www.jard.edu.pl http://dx.doi.org/10.17306/J.JARD.2021.01424

Journal of Agribusiness and Rural Development

pISSN 1899-5241
eISSN 1899-5772

3(61) 2021, 261–270
Accepted for print: 22.07.2021

AGRICULTURAL LAND USE AND POPULATION GROWTH IN NIGERIA. THE NEED FOR SYNERGY FOR A SUSTAINABLE AGRICULTURAL PRODUCTION

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Abstract. This study examined the relationship between the total agricultural land use and population growth rates from 1961 to 2018 in Nigeria. Secondary data were obtained from the Food and Agricultural Organization and the World Bank. Descriptive statistics, trend equation and correlation analyses were used. Findings revealed that agricultural and arable land utilization grew at the rate of 0.62% and 0.72%, respectively, per annum, while the total population growth rate stood at 2.57%. Also, urban and rural populations grew at a rate of 4.75% and 1.67%, respectively. In addition, the agricultural and arable land utilization rates had significant positive correlations with the total population, urban and rural population. What is more, the findings revealed that agricultural land (to total land ratio) has continued to increase and currently averaged at 68.78%, indicating massive land expansion for use in farming. Furthermore, the findings showed that most arable crop outputs increase majorly from land expansion rather than land productivity. This situation cannot assure sustainable agricultural land use for food security in the near future. Hence, the country needs farming land sparing policies and technologies to slow the current agricultural land expansion drive. Besides, the country's agricultural land policies should focus on achieving land productivity and sustainable land-sharing strategies among major land users. Again, the rural population growth rate is lower than the urban growth rate, implying that the rural population is deteriorating with its probable negative effect on farm labour. This needs to be addressed urgently if a sustainable farming system is to be achieved in Nigeria in the near future.

Keywords: agricultural land, population growth rate, synergy, sustainability, Nigeria

INTRODUCTION

Unguided processes of urbanization and mounting population density have exerted enormous pressure on available agricultural land in Nigeria (Enaruvbe and Atedhor, 2015; Akpan and Udom, 2018). Literature has provided evidence that Nigeria is typically an agrarian society and the most populous country in Africa (Akpan et al., 2012). These attributes of Nigeria have constantly interacted with each other in a predatory manner. For instance, the agricultural sector, on one part, is the largest user of land resources in the country, while population growth depends mainly on the availability of land. An increase in the human population is often accompanied by the rise in urbanization processes and habitually involves developing infrastructures in an expanse of arable land. For more than a decade, the country's population growth rate has revolved around 2.50% per annum (NPC, 2020). Consequently, this has resulted in the massive expansion of cities, towns and peri-urban areas in the country (Bloch et al., 2015). Some of the adverse effects of the continuous growth of urban areas are the persistent encroachment of the reserved land areas and shifting farming activities to the periphery or less productive/marginal lands.

In Nigeria, frequent encroachment and unplanned land development are common phenomena and are often part of most political agendas (Aliyu and Amadu, 2017). In an attempt to decongest most urban areas

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and/or triggered industrialization processes, the country has experienced massive construction of roads and other infrastructures across farm settlements, especially in the southern region of the country, resulting in increasing deforestation and pollutions of aquatic as well as terrestrial environments (Adedeji et al., 2014). These activities deteriorate farm production in terms of the economics of scale, the biodiversity on which farm production depends so much and the environment as a whole (Akpan et al., 2019a; 2019b). Thus, land resources and their availability are the major determinants of farming output and population growth. Therefore, a balance in land utilization between human population and agricultural production is one of the prerequisites for sustainable agricultural production and population growth, especially in developing societies.

The impact of increasing population on agricultural land availability and production in developing countries is studied in different dimensions. In one way, researchers have suggested that increased population and urbanization increase rural-urban labour migration (Chappell et al., 2009; Igbolo and Adaka, 2017), leading to labour scarcity, inefficiency in farm resource use and wrinkling productivity at the farm level. In another dimension, Dayo et al. (2009) opined that the low productivity of agricultural land is due to the continuous depletion of soil nutrients following continuous cropping resulting from excessive land fragmentation and shortages of arable lands induced by an increase in population. Evidence abounds that population pressure is one of the significant initiators of land fragmentation in developing countries (Wan and Cheng, 2001; Udoh and Akpan, 2007). Irrespective of the approach used to analyse the relationship between population growth and agricultural production, a long-term predatory correlation is likely envisaged, especially for the developing countries. By implication, most land conservative methods used in most developing countries, such as land rotations and bush fallowing, will no longer be practised in a short while. Hence, the continuous farming land constriction due to population growth and the rapid encroachment of the reserved farming lands in the country without concerted efforts to increase land productivity amounts to an unsustainable farming system now and in the future. The corrective measure lies in developing sound farmland use and population policies and programmes to tackle the current realities (Akpan et al., 2012).

Therefore, the need to understand and established the relationship between population growth rate and agricultural land use rate in the country is overwhelmingly necessary now that the poverty rate has increased tremendously in the country (NBS, 2015). In addition, the population density is growing on an annual basis, and the reserved agricultural land is shrinking, resulting in excessive land fragmentation, especially in the south-south region. Therefore, the sustainability of the farming system in the country rests on the need to manage the ratio of population growth rate and agricultural land use rate efficiently. This requires a holistic policy package designed using outcomes from relevant research on population growth rate and land use rate interactions. Thus, as part of the contribution to the literature, this study specifically focused on establishing the relationship between farming land use rate and population growth rate over time in Nigeria.

RESEARCH METHODOLOGY

Study area

The study was conducted in Nigeria. The country is situated on the Gulf of Guinea in sub-Saharan Africa. Nigeria lies between 4° and 14° north of the equator and between longitude 3° and 15° east of Greenwich. The country has a total land area of about 923,769 km^2 (or about 98.3 million hectares) with 853 km of coastline along the northern edge of the Gulf of Guinea and a population of around two hundred (200) million (NPC, 2006 and NPC, 2020). The country is bounded by the Republics of Benin in the west, Chad and Cameroon in the east and Niger in the north. It is an agrarian society with a diverse vegetation distribution. From the south to the north, the vegetation spread through the rainforest belt (mangrove, freshwater swamps); Guinea savanna (woodland and tall grass savanna, Montane), Sudan savanna (short grass savanna) and the Sahel savanna (Marginal savanna), yielding a diverse mix of plant and animals. The vegetation distribution supports a lot of crop and animal production, both on subsistence and commercial scales. The tropical evergreen rain forest belt bears timber production and forest development, production of cassava, plantation and growing of fruit trees – citrus, oil palm, cocoa and rubber, among others. Temperatures across the country are relatively high, with a slight variation in seasonal and diurnal temperatures ranging from 22 to 36ºC. There are two main

seasons: the wet season, which lasts from April to October, and the dry season, from November till March. The country is endowed with significant agricultural, mineral, marine and forest resources. Its diverse vegetation zones, high rainfall, surface water and underground water resources and moderate climatic extremes allow for the production of various food, tree and cash crops. Over 60 per cent of the population is involved in producing the food crops such as cassava, maize, rice, yams, different beans and legumes, soya, sorghum, ginger, onions, tomatoes, melons and vegetables. The main cash crops are cocoa, cotton, groundnuts, palm oil and rubber (FME, 2019).

Data source

This study used secondary data. These data were sourced from the World Bank and Food and Agricultural Organization (FAO). Data covered the period from 1961 to 2018. The choice of the period was based on the availability of data. Annual time series data collected included the following: total population, urban and rural population, agricultural land, arable land, some arable crop outputs and harvested areas.

ANALYTICAL TECHNIQUE

The trend analysis

The study investigated the nature of movement and growth rates in agricultural land, arable land total population, and urban and rural population in Nigeria from 1961 to 2018. The study assumes an exponential growth rate for the specified variables due to the continuous and often induced expansion in these variables over time. Hence, an exponential trend equation is determined as follows:

$$\log_e AGL_t = b_0 + b_1 T + U_t \quad (1)$$

Where T is the time expressed in years, while the dependent variable is a set of variables defined as:

AGL_t – Agricultural land (× 1000 ha)
ARL_t – Arable land (× 1000 ha)
TPO_t – Total population (× 1000 persons)
RPO_t –Rural population (× 1000 persons)
UPO_t – Urban population (× 1000 persons)

$$\text{The exponential growth rate is given as } (r) = (e\text{b}^1 - 1) \cdot 100 \quad (2)$$

Where e (2.71828) is the Euler's number and a constant; r – exponential growth rate (%) and b_1 – time coefficient as expressed in equation 1, note, agricultural land refers to the arable land and land under permanent crops or tree crops as well as permanent pasture lands. In addition to arable land, as defined by the FAO, are lands under temporary or short duration crops (FAO, 2020). The total agricultural land refers to (note, not the combination) the agricultural land and arable land in the study.

Measuring the Pearson correlation matrix of population and land variables used in the study

The Pearson correlation coefficient was estimated to establish the strength and direction of a linear relationship between and among the population and total agricultural land variables used in the study. The formula is described below in equation (3):

$$r_{xy} = \frac{\sum (x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum (x_i - \bar{x})^2 \sum (y_i - \bar{y})^2}} \quad (3)$$

The r_{xy} is the Pearson correlation coefficient that shows the linear relationship between variables X and Y. The correlation coefficient ranges from –1 (a strong negative relationship) to +1 (a strong positive relationship).

Measuring land productivity (Pr) of major crops in Nigeria

The land productivity was estimated by dividing the annual output of the selected crops by their respective harvested area in period t. it is stated as follows:

$$P_r = \text{Annual output of Crop "i" (tons)} / \text{annual harvested area of crop "i" (ha)} \quad (4)$$

This index was computed to evaluate the performance of the selected crop sub-sector.

RESULTS AND DISCUSSION

The descriptive statistics of variables used in the study are presented in Table 1. The results show a moderate degree of volatility in the agricultural land and arable land variables.

For instance, about 12.90% and 18.90% coefficients of variability were observed in agricultural land and arable land, respectively, in the period considered in the study. This implies that the rate of change or utilization of these variables was progressive in nature and

Table 1. Summary statistics of variables

Variable	Min.	Max.	Mean	Std. Dev.	C.V.	Skewness
Total Agricultural land (× 1000 ha)	47 219	73 700	62 625	8 118.7	0.129	–0.306
Arable land area (× 1000 ha)	16 466	37 000	29 443	5 575.1	0.189	–0.809
Agric. land/total land area (%)	51.85	80.92	68.761	8.9141	0.129	–0.306
Total population (× 1000 persons)	46 063	1.91e+005	1.02e+05	43 639	0.426	0.499
Rural population (× 1000 persons)	38 931	98 078	67 770	18 378	0.271	0.051
Urban population (× 1000 persons)	7 213.6	95 764	35 250	26 371	0.748	0.847

Variables are as defined in equation 1.
Source: own elaboration.

relatively similar in use pattern in the study period. The distribution of the specified land variables skewed to the left of the normal curve with a negative sign, implying that in most periods, land variables utilization rates cluster towards the left region of the normal curve or were increasing at a decreasing rate. For the population variables, the coefficients of variability stood at 42.60%, 27.10% and 74.80% of the total population, rural and urban population, respectively. The population-related variables' distribution is skewed to the right of the normal curve. This implies that these variables relatively increase at an increasing rate within the period specified. By implication, the population variables witnessed much more volatility compared to the agricultural land variables. By comparison, the rate of change or volatility was far higher in population-related variables than agricultural land-related variables. This means that in Nigeria, the population is expanding faster than the growth in land-related factors.

The trends in agricultural land, arable land, total population, rural population and urban population in Nigeria

The exponential equations for the total agricultural land variables are shown in Table 2. The findings show that agricultural land, arable land and agricultural land/total land ratio have a significant positive relationship with time. The magnitude of the relationship indicates that the total agricultural land variables witnessed significant positive growth or use rate in the specified period. The result revealed that the farming land utilization grew at an annual exponential rate of 0.62%, while arable land expansion grew at a rate of 0.72% per annum. Likewise,

Table 2. Exponential trend equation for the total agricultural land variables

Variable	Agric. land	Arable land	Agric. land/ total land
Constant	10.85 (283)***	10.06 (213)***	4.04 (105)***
Time	0.006 (7.39)***	0.007 (5.15)***	0.006 (7.39)***
Exponential growth	0.62%	0.72%	0.62%
F-cal.	54.57***	17.49***	54.57***

*, ** and *** represent significant levels at 10%, 5%, and 1%, respectively, and numbers in parentheses represent *t*-values.
Source: own elaboration.

the agricultural land–total land ratio witnessed an annual exponential positive growth rate of 0.62% in the period considered in the study. This implies that the total agricultural land variables expansion has seen continuous positive growth over the years.

In a similar vein, the exponential growth rate for the population variables is given in Table 3. Again, all population variables have significant positive correlations with the influence of time.

This connotes that over time the total, rural and urban populations have significantly increased. The exponential growth rates of 2.57%, 1.67%, and 4.75% were obtained for the total population and rural and urban population, respectively. By comparing the agricultural land variables and population variables, we observed that the growth rate in population variables

Table 3. Exponential trend equation for population variables

Variable	Total pop.	Rural pop.	Urban pop.
Constant	10.69 (203)***	10.59 (786)***	8.77 (567)***
Time	0.026 (194)***	0.017 (38.8)***	0.047 (126)***
Exponential growth	2.57%	1.67%	4.75%
F-cal.	375***	150.5***	160.5***

*, ** and *** represent significant levels at 10%, 5% and 1%, respectively, and numbers in parentheses represent *t*-values.
Source: own elaboration.

was higher and grew faster than the agricultural land variables within the period considered. The sign and the magnitude of the exponential growth rates obtained for the population-related variables suggest that the country's population growth rate increases with a more than double increase in the growth rate of agricultural land-related variables. By implication and given the low productivity of farm resources and the finite nature of agricultural land as well as the low farming outputs in the country (Akpan et al., 2012), the demand capacity is expanding faster than food production in the country. Literature has provided evidence of the country's low productivity of farm resources (NBS, 2015; Odetola and Etumnu, 2013); hence, this scenario suggests pending danger to the food security and safety of the present teeming population and in the future. It is also observed that the growth rate in the rural population is lower than in the urban population. This means that the populace of the rural areas is reducing while that of the urban areas is increasing. The statistics provided could suggest increasing the outward movement of people from rural to urban areas of the country. One of the adverse effects of this fact is the labour constrain imposed by the scarcity of work in the rural areas where farm production is predominant. On the other hand, there is a possibility of congestion in the urban areas resulting from the probable frictional unemployment and poor infrastructures.

Trends and correlations in agricultural land and population variables in Nigeria

The bivariate correlation coefficients were estimated to determine the relationship between the total agricultural land and population variables. The results are presented in Table 4. The findings revealed that all population variables have a significant positive relationship with the total agricultural land variables in the country. The result implies that as the population increase, the total agricultural land use also increases. Hence, the total agricultural land use increases correspondingly to a rise in population. The finding means that the country's total agricultural land utilization will always respond positively to the population increase. The pictorial trends, representation of the total agricultural land and population-related variables are given in Figures 1 and 2. The trends affirmed the previous result. It is shown that the trend in the total population continuously and exponentially rose from 1961 to 2018. This means that the country's population has been increasing at a growing rate. The result shows that the country's population has

Table 4. Bivariate correlation between agricultural land and population variables

	T. agric. land	Arable land	Agric. /total land.	Total. pop.	Rural pop.	Urban pop.
Total agric. land	1.000	0.958*	1.000*	0.809*	0.810*	0.790*
Arable land	0.958*	1.000	0.958*	0.642*	0.625*	0.640*
Agric./total land	1.000*	0.958*	1.000	0.809*	0.810*	0.790*
Total. pop.	0.809*	0.642*	0.809*	1.000	0.985*	0.991*
Rural pop.	0.810*	0.625*	0.810*	0.985*	1.000	0.954*
Urban pop.	0.790*	0.640*	0.790*	0.991*	0.954*	1.000

* Represents a significant level at 1% probability.
Source: own elaboration.

continued to grow despite the various policies enunciated to slow down its growth rate.

This assertion is derived from the smooth growth rate observed in the population trend in Figure 1. For the agricultural land and arable land trends in the country, the movements over time have been somewhat undulating and perhaps reflecting various agricultural land-related policies in the country. For instance, from 1961 to 1970, the country's farming policy and programmes focused on developing and exporting cash crops such as oil palm, cocoa, groundnut, cotton and rubber. The large expanse of agricultural lands at the regional levels was allocated to the development of these crops. During this period, the population growth rate was lower than the growth rate in land utilization (see Fig. 1 and 2). As noted in the farming policy document of the Federal Ministry of Agriculture, Water Resources and Rural Development (FMAWRRD) (2019), the nation saw massive development of agricultural land as evidenced by the upshot in the trend diagram during this period. However, from 1970 to 1985, the country witnessed an enormous depression in agricultural land use. As noticed in the trend, the country's agricultural land use declined drastically while the population growth rate continued to grow. Many factors contributed to the depression in agricultural land use and the increase in population.

Among the factors were the increasing exploitation of crude oil, increased volatility of macroeconomic fundamentals, the residual effect of civil war and the emergence of Dutch disease during this period (Shuhei, 1999; Odetola and Etumnu, 2013 and Akpan et al., 2012). In addition, as a result of the diversion of interest in agricultural production, the country became a net importer of farm products to match up domestic demand.

Following the dismal performance of the agricultural sector, the government responded by enunciating several agrarian policies and programmes such as National Accelerated Food Production Programme (NAFPP) in 1972, Agricultural Development Projects (ADP) in 1974, and Operation Feed the Nation (OFN) in 1976 and River Basin Development Authorities (RBDAs) in 1976 as well as Green Revolution (GR) in 1980, among others. The intervention yielded a positive effect from 1986 to date. From the trend, it is observed that land uses increased significantly between 1986 and 2018. During this period also, the population showed an exponential

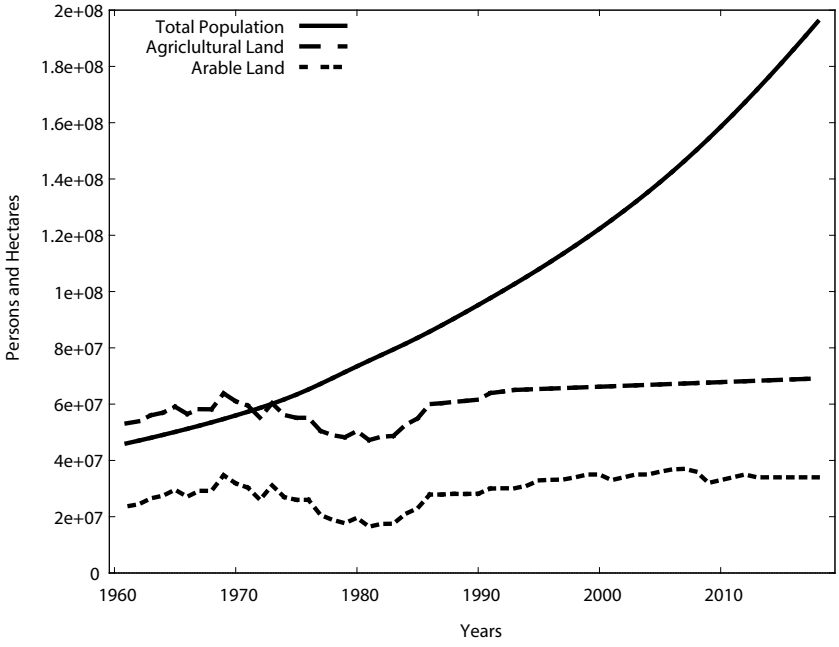

Fig. 1. Trends in agricultural land, arable land and total population in Nigeria (1961–2018)
Source: authors and data from FAO, 2021.

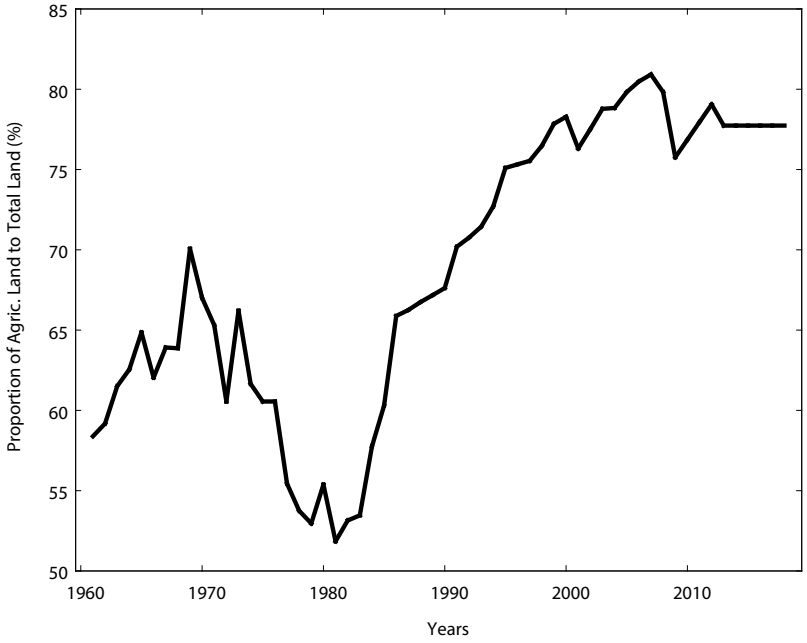

Fig. 2. Trends in agricultural land to total land in Nigeria (1961–2018)
Source: authors and data from FAO, 2021.

growth rate that was far higher than that of the farmland usage rate.

Agricultural land productivity with respect to selected crops in Nigeria from 1961 to 2018

Though the annual population growth rate is found at 2.57% and the farming land grew at the rate of 0.67% per annum, the pertinent question is: does the growth rate in agricultural land use in the country sustainable? Given the finite nature of the land and the established annual population growth rate in the country, it is beckoned on the policymakers to identify the sustainable growth rate in agricultural land to sustain the future generations. In order to make a valuable contribution in this regard, the exponential growth rates for the harvested land area, output and land productivity for selected crops from 1961 to 2018 were computed. The essence was to ascertain whether the increase in agricultural crop outputs in the country was due to land productivity or the continuous farming land expansion. The result of the analysis is shown in Table 5.

The result revealed the annual growth rates of 4.053%, 4.095% and 0.042% of the total harvested land area, output and land productivity or yield, respectively, for cassava production in Nigeria. The result indicates that land productivity or yield growth rate was far lower than the rates of the harvested land area and the output produced. This implies that the increase in cassava output in the period considered resulted majorly from the increase in harvested land rather than the increase in land productivity or yield. Furthermore, the result suggests that every cassava output expansion programme in the country was accompanied by the corresponding land expansion.

For cocoa bean and groundnut production, the yield or land productivity growth rates were lower than the growth rates in output and harvested land areas. The results were similar for maize, oil palm fruit, yam and sorghum. The fact remains that though these crops have witnessed a continuous annual increase in tonnage within the time frame of this analysis, it is evident that the rise majorly resulted from land expansion and marginally from the land yield or productivity. Alternatively, land expansion contributes more to the increase in output of arable crops than land productivity. This means that more hectares of cultivable land must be put to use for the continuous rise in arable crop outputs. This assertion cannot yield a sustainable farming system in the

Table 5. Exponential growth rates of harvested area, output and land productivity of some selected crops in Nigeria (1961 to 2018)

Cassava			Cocoa bean			Groundnut		
Hectare	Output	Land productivity	Hectare	Output	Land productivity	Hectare	Output	Land productivity
4.053	4.095	0.042	1.164	1.321	0.157	1.284	2.244	0.959
Maize			Oil palm fruit			Rice		
Hectare	Output	Land productivity	Hectare	Output	Land productivity	Hectare	Output	Land productivity
3.849	5.251	1.403	0.788	0.890	0.102	6.021	6.531	0.509
Yam			Sorghum			Millet		
Hectare	Output	Land productivity	Hectare	Output	Land productivity	Hectare	Output	Land productivity
4.255	4.486	0.231	0.741	1.729	0.988	-0.629	0.319	0.949

Growth rates are expressed in percentage.
Note: computed by authors and data from FAO, 2020.

future because farmland use has an opportunity cost and is a finite factor of production.

However, millet production in the country presents a different scenario compared to other arable crop production discussed earlier. It can be noticed that the growth rate in the harvested area was negative, while the growth rates in output and land yield were favourable. But the most striking part is that the growth rate in land yield was greater than the growth rate in output and harvested land area. The result suggests that the increase in millet production in the country was predominantly due to land productivity than land expansion. This is a healthy relationship between land use and crop production, given the present population growth rate in the country. However, the result implies that most arable crop production in Nigeria does not follow the path of sustainability in terms of efficient land usage. An increase in the outputs of most arable crops in the country is primarily due to land expansion rather than increased land productivity.

The need for synergy for a sustainable agricultural production

The study has established that Nigeria's population is expanding, and the proportion of total agricultural land utilized is equally expanding, whereas the land productivity is not showing commensurate improvement. This means that the future of sustainable agricultural production in the country is oblique, and the desire to attain food self-sufficiency by the federal government might not be achievable unless there is a concerted effort to balance population growth with farmland expansion. For a safer future, the government, the private sector and all stakeholders in the farming sector must collaborate to initiate and implement policies and programmes that would enhance farm resource productivity. Since the majority of the farmers in the country are small scale farmers that control more than 60% of the domestic agricultural production, hence in the short run, the government need to prioritize their policies towards increasing the efficiency and productivity of the majority of farmers in the country (Shuhei, 1999). Thereafter, a planned transformation of the sector in line with the government's long-term objectives should be pursued vigorously. On the other hand, the country needs stringent population policies to curb the current rate of population expansion. And the best global practices like smart agriculture, commercialized or market-driven agriculture and agriculture powered by massive investment in modern technologies as well as export-propelled production should be the preferred long-term strategies.

SUMMARY, CONCLUSION AND RECOMMENDATIONS

The results revealed annual exponential growth rates of 0.62% for the agricultural land and 0.72% for arable land in the time frame considered. Likewise, the exponential growth rates of 2.57%, 1.67% and 4.75% were obtained for the total population, rural and urban population, respectively. Additionally, significant positive correlations between population and agricultural land variables were established in Nigeria. The findings further revealed that the annual increment in the total output of some arable crops like cassava, yam, cocoa bean, maize, sorghum, groundnut and rice were mostly due to land expansion than an increase in land productivity. Based on these results, the apparent reason to implement several population policies enacted previously in the country is justifiable. It is also shown that agricultural land-related variables and population variables have significant exponential growth rates in the period considered. This is an indication that farmland is not used sustainably amidst the mounting population pressure. In conclusion, the country needs to efficiently harness its enormous human and natural resources to ensure short- and long-term sustainable development in agriculture.

On account of the above assertion, it is strongly recommended that the federal government of Nigeria should generate policies enhancing farmland productivity. By implication, such policy should focus on empirically proven strategies like improved fertilizer distribution and development of marginal lands as well as subsidized for Greenfield development, especially in the forest belt of the country. Furthermore, as part of the anticipated revolution in the sector, the level of technology involved in agricultural production needs to be advanced or improved to increase factor (land) productivity. Alternatively, land sparring technologies are strongly advocated, particularly in areas with high population density. The current land expansion policy is not the best option for the country; individual farm level productivity needs improvement in the overall efficiency of the farming system in the country. Also, the current birth control policy should be reinforced and implemented to help reduce the excessive population in the country.

SOURCE OF FINANCING

The research was sponsored by the authors.

ACKNOWLEDGEMENTS

We are grateful to the FAO, National Bureau of Statistics (NBS) of Nigeria and World Bank for providing data used in the study.

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