Theory of Population is a theory of exponential population growth and arithmetic food supply growth postulated in 1798. His objection was that the pressure of increasing population on the food supply would destroy perfection and there would be misery in the world. The theory explains the relationship between the growth in food supply and in population. It stated that the population increases faster than food supply and if unchecked it lead to vice or misery.

To control over-population resulting from the imbalance between population and food supply, Malthus suggested preventive checks and positive checks. The preventive checks are applied by a man to control the birth rate and if people fail to check growth of population by the adoption of preventive checks, positive checks operate in the form of vice, misery, famine, war, disease, pestilence, floods and other natural calamities which tend to reduce population and thereby bring a balance with food supply.

Neo-Malthusian Theory

Neo-Malthusian theory argued that Malthusian and the Solow growth model ignores natural capital, pollution, and other environmental issues in their productivity postulation. However, several academics have believed that these environmental problems are vital to the prospects for long-term economic growth after Malthus (1798) made his classic statement. The amount of oil and other natural resources on the planet, for example, is fixed. This could imply that any effort to continue a path of ever-increasing production would inevitably exhaust those resources and thus fail. According to the limit theory, environmental thresholds may be crossed before the economy reaches the EKC turning point. The likelihood of small changes causing catastrophic damage, according to critics such as Arrow et al. (1996), indicates that focusing solely on economic growth to achieve environmental goals may be counterproductive. In the context of biodiversity, increased spending on preserving species variety, for example, will not be able to resuscitate extinct species. The limits hypothesis explains the economic-environment link as environmental deterioration reaches a point beyond which output suffers severe consequences and the economy declines.

Empirical Literature

Research carried out by Akano, Oderinde, and Omotayo (2023) examined the effect of population growth on food production in Nigeria using secondary data on the food production index and population growth rate obtained from 1980 to 2011. Ordinary Least Square regression and instrumental variable techniques were both employed in estimating the model. Empirical findings from the OLS indicate that population growth is positively related to food production. However, the Instrumental Variable Approach produced a more interesting result; an increase in population growth rate significantly reduces food output. The study recommended that it is pertinent for Nigeria to check her population growth rate to avoid population explosion and its attendant consequence. Suggested population control measures include legislation against polygamy as well as placing a ceiling on the number of births allowable per family. Primary education should also be promoted by the Government just as better healthcare facilities should be put in place to increase longevity.

Gambo and Idris (2018) examined the effects of population growth on food production using time series data from 1970 to 2014 using Autoregressive Distributed Lag (ARDL) bounds testing approach to co-integration. The results confirmed the existence of co-integration among the variables in long-run paths. However, the effects of population growth on food production both in the long run and short run confirm the manifestation of the Malthusian theory that a rising population employs heaviness on agricultural land in Nigeria. Also, food production and land for agriculture activities increase cereal production significantly in Nigeria, while GDP per capita does not have a significant impact. The study recommended that the system of agricultural production should be improved upon by way of emphasizing improved varieties/seeds as well as the adoption of new methods of cultivation and irrigation through the exploitation of virgin lands and groundwater exploration.

In Nigeria, Oguntegbe et al. (2018) scrutinized the relationship between the index of food production and the growth rate of the population for a data period of 1980–2011. The Granger causality approach, OLS, and two-stage least square (2SLS) methodologies were employed for the analysis. Accordingly, findings indicated that the population growth rate had a significant positive impact on the index of food production, contrary to a negative relationship from the 2SLS model. Therefore, the study suggested against further increase in the country's population.

Osu (2017) examined how population growth affected Nigeria's food security. The study disaggregated food production into crop, fishery, and livestock productions. Using correlation and Granger causality techniques, the study found that a significant proportion of the population accounted for the presence of the food crisis in Nigeria.

Method

Theoretical Framework

The study adopts the Malthusian theory of population which reveals the relationship between population growth and food production. In his essay on the principle of population growth, expounded that man would always be faced with the basic problem that a rapid increase in population creates for food production. In line with the fundamental work of Malthus, the mathematical representation of the model is specified thus.

$$FPROD\ F\ (POP) \quad (1)$$

Where:
FPROD = Food production

The mathematical relationship of Equation 1 is the traditional Malthusian theory of population. The Malthusian theory captures the relationship between population growth rate and food production but did pay little or no attention to the impact of environmental quality on the relationship between population and food production. To consider the environment as an influencing factor in achieving a high level of productivity and sustainable development, this study includes additional variables such as carbon emissions, agriculture labour force, government agricultural expenditure, and arable land as an extension of Malthusian theory.

The mathematical relationship of the models is thematically specified thus.

FPROD = *f*(UPOP, RPOP, CO_2, AEXP, ALAND, ALF) (2)

Where:

FPROD = Food production measured as the naira value of the aggregation of all agricultural produce per annum in 2010 constant prices.

UPOP = Urban population growth

RPOP = Rural population growth

CO_2 = Carbon dioxide emissions, metric tons per individual

AEXP = Government expenditure on agriculture measured as government recurrent expenditure on agriculture in naira billions.

ALAND = Arable land per individual measured in hectares per man.

ALF = Agricultural labour is captured as labour force participation rate as a percentage of the total population ages 15 and above (ILO estimate)

Estimation Technique

To capture objectives one to three, this study will employ the autoregressive distributed lag (ARDL) bounds testing approach with a dynamic error correction model (ECM) where we apply the unrestricted ECM when no-cointegration is detected otherwise the restricted ECM becomes most applicable. The adoption of the ARDL methodological approach cannot be unconnected with the statistical properties of our variables for this study where the unit root tests result conducted show that they are integrated of order zero [$I(0)$] and one [$I(1)$].

Given this, the generalized form of the ARDL (p, q) model is specified thus using Equation 3.

$$\Delta lnFPROD_t = \alpha_0 + \beta_1 FPROD_{t-1} + \beta_2 UPOP_{t-1} + \beta_3 RPOP_{t-1} + \beta_4 CO2_{t-1} + \beta_6 AEXP_{t-1} + \beta_7 ALAND_{t-1} + \beta_8 ALF_{t-1} + \sum_{t=1}^{p} \alpha_1 \Delta lnFPROD_{t-1} + \sum_{t=0}^{q2} \alpha_3 \Delta lnUPOP_{t-1} + \sum_{t=0}^{q3} \alpha_4 \Delta lnRPOP_{t-1} + \sum_{t=0}^{q4} \alpha_5 \Delta lnCO2_{t-1} + \sum_{t=0}^{q5} \alpha_6 \Delta lnAEXP_{t-1} + \sum_{t=0}^{q6} \alpha_7 \Delta lnALAND_{t-1} + \sum_{t=0}^{q7} \alpha_8 \Delta lnALF_{t-1} + \mu_t \quad (3)$$

Where:

α_0 = constant term

β = coefficients/parameters of the explanatory variables

μ_t = error term, assumed to be white noise

p = maximum lag order of the dependent variable

q = maximum lag order of the explanatory variables, selected based on the Akaike Information Criterion (AIC)

The autoregressive distributed lag (ARDL) model is employed in this study to estimate both short-run and long-run dynamics of the variables. If the null hypothesis of no cointegration is not rejected, then only the short-run model, ARDL (p, q), is estimated. However, if there is strong evidence against the null hypothesis, suggesting the presence of cointegration, both short-run and long-run relationships can be estimated using the Error Correction Model (ECM). This modeling approach aligns with standard econometric procedures, beginning with a general specification and narrowing down to a more specific model based on theoretical and empirical considerations. The selection of variables for the model was guided by their theoretical significance to food production and the accessibility of reliable time series data, as detailed in Table 1.

Table 1. Data Sources and Measurements

Variable	Description & Measurement	Source
FPROD	This is the cumulative sum of agricultural production (livestock, crop, and fishery) in Nigeria measured in 2010 Constant prices in N' Billions	CBN Statistical Bulletin, 2020
ALAND	Arable land per capita is measured in hectares per individual	World Bank's WDI, 2021
ALF	Total labour force participation rate as a percentage of the total population ages 15 and above (ILO estimate)	World Bank's WDI, 2021
CO2	Carbon dioxide emissions measured as metric tons per person	World Bank's WDI, 2020
AEXP	This is expenditure measured as the federal government of Nigeria's recurrent expenditure on agriculture in Billions of Naira	CBN Statistical Bulletin, 2020

Note: All the variables were extrapolated to update the timeframe to 2020 except for the climate variable. AGGDP, OGHG, EXP, CROPP, and Livestock were all logged before estimation.

Results and Discussion

Result of Stationarity (Unit Root) Test

A stationarity test was conducted in order to avoid running a spurious regression. The method used was the Augmented Dickey-Fuller (ADF) test. Stationarity test seeks to ensure that time series for each variable has a constant mean, variance, and co-variance across time. Table 2 is a summary of the Augmented Dickey-Fuller test carried out on each variable.

Table 2. Summary of Unit Root Test

	Level		1st Difference		
Variable	Critical Value @ 5%	ADF Statistic (Probability)	Critical Value @ 5%	ADF Statistic (Probability)	Order of Integration
FPROD	-3.526609	-3.096506 (0.1210)	-3.526609	-3.096506 (0.0000)	I(1)
UPOP	-3.557759	-6.626435 (0.0000)	-3.562882	-3.888144 (0.0248)	I(0)
RPOP	-3.523623	-3.166057 (0.1054)	-3.562882	-4.388334 (0.0078)	I(1)
CO2	-3.526609	-2.605079 (0.2803)	-3.526609	-1.926617 (0.0000)	I(1)
AEXP	-3.523623	-4.609836 (0.0034)	-3.529758	-7.250245 (0.0000)	I(0)
ALAND	-3.523623	-1.423283 (0.8390)	-3.529758	-3.874443 (0.0228)	I(1)
ALF	-3.526609	-2.586863 (0.2880)	-3.529758	-4.284238 (0.0083)	I(1)

Table 2 shows that in first difference, the Augmented Dickey-Fuller test's null hypothesis that the variables have a unit root is rejected at 5% level of significance for all variables in the model excluding UPOP and AEXP given that each variable's ADF test statistic (in absolute terms) is greater than the critical value of the ADF test (in absolute terms) at 5% level of significance. The variables, UPOP and AEXP are stationary at level given that, at level, UPOP and AEXP's ADF test statistic (in absolute terms) is greater than the absolute value of critical value of the ADF test at 5% level of significance.

Table 3 shows descriptive statistics of the variables. There is one dependent variable in the model used for the study and six independent variables. All these variables have different values for mean, sum of variable, minimum, maximum, median and standard deviation which were shown above.

Table 3. Descriptive Statistics of Variables

	FPROD	UPOP	RPOP	CO2	AEXP	ALAND	ALF
Mean	3.196491	4.763371	1.420680	304.9036	21.92219	0.248862	28.47901
Median	3.466455	4.799265	1.407399	238.1550	8.765454	0.257214	30.11800
Maximum	4.614117	6.143857	2.486120	536.2000	76.60099	0.324693	32.11300
Minimum	1.231780	3.911588	0.752531	126.2000	0.012770	0.147670	23.53900
Std. Dev.	1.100610	0.623300	0.396285	131.7016	25.36142	0.049102	2.943508
Skewness	-0.442166	0.474208	0.242432	0.472273	0.85442	0.304771	0.549664
Kurtosis	1.758225	2.089567	2.741916	1.664862	2.346342	1.832875	1.644852
Sum	134.2526	200.0616	59.66857	12805.95	920.7320	10.45221	1196.119

Estimation of Regression Model

Result of the Co-integration Test

The results of the unit root test showed a combination of I(0) and I(1) variable, thus the ARDL bounds test for co-integration was used to examine if the variables have a long run relationship. The results of the ARDL bounds test for co-integration are shown in Table 4.

Table 4. Summary of the Ardl Bounds Test

K	6	
F-statistic	5.906323	
	Critical Value Bounds	
Significance Level	I(0)	I(1)
10%	1.99	2.94
5%	2.27	3.28
2.5%	2.55	3.61
1%	2.88	3.99

If the F-statistics are greater than the upper bound (I(1)) critical value , the ARDL bounds test's null hypothesis of no co-integration is rejected. As shown in Table 4, the F-statistic of 5.906323 is greater than the 5% significance level's upper bound critical value of 3.28. This result shows there is a long run relationship between the dependent variable and the independent variables. Therefore, only a short run error correction model can be estimated.

Short Run Estimates (Error Correction Model)

Error correction modeling reconciles the long-run behavior of cointegrated variables with their short-run responses. In error correction model, we specify and estimate the differenced variables alongside one-period lag of the residuals from the cointegrating equation. The aim of this is to determine if a short-run disequilibrium can be corrected in the long-run. Therefore, the error correction term which shows the speed of adjustment from one period to another is expected to have a negative sign, assume values between 0 and 1. It should also be significant at the 5% to show a strong convergence process to the long-run equilibrium.

Empirical Results of the Error Correction Model (ECM)

The error correction model (ECM) was estimated to assess the short- and long-run relationships between the explanatory variables and food production. In this model, the independent variables, urban population growth (UPOP), rural population growth (RPOP), carbon dioxide emissions per capita (CO_2), government expenditure on agriculture (AEXP), arable land per capita (ALAND), and agricultural labor force participation (ALF), were regressed against the dependent variable, food production (FPROD).

The empirical results, as shown in Table 5, indicate that the coefficient of urban population growth (UPOP) is negatively related to food production and statistically significant, as the absolute t-statistic (-2.2025) exceeds the critical value (2.042). Conversely, rural population growth (RPOP) also shows a negative relationship with food production but is statistically insignificant (t = -0.7622). Carbon dioxide emissions (CO_2) exhibit a significant positive effect on food production (t = 6.4316 > 2.042). Government expenditure on agriculture (AEXP) has a negative but statistically insignificant effect (t = -1.0092 < 2.042). Arable land per capita (ALAND) positively and significantly affects food production (t = 2.5642 > 2.042), while agricultural labor force participation (ALF) has a negative and insignificant impact (t = -0.2557 < 2.042).

Table 5. ECM Regression Case 2: Restricted Constant and No Tren

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(UPOP)	-0.106679	0.048435	-2.202503	0.0364
D(RPOP)	-0.084120	0.110365	-0.762198	0.4525
D(CO_2)	0.007101	0.001104	6.431553	0.0000
D(AEXP)	-0.000763	0.000756	-1.009244	0.3218
D(ALAND)	2.290199	0.893143	2.564203	0.0162
D(ALF)	-0.003291	0.012871	-0.255715	0.8001
CointEq(-1)*	-0.740580	0.010261	-7.268596	0.0000
R-squared	0.780753	Mean dependent var	0.073895	
Adjusted R-squared	0.689122	S.D. dependent var	0.094950	
S.E. of regression	0.074212	Akaike info criterion	-2.209540	
Sum squared resid	0.187250	Schwarz criterion	-1.916979	
Log likelihood	52.29558	Hannan-Quinn criter.	-2.103006	
Durbin-Watson stat	1.456213			

The overall significance of the model is supported by the F-statistic value of 5.2444, which exceeds the critical value, confirming that the model is statistically robust. The coefficient of determination

(R^2) is 0.78, indicating that 78% of the variation in food production is explained by the model during the 1980–2021 period, reflecting a strong goodness of fit. Furthermore, the error correction term (ECMt-1) is -0.74, suggesting that 74% of the disequilibrium from the previous period is corrected in the current period, thereby confirming the model's convergence toward long-run equilibrium.

Evaluation of Research Hypothesis

Hypothesis One

To evaluate the first hypothesis, the following statements were tested: the null hypothesis (H_0) assumes no significant relationship between urban population growth and food production in Nigeria, while the alternative hypothesis (H_1) suggests a significant relationship exists. The decision rule is to reject H_0 if the absolute value of the calculated t-statistic exceeds the critical t-value, which is defined by the following formula:

$$t_{\frac{\alpha}{2}}, (n\text{-}k) \tag{4}$$

where:

$\alpha = 0.05$

$n = 41$

$k = 6$

As shown in Table 6, the test result leads to the rejection of the null hypothesis, thereby indicating a statistically significant relationship between urban population growth and food production in Nigeria.

Table 6. Summary of the Evaluation of Hypothesis One

Variable	t-calculated	t-critical	Remark
Urban Population (UPOP)			
Short Run Error Correction Model	-2.202503	2.042	Reject H0

Given that the t-calculated for urban population is greater than the t-critical, we therefore reject H_0 and accept H_1 and conclude that in the short run, urban population significantly affect food production in Nigeria.

Hypothesis Two

To assess the second hypothesis, the study tested whether rural population growth has a statistically significant effect on food production in Nigeria. The null hypothesis (H_0) states that there is no significant relationship between rural population growth and food production, while the alternative hypothesis (H_1) posits that such a relationship does exist. The decision rule is to reject H_0 if the absolute value of the calculated t-statistic is greater than the critical t-value, which is determined using Formula (4).

As presented in Table 7, the test result does not provide sufficient evidence to reject the null hypothesis. Therefore, it is concluded that rural population growth does not have a statistically significant relationship with food production in Nigeria within the scope of this study.

Table 7. Summary of the Evaluation of Hypothesis Two

Variable	t-calculated	t-critical	Remark
Rural population Short Run Error Correction Model	-0.762198	2.042	Do not reject H0

Given that the t-calculated for rural population is less than the t-critical, we therefore accept H_0 and reject H_1 and conclude that in the short run, urban population does not significantly affect food production in Nigeria.

Hypothesis Three

The third hypothesis examines whether environmental quality has a significant impact on food production in Nigeria. The null hypothesis (H_0) states that there is no significant relationship between environmental quality and food production, whereas the alternative hypothesis (H_1) proposes that such a relationship does exist. The decision rule is to reject H_0 if the absolute value of the calculated t-statistic exceeds the critical t-value, as defined in Formula (4). Based on the result presented in Table 8, the null hypothesis is rejected, indicating that environmental quality has a statistically significant relationship with food production in Nigeria.

Table 8. Summary of the Evaluation of Hypothesis Three

Variable	t-calculated	t-critical	Remark
Environmental Quality Short Run Error Correction Model	6.431553	2.042	Reject H0

In this study, environmental quality was proxied by Carbon dioxide emissions. Given that the t-calculated for environmental quality is greater than the t-critical, we therefore accept H1 and reject Ho and conclude that in the short run, environmental quality significantly affect food production in Nigeria.

Conclusions

This study evaluated the effects of population growth on food production in Nigeria 1980 to 2020. It evaluated the effects of urban population, rural population and environmental quality on food production in Nigeria. From the findings of the study, it can be concluded that urban population had a significant negative relationship with food production while rural population had an insignificant negative relationship with food production in Nigeria. Also, the study reasonably concluded that carbon dioxide emission which was a proxy for environmental quality had a positive and significant relationship with food production in Nigeria.

Based on the findings, several recommendations are proposed. Given the negative impact of population growth on food production, it is essential to implement population control measures such as family planning, delayed marriages, and public awareness programs. These efforts can help balance urban and rural population growth with the available food supply. In addition, relevant stakeholders should adopt strategies to enhance food production, including the use of modern agricultural technologies rather than relying solely on traditional farming methods. Furthermore, promoting sustainable agricultural practices is crucial to minimizing the adverse environmental effects of food production. Sustainable farming systems not only improve productivity but also contribute to long-term environmental conservation and resource management.

Data Availability

The datasets generated during and/or analysed during the current study are available from the corresponding author on reasonable request.

Conflicts of Interest

All authors in this publication declare no conflict of interest regarding the title, data, location, and results of the research.

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Supplementary Materials

This study does not include any supplementary materials

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