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Declining Rural Population in Nigeria: Implication for Food Security

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Abstract

This study is geared towards investigating the influence of rural population growth on food production in Nigeria from 1961 to 2018. The data was analyzed using the Johhansen cointegration test, ordinary least squares (OLS), dynamic (OLS), and fully modified OLS. The findings portrayed that a long-term link exists between food production and rural population growth in Nigeria. From the dynamic OLS, which is the lead model, it was observed that the influence of rural populations on food production has been negative and significant. This negative effect is linked to the continuous rural-urban migration that has left agriculture in the hands of the elderly. To curb this, the paper suggested that by making agriculture attractive through aggressive mechanization and the provision of inputs, the rural population will be able to accelerate food production and ensure food sufficiency in the country.

Keywords: *Agriculture, Arable Land, Food Security, Crops, Livestock, Rural-Urban Migration*

1. Introduction

Accelerating food production and ensuring food sufficiency have been the major roles of agriculture (Otsuka, 2013; Wegren and Elvestad, 2018; Okijie and Effiong, 2021). The role has also been extended to capture the fact that agriculture is fundamental to economic growth, as it accounted for 4% of global gross domestic product (GDP), while contributions in some least developing countries exceeded 25% of GDP in 2018 (World Bank, 2022). Growth driven by agriculture, poverty reduction, and food security are at risk, varying from manifold blows—from COVID-19-associated disturbances to extreme weather, pests, and conflicts (World Bank, 2022), plus rural-urban migration—that are impacting food systems, bringing about an upsurge in food prices and mounting hunger (World Bank, 2022). Our core concern is the risk caused by rural-urban migration, resulting in rural population attenuation, on food production in Nigeria.

Nigeria, with 70.8 million hectares of agricultural land area, is characterized by prominent crops like yam, maize, millet, guinea corn, beans, cassava, and rice (Food and Agricultural Organization (FAO), 2022). By output, the quantity of rice production in Nigeria escalated by 8.11% from 3.7 million metric tons as of 2017 to 4.0 million metric tons in 2018. Nigeria's annual rice consumption is put at

6.7 million metric tons, implying that domestic production as of 2018 only accounted for 59.70% of the total consumption (FAO, 2022). The domestic deficit of 2.7 million metric tons is thus either imported or covered via smuggling. The government of Nigeria has hitherto banned the importation of rice into the country as a policy measure to boost domestic production. For cassava, Nigeria was ranked the world's highest producer, as it produced 59 million tons as of 2017, making it 20% of the world's total production (International Institute of Tropical Agriculture, 2017; FAO, 2022). For livestock production, it has been stated that the aspect has been less exploited in the northern part of Nigeria due to ecological factors. As of 2017, a total of 76 million goats, 43.4 million sheep, and 18.4 million cattle were reared in Nigeria (FAO, 2022), while 180 million poultry birds were recorded (Federal Ministry of Agriculture and Rural Development (FMARD), 2017).

In line with the FMARD, Nigeria faces diverse problems when it comes to unlocking her agricultural potential, and such include policy framework, political commitment, agricultural technology, and infrastructure deficits (FMARD, 2016). In addressing these challenges, the document made reference to the three pillars of promotion of agricultural investment, financing agricultural development programs, and research for agricultural innovation and productivity as the core ways in which the Federal Government can promote agriculture. In this light, the 2016–2020 policy thrust was centered on four key areas: food security, import substitution, job creation, and economic diversification (FMARD, 2016).

With policies being put in place to stimulate agricultural production, it is still worthy to note that agricultural activities are more concentrated in rural communities. This implies that, apart from firm capital input, labor is also very crucial in agricultural development. With a rural population of 99,033,580 recorded in 2020 as opposed to 38,862,452 as of 1961, it can be said that the rural population has grown significantly within the era. This cannot actually be true when comparing the proportion of the rural population to the total population over time. Our argument can be validated given the trend observed in Figure 1.

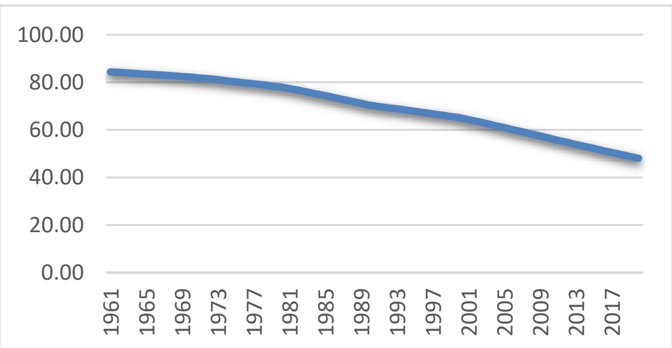

Figure 1: Trend in rural population (% of total population)

Consistent with Figure 1, the proportion of the rural population to the total population has been declining momentously. In 1961, the proportion of the rural population was 84.37% of the total population, and this revealed a substantial rural concentration of the population. With incessant rural-urban drift, the population of the rural communities kept declining, reaching 78.03% and 65.16% in 1980 and 2000, respectively, before plummeting further to 56.52% in 2010 and 49.66% in 2020, which is less than half of the total population.

Likewise, the growth in rural population has been showing some form of peaks and floors over the epochs, with the 1970s recording a peak in rural population growth. Figure 2 unveils this trend.

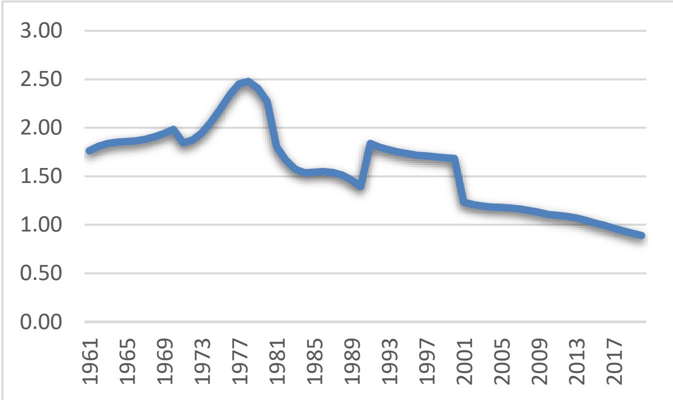

Figure 2: Trend in rural population growth in Nigeria (annual %)

With the rural population growing steadily in the 1960s and reaching a climax of 2.48% in 1978, a tremendous decline was recorded thereafter, with the growth rate waning to 1.39% in 1990 before a leap to 1.84% was recorded in 1991. Subsequent years were marked by a massive decline in rural population, declining to 1.11% in 2010 and 0.94% in 2020.

Given this trend, our concern then stems from the labor-output relationship of the agricultural sector in facilitating food production. With the declining rural population, which could serve as a labor pool in rural areas for agricultural production, could it be that food production will be adversely affected? This paper thus gears towards ascertaining the influence of rural population decline on food production in Nigeria from 1961 to 2018. In particular, the study sought to: (i) investigate the influence of rural population growth on crop production in Nigeria; (ii) examine the weight of rural population on livestock production in Nigeria; and (iii) analyze the inspiration of rural population growth on food production in Nigeria.

2. Overview of Agricultural Programmes and Food Production

2.1. Nigeria's Agricultural Policies and Programmes

Diverse agricultural policies and programs have been put in place to promote agricultural infrastructure and boost agricultural production in Nigeria. These policies, as adumbrated in Kanu and Ukonze (2018) and cited in Effiong and Okijie (2022), are highlighted as follows:

a) Operation Feed the Nation (OFN)

b) National Accelerated Food Production Programme (NAFPP)

c) River-Basin Development Authority (RBDA)

d) Agricultural Development Programme (ADP)

e) The Green Revolution (GR)

f) Agricultural Credit Guarantee Scheme (ACGS)

g) Directorate for Food, Road and Rural Infrastructure (DFRRI)

h) National Agricultural Insurance Corporation (NAIC)

i) National Agricultural Land Development Authority (NALDA)

j) Agriculture Promotion Policy (APP)

In line with the Agricultural Transformation Agenda (ATA), six core components were identified, which include the Nigerian Incentive-based Risk-Sharing System for Agricultural Lending (NIRSAL); the Agricultural Extension Transformation Agenda (AETA); the Staple Crop Processing Zone (SCPZ); the Growth Enhancement Support Scheme (GESS); the Agricultural Marketing and Trade Development Corporations (AMTDCs); and Agricultural Commodity Value Chain Development (ACVCD). As of 2014, the Youth Employment in Agriculture Programme (YEAP) was launched by the federal government to address the issue of youth unemployment in the country (see Olomola and Nwafor, 2018).

Similar to the above include the establishment of the Nigeria Agricultural and Cooperative Bank and President Buhari's agricultural policy (explored by Meshach, 2018) to ban the importation of some food items and boost local food production. All these policies were geared towards the sustainable development of agriculture and ensuring food security in the country. But the extent to which they aid in the actualization of the said policy can be questioned based on the food crisis so experienced in the country as attributed to the recent upsurge in food prices in the country.

With food production growing by more than three times between 1960 and 2015, which was accompanied by productivity-augmenting 'Green Revolution' technologies and a substantial development in the use of land, water, and other natural resources for agricultural purposes, the world is still plagued with persistent hunger and widespread hunger and malnutrition, making the achievement of eradicating hunger by 2030 or even by 2050 seem unachievable (FAO, 2017).

2.2. Food Production in Nigeria

The food production in Nigeria can be looked at in terms of the inputs and the implied output. The inputs considered are the number of tractors, agricultural land, and labor. These inputs capture both capital and labor inputs, though some other inputs like improved seeds, fertilizers, and agrochemicals are also crucial. Table 1 unveils these inputs for selected periods.

Table 1: Agricultural Inputs

Year	Agricultural machinery, tractors	Agricultural land (% of land area)	Arable land (% of land area)	Rural Population (% of total Population)
1961	500	58.39	26.00	84.37
1965	1,000	64.86	32.47	83.45
1970	2,900	67.01	35.00	82.24
1975	5,650	60.55	28.55	80.22
1980	8,400	55.38	21.52	78.03
1985	11,150	60.31	25.25	74.37
1990	13,900	67.62	30.93	70.32
1995	16,650	71.77	36.12	67.80
2000	19,400	72.67	38.43	65.16
2005	23,000	73.56	39.53	60.93
2010	NA	74.46	36.23	56.52
2015	NA	75.36	37.33	52.16
2018	NA	75.90	37.33	49.66

Source: World Bank (2021)

Nigeria has been experiencing a momentous increase in the number of tractors, which are crucial for mechanization. The number of tractors in 1961 was 500, which doubled in 1965. This followed a more than doubled number from 1,000 in 1965 to 2,900 as of 1970. In the 1980s, the number of tractors hovered between 8,000 and 11,000, with a magnificent increase to 16,650 in 1995. This was accompanied by another increase to 23,000 in 2005, though recent data has not been made available.

agricultural land and arable land kept increasing over the years, pointing to the fact that a greater proportion of the arable land has been put under cultivation. The critical point to note is that arable land has not even reached 50% of the total land area, pointing to the low agricultural production in the country. The labor component comprising the rural population is characterized by a declining trend for the selected era. The proportion of the rural population to the total population declined from 84.37% in 1961 to 78.03% in 1980. Additionally, it plummets to 65.16% and 56.52% in 2000 and 2010, respectively, before reaching 49.66% in 2018. This declining trend portrays the disengagement of rural dwellers in agriculture, which has a dampening influence on food production in the country (see Ikelegbe and Edokpa, 2013).

With these inputs, the agricultural indices have shown a continuous increase right from the 1960s, from crop production index to livestock production index, and then to the aggregate food production index. Table 2 captures these dynamics in the diverse indices for selected periods.

Table 2: Agricultural Indices

Year	Crop production index (2014-2016 = 100)	Livestock production index (2014-2016 = 100)	Food production index (2014-2016 = 100)
1961	18.59	17.15	18.31
1965	22.17	18.51	21.62
1970	27.20	23.81	26.73
1975	23.34	27.93	23.67
1980	21.31	44.75	23.75
1985	25.04	57.86	28.47
1990	38.93	50.26	39.90
1995	54.16	61.82	54.85
2000	65.77	74.57	66.61
2005	81.54	87.17	82.05
2010	84.63	98.17	86.02
2015	98.50	101.78	98.85
2018	105.40	103.35	105.20
2019	106.94	103.37	106.58

Source: World Bank (2021)

The general observation from Table 2 is that all these indices has been on the rise, with crop production index surging from 18.59 in 1961 to 65.77 and 105.40 in 2000 and 2018 respectively. As of 2019, crop production index was recorded to be 106.64 (World Bank, 2021). Similar trend is being observed for livestock production which escalated from 17.15 in 1961 to 50.26 in 1990 before reaching 87.17 and 103.35 in 2005 and 2018 respectively, while food production also exhibited similar trend rising from 18.31 in 1961 to 54.85 and 105.20 in 1995 and 2018 respectively. These increase is reflected in the agricultural GDP over the years, which Table 3 clearly present from 1981 to 2020.

Though one can notice a rising trend in food production, having a clear view of whether there has been any improvement in the index will be to compare them with the base year. with the base year index selected to be 100 as 2014-2016, it is clear that majority of the years has not been able to meet up to the base year index, with only minute improvements observed 2018 where the food production index stood at 105.20 against 98.85 in 2015.

Table 3: Agricultural GDP, 1981 – 2020

Year	Agricultural GDP (in ₦' billions)	% of GDP	Year	Agricultural GDP (in ₦' billions)	% of GDP
1981	17.05	12.36	2001	2,015.42	24.73
1982	20.13	13.64	2002	4,251.52	37.35
1983	23.80	15.14	2003	4,585.93	34.18
1984	30.37	18.49	2004	4,935.26	27.51
1985	34.24	18.41	2005	6,032.33	26.36
1986	35.70	18.20	2006	7,513.30	24.99
1987	50.29	20.76	2007	8,551.98	24.92
1988	73.76	23.60	2008	10,100.33	25.54
1989	88.26	21.49	2009	11,625.44	27.03
1990	106.63	21.77	2010	13,048.89	23.89
1991	123.24	21.09	2011	14,037.83	22.29
1992	184.12	20.52	2012	15,816.00	22.05
1993	295.32	23.72	2013	16,816.55	21.00
1994	445.27	25.43	2014	18,018.61	20.24
1995	790.14	25.74	2015	19,636.97	20.86
1996	1,070.51	26.46	2016	21,523.51	21.21
1997	1,211.46	27.69	2017	23,952.55	21.06
1998	1,341.04	28.19	2018	27,371.30	21.43
1999	1,426.97	26.30	2019	31,904.14	22.12
2000	1,508.41	21.58	2020	37,241.61	24.45

Source: Central Bank of Nigeria (2020)

In line with Table 3, agricultural output has been on the surge over the selected time with an output valued at N17.05 billion in 1981 rising to N106.63 billion in 1990. This trend continued reaching N13,048.89 billion in 2010 before growing momentously to N37,241.61 billion in 2020. What has been dangling is the contribution of the agricultural sector to the overall GDP. With the contribution of 12.36% in 1981, it rose sharply to 21.77% in 1990 before reaching a relative maximum of 28.19% in 1998. This was followed by a continuous decline reaching 24.73% in 2001 before a magnificent leap was recorded in 2002 up to 34.18% in the subsequent year of 2002. With this feat being reached, subsequent years was marked with declining agriculture contribution to GDP from 34.18% in 2003 to 20.24% in 2014. Slight improvement were recorded as the value seems to rise in subsequent years up to 24.45% in 2020.

2.3. Linkages Concerning Food Production and Population Growth

Studies on food production and population can be linked to the theory of population by Thomas Malthus, where population was observed to rise faster than the supply of food. Our study is then centered on rural population as a labor input in food production, and given the continuous decline of the proportion of rural population driven by rural-urban migration, food production could likely be affected. On whether population could affect food production, some studies have put forth diverse arguments and findings.

As Abdulrahman (2013) noted, food production does not grow in line with the upsurge in population while conducting a study for Nigeria by comparing it with India and the USA. The study noted that Nigeria has been below the base year index in her food production, pointing to the problem of food sufficiency in the country.

Ikelegbe and Edokpa (2013) utilized survey research to detect "agriculture production and food nutrition security in twenty rural communities in Benin, Nigeria." The study discovered that the migration of people from rural areas to cities causes a labor shortage in the agriculture sector. Major contributing causes to the loss in agricultural production over the past five years in the studied areas are a lack of access to fertilizer and inadequate infrastructure.

The work of Mekuria (2018) aimed at investigating the association concerning population upsurge and food production in Ethiopia while highlighting trends and conflicts in population expansion. This analysis reveals that agricultural productivity and population growth have both risen over time. In contrast to population increases, production growth exhibits erratic trends.

Also, Adama et al. (2018) scrutinized the repercussions of economic and socioeconomic issues on agricultural output in rural communities in Nigeria. The study considered four crops: cassava, yam, maize, and rice. Two models, which were estimated via OLS, were specified. The first model captures the influence of economic and socioeconomic issues on the identified crops, while the second model captures the influence of economic and socioeconomic issues on total output. In the first model, family labor and farm size posed a positive and substantial weight on cassava production and on maize production. For yam and rice production, farm size put forth a positive and significant effect, while family labor wielded a negative influence on rice production but a positive wave on yam production. In both cases, the effects were not significant. At the aggregate, both farm size and family labor put forth a positive inspiration for the total output of the farmer, though such effects were not significant.

Oguntegbe et al. (2019) have studied the problem of population as it affects food production in Nigeria. With the study using data from 1980 spanning through 2011 and using the OLS and the 'instrumental variable approach (IVA)' of estimation, the result of the OLS captured that population and food production exhibit a positive connection. Meanwhile, it was reported based on the IVA that population growth increases food production, thus calling for population control policies.

Our study is centered around rural population attenuation as it affects food production in Nigeria. Food production will be split into crop production, livestock production, and aggregate food production in Nigeria. The estimation technique lies within the cointegration and OLS estimation of diverse varieties: OLS, DOLS, and FMOLS.

3. Methodology

3.1. The Model

The model for this study is modified from the works of Oguntegbe et al. (2019) where they explored "population growth and food security in Nigeria. Their model defined food production (food production index being used as a proxy) as being dependent on population growth, income per capita, and arable land. Our model follows the same pattern but excludes income per capita, in addition to disaggregating it into crop production, livestock production, and then to food production. The models so specified are in line with the intent of the study which were splits into three major categories. In specifying our models, arable land and rural population growth are the independent variables while crop production, livestock production, and food production turns out to be the dependent variable for Model I, Model II, and Model III respectively.

Model I: This focuses on specifying the connection inherent in crop production and rural population growth. The functional form is specified thus,

$$CRP_t = f(ALA_t, RPG_t) \quad (1)$$

Where CRP = crop production (measured by crop production index)

ALA = arable land (measured as % of total land area)

RPG = rural population growth (measured in %)

Equation (1) is renovated into an amenable form for estimation is given thus;

$$CRP_t = \beta_0 + \beta_1 ALA_t + \beta_2 RPG_t + \mu_t \quad (2)$$

Where the variables are the same as given above, β_0 is the constant, β_1 and β_2 are the parameters to be estimated, and μ_t is the stochastic component. It is anticipated that $\beta_0 \neq 0$; $\beta_1 > 0$; and $\beta_2 < 0$.

Model II: This model reflects on the influence of rural population growth on livestock production, and it is expressed thus;

$$LPI_t = f(ALA_t, RPG_t) \quad (3)$$

Where LPI reflects livestock production (measured as crop production index). With a renovation of Equation (3), the estimable form becomes;

$$LPI_t = \varphi_0 + \varphi_1 ALA_t + \varphi_2 RPG_t + \mu_t \quad (4)$$

With φ_0 being the constant, φ_1 and φ_2 being the parameters to be estimated, μ_t and being the stochastic component. It is expected that $\varphi_0 \neq 0$; $\varphi_1 > 0$; and $\varphi_2 < 0$.

Model III: The model captures the influence of rural population growth on food production. The model is specified as follows:

$$FPI_t = f(ALA_t, RPG_t) \quad (5)$$

Where FPI is food production and the variables on the right are as earlier defined. A transformation of Equation (5) yields a model amendable for estimation which is expressed as follows.

$$FPI_t = \delta_0 + \delta_1 ALA_t + \delta_2 RPG_t + \mu_t \quad (6)$$

With δ_0 being the constant, δ_1 and φ_2 being the parameters to be estimated, μ_t and being the stochastic component. It is expected that $\delta_0 \neq 0$; $\delta_1 > 0$; and $\delta_2 < 0$.

3.2. The Model

The data spans from 1961 through 2018, making a total of fifty-eight (58) years under consideration. These data were obtained on key variables like crop production, livestock production, food production, arable land, and rural population growth. These were solely gotten from the World Bank's (2021) database on "World Development Indicators," and this source is reliable as it stands as an official body globally recognized.

3.3. Analytical Technique

As our study makes use of time series data, our data were first subjected to unit root test. The test which was conducted under the constant and trend assumption followed the Augmented Dicky-Fuller (ADF) approach. The data were further analysed using the cointegration test to reveal the existence of any form of long-run link in the model. The study also put to use, the OLS approach with varying dimensions – the OLS itself, the Dynamic OLS, and the Fully Modified OLS. These method aids in estimating long-run (stable) estimates of the models. Meanwhile, the selection of the lead model will be based on the explanatory power that it has the significance of the variable(s) of interest.

4. Empirical Findings

4.1. Stationarity Test

The stationarity test so conducted aids in the detection of the prevalence of 'unit root' in the series, and the ADF approach is utilized.

Table 4: Unit root test result

Variables	Level ADF Test Statistic	Fist Difference ADF Test Statistic	Order of Integration
CRP	-2.1091 (0.5293)	-3.5067 (0.0485)*	I(1)
LPI	-3.0043 (0.1401)	-8.5843 (0.0000)**	I(1)
FPI	-2.0680 (0.5516)	-3.5560 (0.0433)	I(1)
ALA	-1.7952 (0.6941)	-8.2008 (0.0000)**	I(1)
RPG	-2.6737 (0.2512)	-5.8389 (0.0001)**	I(1)

Note: ** and * means significance at 1% and 5% level respectively.

An overview of Table 4 unveils that all the series only turned stationary after they have been differenced once. Thus, the order of integration of the variables are strictly at first difference, expressed as I(1). Our analysis will advance to defining any form of cointegration that may exist concerning the variables in the respective models.

4.2. Cointegration Test

In the course of the variables being I(1), the right test for long-run connection concerning the variables is the 'Johansen cointegration test'. Table 5 through Table 7 unveils the result of the test so conducted.

Table 5: Johansen cointegration test result for Model I

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Probability
None *	0.260142	31.14097	29.79707	0.0348
At most 1	0.136523	14.26837	15.49471	0.0759
At most 2*	0.102376	6.048214	3.841466	0.0139

Source: Researchers Computation (2022)

Result for Model 1 reports the existence of one cointegrating equation given that the level of significance in 5%. This is achieved since the Trace statistic is more than the critical value at $p < .05$. Such supports that cointegration exists, confirming that a long-run relationship exists concerning crop production and rural population growth.

Going to Model II, the result is obtainable in Table 6 where it is observed that there abound one cointegrating equation.

Table 6: Johansen cointegration test result for Model II

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Probability
None *	0.343041	30.47371	29.79707	0.0417
At most 1	0.113911	6.946258	15.49471	0.5839
At most 2	0.003097	0.173713	3.841466	0.6768

Source: Researchers Computation (2022)

Such existence of cointegration supported by the result adumbrated in Table 6 supports that a long-run link exists concerning livestock production and rural population growth.

Table 7 reflects on the same test in regard to Model III where one cointegrating equation is being reported.

Table 7: Johansen cointegration test result for Model III

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Probability
None *	0.269904	32.14601	29.79707	0.0263
At most 1	0.139841	14.52961	15.49471	0.0695
At most 2*	0.103108	6.093896	3.841466	0.0136

Source: Researchers Computation (2022)

With the existence of the cointegrating equation, it is valid to state that a long-run rapport abounds concerning food production and rural population growth.

To detect the stability of the long run cointegrating relationship, the Hansen instability test is utilized and Table 8 unveils the result.

Table 8: Hansen Instability test result

Model	Lc statistic	Stochastic Trends (m)	Deterministic Trend (k)	Excluded Trends (p2)	Probability
I	0.4980	2	0	0	0.0451**
II	0.5406	2	0	0	0.0359**
III	0.5030	2	0	0	0.0438**

Note: ** means significance at 1% level.
Source: Researchers Computation (2022)

With the aid of the 5% probabilities, the Hansen instability test result in Table 8 portrays that the Lc statistics for all the three models were significant ($P < .0.05$). This points to the refutation of the 'null hypothesis' that the long run cointegrating estimates are instable.

4.3. Regression Estimates

The regression result so estimated is in accordance with the three models that were specified in the study. The results so obtained are unveiled in Table 9 through Table 11, where the influence of the explanatory variables is observed as they affect crop, livestock, and general food production. The result so observed is based on the three approaches of estimation which are the OLS, Dynamic OLS, and the Fully Modified OLS.

Model I

Model I is estimated to bring to the fore, how rural population growth affects crop production. The result of the estimation is unveiled in Table 9.

Table 9: Regression result (Model 1)

Dependent Variable: Crop Production Index (CRP)			
Variables	OLS	DOLS	FMOLS
ALA	1.7907 (0.0000)**	1.6038 (0.0116)*	1.7243 (0.0030)**
RPG	-41.560 (0.0000)**	-49.2585 (0.0000)**	-48.4444 (0.0000)**
C	57.690 (0.0040)**	77.0585 (0.0248)*	71.8092 (0.0144)*
R-Squared	0.7878	0.8714	0.7778
Adjusted R-Squared	0.7801	0.8491	0.7695

Note: ** and * means significance at 1% and 5% level respectively.
Source: Researchers Computation (2022)

For Table 9 under the OLS approach where the dependent variable is crop production (CRP), rural population growth is captured to a negative sway on crop production which matches with our a priori expectation; with such influence being significant. The coefficient attracts a 41.560% decline in crop production given a 1% decline in rural population growth. In the same Table 9, arable land (ALA) put forth a significant influence on crop production, with the effect being positive. With arable land increasing by 1%, there is a likelihood that crop production will increase by 1.7907%. Holding ALA and RPG unchanged, the constant (C) portrays that crop production will be 57.69. It is also being unveiled here that the two variables account for 78.78% of the total changes in crop production, given the R-squared of 0.7878; and such will still be 78.01% if the degree of freedom is taken in cognizance.

In the DOLS estimates, the a priori sign are still the same with the OLS and the estimates are also significant in influencing crop production. If arable land increases by 1%, there is a likelihood that crop production will escalate by about 1.6038%; while if rural population growth upsurges by 1%, crop production plummets by 49.2585%. With ALA and RPG devoid if variations, crop production will attract a value of 77.06. The model defined 87.14% of the overall changes in crop production and remained at 84.91% is consideration is made for the degree of freedom.

In the FMOLS, similar outcome is observed where RPG wields a negative sway on CRP and ALA put forth a positive weight, all of which are significant. As ALA surge by 1%, CRP escalates by 1.7243%; while as RPG intensifies by 1%, CRP plummets by about 48.4444%. The CRP will be about 71.81 if ALA and RPG remain unchanged. The model also explains about 77.78% of the aggregate variations in CRP with such explanatory power remaining at 76.95% with due consideration of the degree of freedom.

Given the results from the three approaches, it is clear that the best model is the one being estimated by the DOLS where the coefficients are significant and the R-squared is also higher compared to the other two approaches.

Model II

Model II is estimated to bring to the fore, how rural population growth affects livestock production, with the result presented in Table 10.

Table 10: Regression result (Model I1)

Dependent Variable: Livestock Production Index (LPI)			
Variables	OLS	DOLS	FMOLS
ALA	0.6476 (0.1456)	0.3378 (0.6671)	0.5604 (0.4062)
RPG	-53.6197 (0.0000)**	-62.1842 (0.0000)**	-59.8215 (0.0000)**
C	122.5205 (0.0000)**	147.7054 (0.0011)**	136.0602 (0.0002)**
R-Squared	0.7186	0.8146	0.7187
Adjusted R-Squared	0.7083	0.7823	0.7083

Note: ** means significance at 1% level.
Source: Researchers Computation (2022)

With the result under the OLS, arable land put forth a positive wave on livestock production while rural population growth wielded a negative influence. The so identified influence of the variables is also significant in affecting the dependent variable. If arable land intensifies by 1%, the outcome will be that livestock production will gather a rising trend by 0.6476%; while if rural population growth surges by 1%, livestock production plummets by 53.6197%. The index of livestock production will be 122.52 if ALA and RPG persist to be unchanging. The model is seen to explain 71.86% of the entire variations in livestock production, and it still stands at 70.83% given a case of considering the degree of freedom.

In the DOLS, ALA still wields a positive weight on LPI while RPG put forth a negative inspiration; with the effect of the two variables being significant. Livestock production is likely to increase by 0.3378% if a 1% increase in ALA is recorded; while the variable will experience a 62.1842% degeneration if RPG surges by 1%. Livestock production index will remain at 147.71 is ALA and RPG stays unchanged. The R-squared is an indication that ALA and RPG jointly account for 81.46% of the entire changes in livestock production, and it will be 78.23% if allocation is made for degree of freedom.

The FMOLS approach still offer a similar result where ALA put forth a positive influence which is significant, and RPG put forth a deleterious influence which is also significant. If ALA surges by 1%, there is a likelihood that LPI will escalate by about 0.5604%; while a 1% surge in RPG make LPI to plummet by 59.8215%. Livestock production will remain at 136.06 is both ALA and RPG remains unchanged. The ALA and RPG collectively account for 71.87% of the entire changes in livestock production, and the explanatory power retains its goodness of fit at 70.83% is allocation is given to the degree of freedom.

It is also glaring that the DOLS offers the best estimates as it holds a greater explanatory power as showcased in its higher R-squared when compared to other approaches. Thus, the estimate forms the DOLS approach serves as our lead model.

Model III

Here, the overall food production in the economy is considered and the model traces how rural population growth and arable land influences it. Table 11 offers an eye view of the result so obtained from the estimation.

Table 11: Regression result (Model I1I)

Dependent Variable: Food Production Index (FPI)			
Variables	OLS	DOLS	FMOLS
ALA	1.6653 (0.0000)**	1.4648 (0.0215)*	1.5961 (0.0059)**
RPG	-42.9465 (0.0000)**	-50.7416 (0.0000)**	-49.7721 (0.000)**
C	64.7797 (0.0014)**	84.7895 (0.0149)*	78.8818 (0.0078)**
R-Squared	0.7855	0.8702	0.7762
Adjusted R-Squared	0.7777	0.8477	0.7680

Note: **and * respectively means significance at 1% and 5% level.
Source: Researchers Computation (2022)

As the overall food production is being considered, similar result is observed where, under the OLS, arable land accounted for a positive sway while rural population growth wielded a negative inspiration on food production. A unit percent upsurge in ALA accounts for a 1.6653% escalation in total food production; while a 1% surge in RPG causes food production to plummet by 42.9464%. With arable land and rural population being kept unchanged, food production index attracts a value of 46.78. Both ALA and RPG is noted to account for 78.55% of the overall volatility in food production, and this remains at 77.77% is adjustment is given for degree of freedom.

In the DOLS approach, it is noticed that the effect of ALA was positive while that if RPG was negative, with both wielding a significant inspiration on food production. As ALA proliferates by 1%, FPI also surges by 1.4648%; while the proliferation of RPG causes FPI to plummet by 50.7416%. Food production index will be 84.79 if RPG and ALA is held constant, while the two variables altogether explain 87.02% of the overall discrepancies in food production.

With respect to the FMOLS similar trend is also being reported where the weight of ALA is positive and significant, while that of RPG is negative and significant. It emanates from the coefficient that if ALA surges by 1%, FPI will proliferate by 1.5961%; and if RPG surges by one percent, FPI shrinks by 49.7721%. The FPI will be 78.88 if both RPG and ALA are not allowed to vary; and RPG and ALA jointly account for 77.62% of the overall changes in food production.

Still one the lead model, the result offered by the DOLS offers a greater explanation of the changes in FPI by having a higher coefficient of multiple determination compared to the OLS and the FMOLS. Consequently, the result offered by the DOLS is being upheld.

5. Discussion of Findings

Two major findings are drawn from this study. First, that arable land put forth a positive and significant weight on food production and second, that rural population growth wielded a deleterious and significant influence on food production in Nigeria. Going by the first major findings, it is expedient that as more agricultural land is put under cultivation, the outcome will be rising agricultural output which stems to greater food production in Nigeria. As our data has indicated, arable land (% of total land area) has been rising over the years, and this translates to a greater quantity of food produced in the nation.

For the second major finding, it is no longer a new issue that agriculture is being practiced primarily by rural dwellers in Nigeria. Consequently, a greater rural population without a declining marginal product of labor which can be achieved via mechanization, agricultural activities can be boosted which in turns boost food production. The rural population in Nigeria has been characterized by greater rural-urban migration, which has led to agriculture being abandoned by the agile youths who seek greener pasture in the urban centers. Such migration and neglect of agriculture in the rural areas can be linked to the negative influence in which rural population growth put forth on food production in Nigeria.

The findings of this study are in line with the one reported by Oguntegbe et al. (2019) where they noticed that population growth wielded a negative weight on food production while arable land put forth a positive effect, which were significant in both cases. With declining rural population growth which implies increased urbanization, it is likely that the increased urbanization will reduce the size of agricultural land for non-agricultural purposes (See Satterthwaite, et al., 2010). The implications of these findings center on the need to put more arable land under cultivation and the need to curb the rising rural-urban migration that has depleted rural labor supply in agriculture.

6. Conclusion and Recommendation

Nigeria has been noted as a nation characterized by a rising urban population, which is due to the massive influx of people from rural areas to urban areas (Effiong and Okijie, 2022). In this regard, there has been an outflow of rural labor that could amplify agricultural production, which is a panacea for food production and sufficiency. The concern of this paper stems from this angle, and this led to the examination of the influence of rural population growth on food production in Nigeria from 1961 through 2018. The methodology of the study follows the stationarity test, cointegration test, and ordinary least squares approach of diverse variants (OLS, DOLS, and FMOLS). Our models were segmented into three categories: first, ascertaining the influence of rural population growth on crop production; second, capturing the influence of rural population growth on livestock production; and third, reflecting on the influence of rural population growth on food production in general.

The test for stationarity executed with the aid of the augmented unit root test gave us that our variables were all stationary at the first difference, leading to the cointegration analysis. In line with the result of the Johansen cointegration test, it was revealed that cointegration exists among the three models, and this was further upheld by the Hansen instability test. With the R-squared of the models being used in the selection of the lead model for OLS, DOLS, and FMOLS, it was realized that the DOLS served better as it recorded the highest R-squared in all cases, and the coefficients were also significant. From the result, we noticed that rural population growth put forth a negative effect on crop production, livestock production, and food production in general, and the effect was significant. It was further observed that arable land put forth a desirable influence on crop production, livestock production, and crop production in general. Our model unveiled that both arable land and rural population growth collectively explained 87.14%, 81.46%, and 84.77% of the whole variation in crop production, livestock production, and food production, respectively.

The findings therefore raise concern about the capability of rural communities to drive food sufficiency in the nation, as characterized by the continuous rural-urban drift. This calls for rural agricultural development driven by aggressive mechanization, plus ensuring rural development to curtail the menace of rural-urban migration that has spearheaded the deleterious influence of the rural population on food production. Driving the agricultural revolution by harmonizing diverse rural agricultural policies and programs will aid in facilitating a rapid and substantial upsurge in food production within the country.

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