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RESEARCH ARTICLE

Analyses of sugarcane production trend, growth rate, instability index and decomposition in Nigeria

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Abstract

The research examined the trends, growth rates, and instability indices related to the output, harvested area, and yield of sugarcane in Nigeria. It also analyzed the decomposition of sugarcane production in Nigeria.

Utilizing secondary data sourced from the Food and Agricultural Organization (FAO) covering the period from 1961 to 2022, the study revealed inconsistent patterns in trend of output, harvested area, and yield of sugarcane across the specified timeframe.

The compound growth rates identified were 1.11% for output, 1.03% for harvested area, and 0.08% for yield. For the period 1961 to 2022, the Cuddy-Della Valle instability index (CDI) and the Coppock Instability Index (COI) were calculated at 21.23 and 58.79 for output, 35.70 and 72.34 for harvested area, and 20.55 and 50.99 for yield, respectively. These instability indices were relatively moderate, indicating significant activity within the sugarcane sector in Nigeria.

A decomposition analysis of the total effect of sugarcane output showed that the land area effect accounted for 144.55%, the yield effect for -3.60%, and the interaction effect for -40.95% of the total variability in output.

The findings suggest that the land area effect is the predominant factor driving the growth of sugarcane production in Nigeria. Consequently, it is recommended that various programs be implemented within the sub-sector to stimulate increased activity and potentially enhance both output and yield.

Keywords: Growth, instability index, sugarcane, trend, decomposition, Nigeria

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Introduction

The sugar sub-sector constitutes an important source of industrial employment in Nigeria (National Sugar Development Council (NSDC) 2012; Akpan 2013). Additionally, the sub-sector is integral to the federal government's food self-sufficiency initiatives (NSDC, 2024).

The sub-sector supplies essential raw materials for various industries, including food and beverage, bakery and confectionery, soft drinks, and pharmaceuticals among others.

The demand for refined sugar, both for household and industrial use, has remained robust in Nigeria. As of 2020, the domestic consumption of sugar was approximately 1.53 million tons annually (FAO, 2024; NSDC, 2024). However, domestic sugar production has fluctuated between 50,000 tons in 2006 to 38,597 tons in 2019 (NSDC, 2024 and FAO, 2024).

The majority of Nigeria's sugar needs are satisfied through the importation of raw sugar, which is subsequently refined within the country.

The country's sugar import rose from 0.7 million metric tons in 2003 to 1.3 million metric tons in 2009.

Approximately 98 percent of sugar imports consist of raw sugar, with the remaining portion being refined sugar. Presently, domestic sugar production accounts for just under 3% of the nation's annual requirements (NSDC 2024).

Between 2001 and 2005, domestic sugar production experienced a significant decline, reaching an all-time low of less than 1% of the total sugar consumed in Nigeria (FAO 2024, NSDC 2024).

Nigeria, despite its reliance on imports, stands as the foremost consumer of sugar in West Africa and possesses extensive cultivable land that is conducive for the cultivation of industrial sugarcane (Busari and Misari, 1996). Over the years, the federal government has implemented various policies aimed at enhancing domestic sugar production (Akpan et al. 2013a).

These initiatives include a zero percent import duty on sugar machineries, provision of 50% loan to sugarcane out growers, provision of cheap loan to investors in sugar industry, increase import duty and levy on raw and refined sugar imported into the country from 2012 till date, a five-year tax exemption for sugar refineries, the privatization of major sugar enterprises, and a sugar expansion program in partnership with the African Development Bank and the African Development Fund in 1989 and 1991, respectively, among others (NSDC 2014). Such measures were designed to invigorate local sugar production and improve both productivity and capacity utilization within the sector. Nevertheless, Nigeria continues to import over 90% of its locally consumed sugar (Nigerian Financial Business News, 2010).

This situation necessitates a substantial outflow of foreign exchange for sugar imports, which has adversely affected the nation's external reserves, thus hindering the development of other economic sectors, and negatively impacted the livelihoods of sugarcane farmers. For example, in 2019 and 2020, approximately $382,294,903.48 and $433,406,293.00 respectively were expended on sugar imports (Gourichon 2013; Akpan et al., 2015; Olife et al., 2022; NSDC 2024).

The National Sugar Development Council (NSDC) indicates that Nigeria has the potential to cultivate over 500,000 hectares of industrial sugarcane, capable of producing more than 5 million metric tons of sugarcane, which could yield around 3 million metric tons of sugar upon processing. Sugarcane is an 'energy crop' used in the production of fuel ethanol and generation of electricity besides so many other spin-off industries (Ja'afar-furo et al. 2012; Usman et al. 2015; NSDC 2024). However, the sector has been largely overlooked and remains heavily reliant on the importation of raw brown sugar from Brazil and other countries. Nigeria was ranked 4th in 2009 among sugar importing countries in the World (NSDC 2024). In reaction of the dwindling fortune of the sugar subsector in the country, the government has persistently pursued initiatives and policies aimed at enhancing the productivity of the subsector (Akpan et al. 2013b; Buba, 2018). In 2013, a revision of the sugar tariff structure was undertaken to invigorate the sugar industry, increase domestic raw sugar production, and generate employment opportunities.

This revision included the announcement of new tariffs for both raw and refined sugar, as well as for equipment and machinery related to sugar production. Notably, the government instituted a zero percent import duty on machinery and spare parts intended for local sugar manufacturing, free excise duties on sugar production, alongside a five-year tax holiday for investors engaged in the sugar value chain. Additionally, a ten percent import duty and a fifty percent levy were imposed on imported raw sugar, while imported refined sugar faced a twenty percent duty and a sixty percent levy (Akpan et al. 2011; Akpan et al. 2012; NSDC 2024). These strategic measures aimed to redirect investments into the sub-sector and encourage backward integration as well as stimulate productivity and capacity utilization within the sugar value chain (Akpan et al. 2014). Despite these lofty initiatives, the productivity and capacity utilization of sugar sub sector in the country has continue to fall short of the expected levels. As noted by Akpan et al. (2012), the problem of the Nigeria's sugar industry is not really achieving efficient or installed capacity utilization, but rather lack of sufficient raw materials or industrial sugarcane production.

The improve capacity utilization of the industry is fundamentally hinged on the increase quantity of sugarcane production. Logically, the increase in domestic sugar production is depended on the availability of sufficient industrial sugarcane production.

The increase production of industrial sugarcane crop would help to save foreign exchange with the protection of local currency. Therefore, understanding the variation of industrial sugarcane production, cultivated or harvested area and the yield component is a prerequisite for achieving the required growth in the sugar sub sector in the country. Research that focused on analysis of output, harvested area and yield of industrial sugarcane production is notably lacking in the existing literature in Nigeria.

The nation currently relies on sugar imports to meet both domestic and industrial needs. Consequently, there is a pressing necessity to re-focused research attention to the raw material availability, utilization of land and the yield component.

This is necessary to balance research approach in the sub sector and generate up-to-date and holistic policies that would upsurge the productivity of the subsector in future. Premise on this assertion, the study is designed to analyse the growth rate and instability indices in production, harvested land area and yield of industrial sugarcane from 1961 to 2022 in Nigeria. It also isolate the contributions of land area, yields and interaction component on the overall quantity of sugarcane production in the country.

Materials and Methods

Study Area

The study was conducted in Nigeria. The country is endowed with abundant agricultural, marine, and forest resources. The richness of natural resources allows for the cultivation of a wide range of agricultural products. More than sixty percent of the population is involved in agricultural activities, including the production of cassava, groundnuts, oil palm, cotton, sugarcane, rubber, cocoa, rice, maize, aquaculture and artisanal fishing, coconut, livestock, yams, various beans and legumes, sorghum, carrots, and a variety of vegetables, among others.

Data source

The study made use of secondary data sourced from Food and Agricultural Organization (FAO). The time series examined spanned from the year 1961 to 2022.

Model Specification

Analytical Techniques

The research utilized descriptive tests and calculated the exponential growth rate derived from a compound growth rate to analyze the growth rate and instability index in sugarcane production, harvested area, and yields. The choice of the exponential growth rate was based on the assumption that the dependent variables (sugarcane output, harvested area and yield) would exhibit exponential growth patterns over the years as a result of various intervention policies implemented by the federal government to boost the subsector's productivity over the years. .

Measuring an exponential growth rate or a compound growth rate of variables

"To determine the exponential growth rate of sugarcane production, harvested area, and yield, the following equation were defined in accordance with Akpan et al., 2015"

$$\log_e\left(Y_o, Y_a, Y_y\right) = \delta_0 + \delta_1 t + U_t \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots (1)$$

Where Y_o, Y_a, Y_y are the output in tons, harvested area in hectare and yields in ton/ha of sugarcane in a given year. Variable "t" represents the time variable measured in years. Given a compound growth rate as in equation 2, and comparing it with equation 1, the exponential growth rate is as specified in equation 3.

$$Y_t = Y_0(1+r)^t \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots (2)$$

Comparing with an exponential equation

$$r = \left(e^{\delta_1} - 1\right) \text{ x } 100 \text{ or (antilogb1 – 1) x 100} \dots (3)$$

Where r is the measure of a compound growth rate or exponential growth rate for a specified variable express in a percentage.

The OLS technique was used to estimate the required parameters.

Measuring series instability index

The research utilized the coefficient of variability (COV), Cuddy-Della Valle index (CDI), and Coppock Instability Index (COI) to evaluate the instability in output, yield, and harvested land area of sugarcane in Nigeria. Detailed estimations of each measure are outlined in the following sections.

Coefficient of Variability (COV)

The Coefficient of Variation (COV) is a prominent index used for assessing variability and instability within a series. It quantifies the relative dispersion of data around the mean value. However, it is important to note that the COV tends to overestimate instability in time series with long-run trends and does not adequately account for the trend component inherent in the data. A higher COV indicates greater variability, while a lower COV suggests less variability.

$$COV = \frac{\text{standard deviation}}{\text{mean}} \dots\dots\dots\dots (4)$$

Cuddy-Della Valle index (CDI)

The Cuddy Della Valle index removes trend effects from annual series, providing a clear indication of instability direction (Cuddy and Della Valle, 1978). By utilizing the coefficient of determination, it eliminates the impact of trends on the coefficient of variation (COV), resulting in a superior measure of instability in production, harvested area, and yields compared to the coefficient of determination (Wasem, 2001).

A low value of this index suggests low instability in the series, whereas a high value indicates the opposite. The formula for calculating this index is as follows:

$$CDI = CV\sqrt{1-\bar{R}^2} \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots (4)$$

Where CV is the coefficient of variation in percent, and $\bar{R}^2$ denotes the adjusted coefficient of determination obtained from time trend regression on output, harvested area and yield of sugarcane in the country. The degrees of instability are classified into three ranges: Low instability (from 0 – 15); medium instability (greater than 15, but less than 30) and high instability (>30).

Coppock Instability Index (COI)

The Coppock (1962) instability index measures instability by utilizing log variance methodology.

A greater Coppock instability index indicates heightened instability, while a lower index signifies lower instability.

$$\text{Coppock Instability Index (COI)} = \text{Antilog}\left(\sqrt{\log V} - 1\right) \text{x } 100 \dots (5)$$

Where,

$$\log V = \frac{1}{N-1}\sum(\log X_{t+1} - \log X_t - M)^2 \qquad (6)$$

$$M = \frac{1}{N-1}\sum(\log X_{t+1} - \log X_t) \dots\dots\dots\dots\dots\dots\dots\dots (7)$$

Where,

Xt is the time series variable under consideration (output/area/yield) in period t.

M = mean value of the first differences of logarithm

Sugarcane Output Decomposition

The examination of growth rate and instability indices does not consider the proportional impact of harvested area and yields on overall sugarcane production. Decomposing the sugarcane output is essential in order to isolate the individual effects of yield, harvested area and the interaction effect on production. Therefore, a decomposition analysis was conducted to achieve this goal. The initial assumption is as follows:

Production (total effect) = Area effect of sugarcane+ Yield effect of sugarcane + Interaction effect

$$P = \frac{A_0 \Delta Y * 100}{\Delta P} + \frac{Y_0 \Delta A * 100}{\Delta P} + \frac{\Delta Y \Delta A * 100}{\Delta P} \ldots\ldots\ldots\ldots\ldots (8)$$

Where,

A0 = Area in the base year

ΔA = Current harvested area minus the base area

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ΔA = Current harvested area minus the base area

Y0 = Yield in the base year

ΔY= Current yield minus the base yield

ΔP = Current production minus base production

All analyses specified in the study are done for three (3) periods i.e. 1961–1985, 1986–2022 and 1961 – 2022.

Results and Discussion

Trend Analyses

The trends for sugarcane quantity or output, yield, and harvested land area in Nigeria from 1961 to 2022 are presented in figures 1, 2, and 3, respectively.

The annual harvested sugarcane displayed a fluctuating pattern, with notable irregular peaks and troughs over the examined period.

In 1961, the quantity of harvested sugarcane was 172,000 tons, steadily increasing until 1993 when it peaked at 905,000 tons. A decline was observed from 1994 to 1995, followed by an upward trend until 2007.

However, from 2008 to 2011, there was a consistent downturn in sugarcane production.

This trend reversed from 2012 to 2022, as the sector experienced a resurgence with a steady increase in harvested quantity, reaching a peak of 1,525,591.66 tons in 2022.

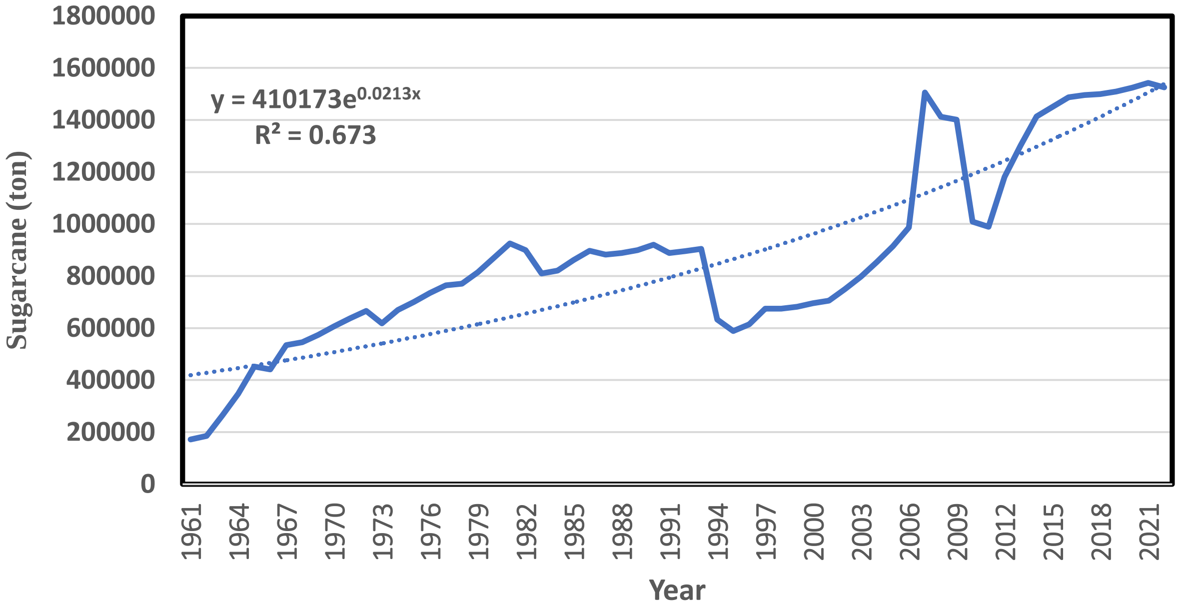

Figure 1. Trend in industrial sugarcane production in Nigeria (1961 – 2022)

The trend in the harvested land area of sugarcane was similar to the pattern exhibited by the quantity of harvested sugarcane within the same period. From 1961 to 1993, the trend showed a marginal positive growth rate. A depression was observed from 1994 to 2001 and 2009. From 2002, the trend in harvested land area assumed an average marginal upward pattern up to 2022.

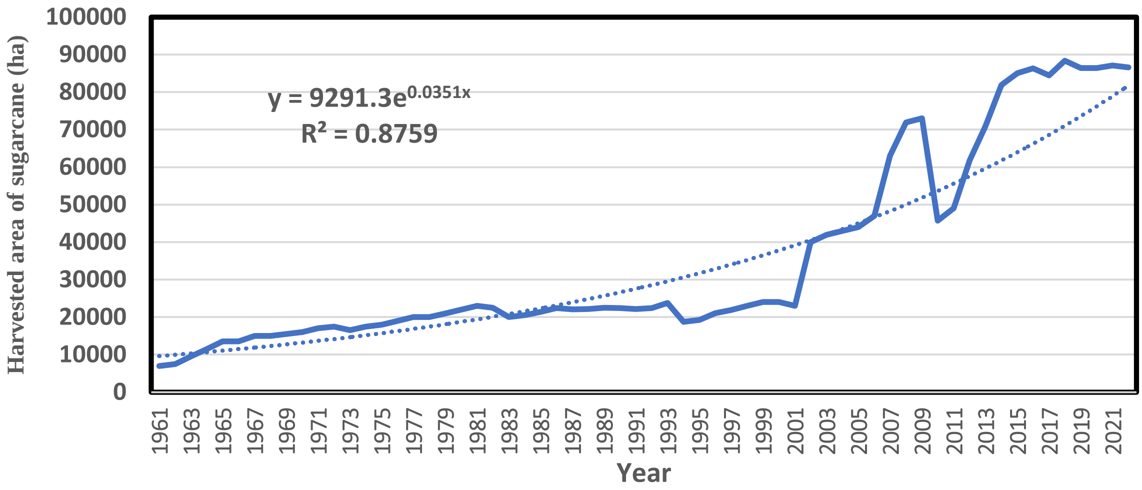

Figure 2. Trend in industrial sugarcane harvested area in Nigeria (1961 – 2022)

The trend in sugarcane yields has been influenced by various events and government policies aimed at significantly transforming the output of this agricultural sub-sector. Notably, between 1961 and 1993, the yield exhibited a consistent upward trend, a period that coincided with the establishment of major sugar companies in the country. Substantial investments were made in this sector during this time, Particularly through the import substitution policy implemented in the 1970s. However, from 1986 to 1993, the impact of the Structural Adjustment Programme (SAP) became evident as sugarcane yield experienced marginal improvement. The privatization and commercialization initiatives affected the major sugar companies, leading to their privatization and the introduction of new investment opportunities within the sub-sector.

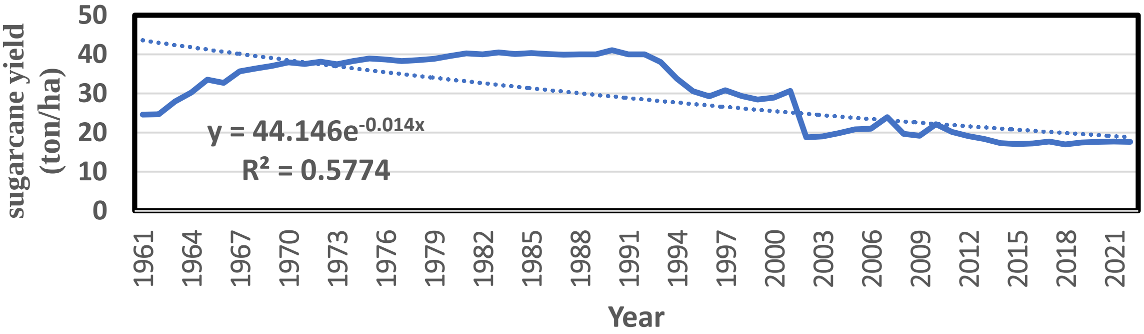

Figure 3. Trend in industrial sugarcane yield in Nigeria (1961 – 2022)

Despite the yield trends during this timeframe, the combined capacity utilization of the four major sugar companies remained low, with total domestic production failing to meet domestic demand (Olife et al. 2022). In light of government interventions through various initiatives, the demand for sugar imports continued to rise, adversely affecting the country's exchange rate stability. The implementation of initiatives such as the establishment of the National Sugar Development Council (NSDC) in 1993 and later the sugarcane out grower schemes had a limited impact on domestic sugarcane production and yield, especially in meeting the country's demand for sugar imports. From 1994 to 2022, the yield of sugarcane experienced fluctuations with a slight overall upward trend. This period coincided with the post-Structural Adjustment Program (SAP) era, during which the government provided various fiscal and monetary incentives to support the sugar sub-sector. However, the sub-sector faced challenges such as inefficiency in production, low-capacity utilization, and a significant reliance on imported raw and refined sugar. During this time, infrastructure within the sub-sector deteriorated, and some companies experienced encroachment on their sugarcane plantations. Productivity in the sub-sector remained low, management of existing companies was plagued by corruption, and government interest in sugar development was not a top priority. In 2022, Nigeria's average sugarcane yield was recorded at 17.61 tons per hectare, significantly lower than the yields reported in Ghana (24.46 tons per hectare), South Africa (69.62 tons per hectare), and Egypt (105.51 tons per hectare) during the same timeframe (FAO, 2024).

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The Compound growth rate and Instability Index in output, area and yield of sugarcane in Nigeria

The coefficients of variability, compound growth rate (CGR), Cuddy-Della Valle instability index (CDI), and Coppock Instability Index (COI) pertaining to the output, harvested area, and yield of sugarcane in Nigeria for the periods 1961–1985, 1986–2022 and the overall span from 1961 to 2022 are presented in Tables 1, 2, and 3, respectively.

Growth rates and Instability Indices in sugarcane output (tons) in Nigeria

The analysis indicates that the coefficient of variability (COV) and the compound growth rate (CGR) for sugarcane production from 1961 to 1985 were recorded at 34.73% and 5.71%, respectively.

This period was characterized by a significant increase in the output of sugarcane within the nation. The CGR value suggests that time factors had a positive influence on sugarcane production during this timeframe, specifically indicating an average annual increase of 5.71% in production. Furthermore, the coefficient of variability (COV) reflects moderate annual fluctuations in sugarcane output during this period.

Table 1. Growth rates and Instability Indices in Sugarcane Output (tons) in Nigeria

Parameters	1961 - 1985	1986 - 2022	1961 - 2022
Mean	6.2756e+005	1.0540e+006	8.8203e+005
Standard deviation	2.1793e+005	3.3240e+005	3.5827e+005
COV (%)	34.726	31.538	40.619
CGR (%)	5.7053	2.2833	2.1549
		Instability indices	
CDI (%)	11.0559	19.2684	21.2324
COI (%)	36.7918	58.5716	58.7983

Note: COV = Coefficient of Variation; CGR = compound growth rate; CDI = Cuddy - Della Valle instability index; COI = Coppock instability index.

The Cuddy-Della Valle index (CDI) and the Coppock Instability Index (COI) in the period were calculated at 11.06 and 36.79, respectively. These indices demonstrate that the instability in the sugarcane production from 1961 to 1985 was relatively low in Nigeria, suggesting low activity within this agricultural sub-sector during the specified period. During this period, the federal government make a concerted effort to expand sugarcane production in order to meet the capacity utilization of the major existing sugar companies. The country enjoyed initial increase in production of sugarcane through land expansion, but however, the success was short-live. The period was characterized by government prominent role in direct production of sugarcane as part of import substitution policy adopted during the era. Between 1986 and 2022, the coefficient of variation in sugarcane output was documented as 31. 54%, with an estimated compound growth rate (CGR) of 2. 28%.

The data indicates that there was a decrease in the average annual growth rate of sugarcane production during this period, amounting to 2.28%. The findings suggest that the time factor positively influenced sugarcane production during this period, although the extent of the impact was lower compared to the previous period under consideration. The coefficient of variation was lower compared to the previous period analyzed. The Cuddy-Della Valle Instability Index (CDI) was calculated as 19.27, while the Coppock Instability Index (COI) was found to be 58.57. Based on the magnitude of CDI and COI, it can be inferred that there was a moderate instability in sugarcane output during this period.

During this period, it is suggested that there were more activities within the subsector that had a direct impact on sugarcane output, as compared to the previous period. The key intervention policy during this era was the privatization of the major sugar factories in the country and the establishment of National Sugar Development Council (NSDC).

Analysing pooled data from 1961 to 2022 revealed a COV of 40.62% and a CGR of 2.16%. These findings suggest that, on average, the time factor positively influenced the output of sugarcane in Nigeria. The Cuddy-Della Valle instability index (21.23) and Coppock Instability Index (58.80) reflected moderate instability in output of sugarcane from 1961 – 2022 timeframe.

Growth rates and Instability Indices in harvested area (ha) of sugarcane in Nigeria

The distribution pattern of indicators related to harvested area shows similarities to output indicators. Specifically, the compound growth rate (CGR) was positive across the periods of 1961 to 1985, 1986 to 2022, and 1961 to 2022, indicating a consistent increase in the harvested land area of sugarcane over time. Notably, the CGR was higher during the period of 1986 to 2022 compared to other time frames. The coefficient of variability (COV) was 55.79% in the period of 1986 to 2022 and 73.09% from 1961 to 2022.

Table 2. Growth rates and Instability Indices in harvested area of sugarcane (ha) in Nigeria

Parameters	1961 - 1985	1986 - 2022	1961 - 2022
Mean	16796.0	48081.0	35466.0
Std. dev.	4486.4	26824.0	25922.0
COV (%)	26.711	55.789	73.089
CGR (%)	3.9805	5.2183	3.5695
	Instability indices		
CDI	9.2722	20.5081	35.7032
COI (%)	50.7636	66.2202	72.3365

Note: COV = Coefficient of Variation; CGR = compound growth rate; CDI = Cuddy - Della Valle instability index; COI = Coppock instability index.

This suggests that the subsector witnessed significant fluctuations in the annual harvested land area. The instability indices of CDI and COI, showed low instability in the 1961 – 1985 period and moderate or medium instability during the period of 1986 to 2022. With a calculated CDI of 35.70 and COI of 72.33, the harvested area of sugarcane land displayed a high level of instability throughout the aggregate period of 1961 to 2022.

The outcome is likely due to the efforts of our grower sugarcane farmers established to complement the sugarcane production of the primary sugar companies in the nation. Additionally, the establishment of additional small sugar refineries has stimulated the cultivation of sugarcane by small-scale farmers.

These activities resulted in significant fluctuations in the amount of land designated for sugarcane cultivation in the country.

Growth rates and Instability Indices in the Yields (ton/ha) of sugarcane in Nigeria

The results indicated that the coefficients of variation (COV), compound growth rate (CGR), Cuddy-Della Valle instability index (CDI), and Coppock instability index (COI) for sugarcane yield were 12.97%, 1.66%, 4.50, and 42.55 respectively from 1961 to 1985.

During the period, the sugarcane yield in the country increased by 1.66% per annum, a rate lower than the yields achieved in Ghana (2.82%) and Cameroon (4.72%) during the same period (FAO, 2024).

The values of CDI and COI indicate minimal variability in sugarcane yield over the specified time frame. The findings indicate that the period (1961 to 1985) was characterized by low activity that had a significant impact on the sugarcane yield in the country. During this period, the entire agricultural sector was largely neglected as a potential source of foreign exchange by all tiers of government, with heavy reliance placed on the crude oil industry instead. This period was also characterized by unguided robust investment in the agricultural sector by the government through import substitution policies, which were marred by corruption and a lack of genuine commitment. Consequently, the agricultural sector faced a decline in private sector investment due to an obnoxious policy mandating government participation in agricultural investments within the nation.

The output of research and development did not significantly applied in the sugarcane unit as the system was still operating using inefficient technology. As such, there was a lack of innovations in the sugarcane unit that actually led to low yield.

Table 3. Growth rates and Instability Indices in yield of sugarcane (ton/ha) in Nigeria

Parameters	1961 - 1985	1986 - 2022	1961 - 2022
Mean	36.222	25.926	30.078
Std. dev.	4.6965	8.8377	8.9831
COV (%)	12.966	34.088	29.866
CGR (%)	1.6588	-2.7894	-1.3658
		Instability indices	
CDI	4.5008	13.2897	20.5494
COI (%)	42.5507	51.0388	50.9973

Note: COV = Coefficient of Variation; CGR = compound growth rate; CDI = Cuddy - Della Valle instability index; COI = Coppock instability index.

Between 1986 and 2022, the sugarcane yield experienced a deterioration, characterized by a coefficient of variation (COV) of 12.96% and a compound growth rate (CGR) of -2.79.

The instability in sugarcane yield was low and the CGR declined at an annual rate of 2.79% denoting that time factor had an adverse effect on sugarcane yield during this period.

The compound growth rate (CGR) of sugarcane yield in various African countries from 1986 to 2022 varied significantly. South Africa saw a modest growth rate of 0.145%, while Egypt experienced a slightly higher rate of 0.296%. In contrast, Cameroon exhibited a substantial growth rate of 4.839%, and Angola had a moderate growth rate of 0.418%.

Despite the federal government's efforts to revitalize sugarcane cultivation through the implementation of an out grower scheme, the impact of this initiative and other related policies failed to improve the declining sugarcane yield in the country. In general, the yield of sugarcane in the country declines because of a lack of innovations through organized research and development programs within the industry.

The analysis of pooled data (1961 – 2022) revealed overall figures for COV, CGR, CDI, and COI at 29.87%, -1.37%, 20.55 and 50.99 respectively.

These findings suggest that the annual growth rate of the sugarcane yield was negative at 1.37%, a figure that is insufficient to satisfy the domestic annual demand or to enable competitive positioning of the country in the global market.

Within the same period, some African countries recorded a more progressive CGR reports on sugarcane yield compared to Nigeria. For instance, Ghana had 0.244% CGR in sugarcane yield, Egypt recorded 0.564% and Cameroun had an impressive 4.257% (FAO 2022). This finding suggests that the country did not prioritize sugarcane yield.

Decomposition of output of sugarcane in Nigeria

The analysis of the decomposition of sugarcane output is presented in Table 4. The findings showed the various components contributing to the total effect, which encompasses the area effect, yield effect, and interaction effect. It is observed that during the periods of 1961 to 1985, the total effect in sugarcane production was attributed to 51.28% of the land area effect, 15.94% of the yield effect and 32.78% of the interaction effect. During this timeframe, the area effect emerged as the predominant factor influencing industrial sugarcane production or output.

This means that during this period, the increase in sugarcane output was primarily attributed to the expansion of cultivable land rather than advancements in technology or agronomic practices.

Consequently, it can be inferred that the federal government focused its efforts on increasing the cultivable area without making significant strides in enhancing sugarcane yield.

The period 1986 – 2022 marked the overwhelming contribution of the area effect to the total effect of sugarcane production. The area effect contributed 409.19% to the total effect in output compensating the negative contributions of yield effect (-79.95%), and interaction effect (-229.24%). This period corresponds to the Structural Adjustment Programme (SAP) and post-SAP periods in the country.

During this period, the subsector was bewildered by several issues ranging from inactive sugar refineries, mounting import of raw and refined sugar, poor innovation adoption in the subsector, sugarcane plantation encroachment, poor farmers' out grower coordination, and minimal research and development initiatives in the subsector among others.

Table 4. Percentage decompositions of area, yield and their interaction effects on oil palm fruit production in Nigeria

Components	1961 - 1985	1986 - 2022	1961 - 2022
Area effect	51.28	409.19	144.55
Yield effect	15.94	-79.95	-3.60
Interaction effect	32.78	-229.24	-40.95
Total effect	100.00	100.00	100.00

Source**:** computed by authors.

Furthermore, there was a lack of sufficient government commitment to effectively implement relevant policies, tackle corruption, address technological constraints, and combat infrastructural decay within the subsector during this time period. Following the negligence of the subsector, the country's sugar import exceeded 95.00% of the total domestic sugar consumption.

Sugarcane cultivation in this period was dominantly carried out by the small-scale farmers who were not guaranteed a steady and profitable market environment in the country.

The incentive to improve sugarcane yield was absent as the major sugar factories were either moribund or operated below installed capacity. A comparable finding was observed in the aggregated or pooled data covering the years 1961 to 2022.

The finding revealed the dominant role of land area effect on sugarcane output in the country. The result shows that the land area effect overwhelmingly contributed 144.55% of the total effect circumventing the negative impact of the yield effect (-3.60%) and the interaction effect (-40.95%). Overall, these results indicate that land area effect is a key factor in explaining the total variation in sugarcane production within Nigeria.

Conclusion

The research investigated the trends, growth rates, and instability index associated with sugarcane production, harvested area, and yield in Nigeria from 1961 to 2022. A decomposition analysis was performed to differentiate the total output effect into area effect, yield effect, and interaction effect. The analysis was divided into three distinct sub-periods: 1961–1985, 1986–2022, and the overall period from 1961 to 2022. The trend analysis indicated variability in the output, harvested area, and yield of sugarcane throughout all sub-periods, as well as in the pooled period.

The computed compound growth rates for sugarcane output, harvested area, and yield were positive during the 1961–1985 period, suggesting that these factors increased over time. In contrast, the CGR in period 1986 to 2022 suggested a positive correlation between the sugarcane output, harvested area and time factor, while the yield component exhibited a negative correlation. This indicates that during this latter period, both the output and harvested area of sugarcane responded positively to changes over time, whereas the yield demonstrated a negative trend. For the entire time frame from 1961 to 2022, the overall estimated compound growth rates were 2.15% for sugarcane output, 3.57% for harvested area, and -1.37% for yield. The coefficient of variation was notably high for both harvested area and output across all specified periods, while it remained low for the yield component.

The Cuddy-Della Valle index (CDI) and Coppock Instability Index (COI) for the pooled period on sugarcane production (21.23 and 58.79, respectively), harvested area (35.70 and 72.34, respectively), and yield (20.55 and 50.99, respectively) indicated a moderate level of instability in sugarcane production, a high level of instability in the area harvested, and a moderate level of instability in yield components.
These findings imply that several activities within the sub-sector from 1961 to 2022 led to fluctuations in these parameters. Decomposition analyses reveal that from 1961 to 1985, 1986 to 2022, and across the entire period from 1961 to 2022, the effect of land area was the primary driver of total sugarcane output in the country.

This suggests that increases in sugarcane production were primarily attributable to the expansion of cultivable land rather than improvements in yield. Consequently, the observed increases in output during these periods can be attributed mainly to land area factors, with yield and interaction effects playing a negligible role. Given these insights, it is essential to implement additional initiatives within the sub-sector to foster increased activity and potentially enhance yield performance.

To achieve a meaningful improvement in yield contributions, the sugarcane sub-sector should embrace advanced technologies, decrease dependence on harvested land area, and possibly mitigate the effects of interaction components. Furthermore, enhancing the capabilities of out grower sugarcane farmers by providing access to improve planting materials, financial support, and land would greatly enhance activities within the sub-sector.

References

Akpan SB (2013) Investigating the Trend and Sources of Economic Efficiency in the Sugar Industry in Nigeria. Asian Journal of Agricultural Extension, Economics & Sociology, 2(1), 85-104.

Akpan SB, Glory EE, and Inimfon VP (2015) The Battle of Sugar Imports and Domestic Sugar Production in Nigeria: Roles of Political, Policies, and Economic Environments. Economy, 2 (4), 71-81.

Akpan SB, Ini-mfon VP, and Daniel E. John, (2012) Impact of macro-Economic Variable fluctuations on technology based capacity utilization in sugar industry in Nigeria. International Journal of Economics and Management Sciences; 1(11), 26-34.

Akpan SB, Inimfon VP, Daniel EJ, and Samuel JU, (2013a). Analysis of Economic Capacity Utilization in the Nigerian Sugar Industry (1970 - 2010). Journal of Development and Agricultural Economics, 5(6), 242-254.

Akpan SB, Obasi OU, Onyenweaku CE. and Daniel EJ, (2012). Empirical Relationship among Technical Efficiency, Macroeconomic Variables and Industrial Policy Regimes: A case study of Sugar Industry in Nigeria. International Journal of Economics and Management Sciences,1 (10), 01-11.

Akpan SB, Obot DA, Samuel JU and Daniel EJ, (2013b). Analysis of the Physical Capacity Utilization in the Sugar Industry in Nigeria. British Journal of Economics, Management & Trade, 3(2), 123-140.

Akpan SB, Samuel JU and Uwemedimo EO (2014). Examination of Empirical relationships between Industrial activities and Agricultural Policy Outputs in Nigeria (1970-2012). International Journal of Food and Agricultural Economics, 2(1), 13-22.

Akpan, SB, Udo UJ, and Essien UA (2011). Influence of Firm related factors and Industrial Policy Regimes on Technology Based Capacity Utilization Rate in Sugar Industry in Nigeria. Agric. on-line Papers in Economics and Informatics, 3(3), 15-22.

Buba AB. (2018) Dwindling fortune of sugar production in Nigeria: Perspective from Dangote Sugar Company. Dutsinma Historical Review, 1(1), 205-222.

Busari LD and Misari SM (1996) Sugar and sugarcane in Nigeria. Nigeria: A Publication of National Crop Research Institute in Bida.

Coppock JD (1962) International Economic Instability. McGraw-Hill, New York, pp. 523– 525.

Cuddy PA. Della Valle (1978). Measuring the Instability of Time Series Data Oxford Bulletin of Economics and Statistics, 40 (1), 79-85.

Food and Agricultural Organization FAO, (2024). Website mega data from Nigeria agricultural sector. Available from: https://www.fao.org/faostat/en/#data.

Ja'afar-furo MR, Ahmed SA, and Alsharief H (2012). Economic potentials of sugarcane as an industrial crop in Nigeria. African Crop Science Conference Proceedings, 11, 621 – 625.

Gourichon H, (2013) Analysis of incentives and disincentives for sugar in Nigeria. Technical notes series, MAFAP, FAO, Rome.

National Sugar Development Council (NSDC) (2024). Reviewed documents on sugar development in Nigeria. Retrieved from various documents of NSDC on the 9th - 11th of November, 2024, at: https://www.nsdcnigeria.org/.

National Sugar Development Council (NSDC) document (2012) Available at: www.nsdc.gov.ng.

Nigerian Financial Business News, (2010) Available from www.thenigeriabusiness.com. Accessed 11–11 –2024.

Olife IC, Mohammed AH, Ibrahim HD (2022). Towards Achieving Sugar Self- Sufficiency in Nigeria: A Review. Journal of Resources Development and Management, 82; 10-16.

Usman IS, Alasan DH, and Abdullahi US (2015) The sugar industry as an alternative power and fuel energy provider in Nigeria – review. Biological and Environmental Sciences Journal for the Tropics, 12(2), 822 – 828.

Wasim MP (2001) Agricultural Growth and instability in major crop production: A Province–wise analysis in Pakistan. Asian Economic Review, 43, 294-314.