Innovations

Impact of farm mechanization on rice production in Nigeria: implication for food security in 2030

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Abstract:
Rice is one of the most staple food in Nigeria with consumption per capita of 32kg. Despite the country's favourable rice production ecology, there is still a huge gap between domestic rice production and consumption patterns. This study used a trend analysis to check the performance of rice production. The study is aimed at assessing the effects of farm mechanization on rice production in Nigeria. The study was based on secondary data from (2010- 2022) collected from the IMF World economic outlook, and the World Bank report. Time-response graph and Autoregressive Moving Average (ARMA) was used to assess the trend of rice production in Nigeria from 2010- 2022, an independent t- test was used to test the relationship between rice production in the northern and southern Nigeria. The result showed that rice production in the northern Nigeria are faced with a lot of constraints arising from low adoption to mechanized methods of rice cultivation while the rice cultivation in the south is faced with the challenge of unavailability of mechanized methods of cultivation. There is a significant difference between rice output in the Northern rice farms and southern rice farms. This *study suggests that there is a need to enhance the area under cultivation, improve the irrigation system, provide timely mechanize equipment and supply of agricultural credit to farmers at flexible interest rates, change planting dates, apply recommended doses of fertilizers, and diversify crop cultivation*

Key Words: *1.Rice production, 2.Mechanization, 3.Trend analysis, 4.food security, 5.Nigeria.*

Introduction

Rice has become the most rapidly growing food crop in Nigeria. Is an important staple in Nigeria and is internationally consumed by all social and economic classes. However, Rice constitutes one of the most important staple foods for over half of the world population, Olasehinde, Qiao and Mao (2022). It is a globally significant cereal crop and the primary source of food for more than 3 billion people living mostly in developing countries, Udemezue, (2018). Rice is an increasingly important crop moving in recent times from a ceremonial food to a staple food in many homes. Rice consumption in Nigeria has immensely risen at about 5% per annum owing to changing consumer choices (Ishaku, 2013). Rice production is generally small-scale in Nigeria. Local production has not met the demand for its teeming population. This, however, led to a demand/supply gap causing a shift in local production to meet the demand for its teeming population. Relying on the import of expensive food on global markets not only stimulates domestic inflation, but also

hurts Nigerian farmers, displacing local production and fueling rising unemployment (Mohammed- Lawal et al, 2020).
In 2016, the price of rice doubled over 2015 prices, owing largely to foreign exchange rates and fluctuations in government policy on rice importation. Yet, domestic demand for rice is still high.
Previous literatures (Akomolafe, Awoyemi, and Babatunde, 2018; Sims and Kienzle, 2016; Guardian, 2016)reflects atremendous gap between domestic rice production and consumption. For example, Nigeria produced between 2.8 to 3.8 million tons of rice from 2010 to 2019 (Olasehinde et al 2022). While on the other hand, domestic demand increases from 4% to hit about 6.7 million tonnes during the 2017/18 farming season. (Rice today 2013). As at 2011, rice accounted for about 10% of household spending. As a result of the importance of rice as a staple food in Nigeria, boasting rice production has been accorded high priority by the government in the past years especially by the present administration. Although significant progress has been recorded, rice production in Nigeria has reached a peak of 3.7 million tonnes. https://www.pwc.com (2021).

Despite the potential of agricultural capacity with favourable ecologies forrice cultivation, virtually having all rice-growing ecosystems. Thus, the country'sinability to match its domestic demand has raised several concerns in the policy circle andamong researchers. One of the principal explanations for this problem in the literature is thepersistently low efficiency of inputs and the lack of modern agricultural technologies (Amusa, Igwe and Oti 2020).Currently, Nigeria is not self-sufficient in rice production, but can produce the amount needed and even more for export if farm resources and mechanization are well utilized and provided across the production stages of the product ,Mohammed, Ibrahim, Hayatu and Muhammed,(2019). Rice production cuts across pre-harvest and post-harvest activities with a wide range of activities ranging from land selection, clearing, nursery, rice field preparation, planting/transplanting, weeding, manuring/fertilizer application, scaring off birds and rodents, harvesting, threshing, parboiling, drying, winnowing, packaging to marketing. Each of these stages of rice farming is important and requires a wise allocation of farm resources and mechanization resulting from informed farm decisions, Ade, Chukwudi and Lynda, (2022).

Nigeria rice statistics from previous literatures suggest there is an enormous potentials to raise productivity and increase production. Yield has remained at 2 tonne per hectare which is about half of the average achieved in Asia. (www.pwc.com/ng 2021). However food security cannot be achieved by a system that depends almost entirely on human muscle power and other manual methods of cultivation. Nigeria mechanization has remained low at 0.3hp/ha (https://www.pwc.com). Low income limited the adoption of mechanization across the rice value chain. Little evidence exists on the growth performance of rice farms in sub-Saharan Africa.
The number of extant studies has only focused on the technical efficiency of rice farmsusing cross-sectional data,Comparative Analysis of the Contributions of Men and Women to Farming Decisions among Rice Producing Households. (Kumari, and Sandhvi, 2016; Ade, Chukwudi and Lynda 2022; Ali Liu and Ishaq 2017).
This study focus on two major research questions, first, the study assess the trend of rice production from 2010- 2022 in Nigeria. The data were obtained from national Bureau of statistics, World Bank reports and secondly, the study explore the trend of technological difference between Nigeria's North and South rice production. Oseni et al (2015).This study contributes to the growing literature on the regional differentialgap in rice production by testing whether rice farms in Nigeria's North and South regionsadopt the same production technology. This studyemployed an autoregressive moving average and time response graph approach as proposed by Enwa and Ewuzie (2022), which allows the time response graph to show the trend of rice production from 2010 to 2022. To the best of our knowledge,this study is the first to use this approach in rice farms. Earlier production and technological efficiency studies on rice production in Nigeria focused on estimating technical efficiencyby assuming homogenous technology across farms (Yusuf, Adesope and Adebayo (2020).

Little evidence exists on the growth performance of rice farms in Nigeria. The number of extant studies has only focused on the technical efficiency of rice farms using cross-sectional data (Udumezue 2018, Komolafe et al Olasehinde, 2022). These studies have shown that technical efficiency in rice farms was as high as 0.55–0.86, even though rice yields were low. (Ayanlade and Redaney (2020). However, Maritnez, (2021) exposed several flaws in using the Stochastic cross-sectional models.

This study intends to investigate the differences that exist between Kaduna and Anambra states (Northern and sourthern) Nigeria agricultural rice production. Awotide, Karimov and Diagne (2016), reported that the northern region of Nigeria has been the main rice producing area given its climate, improvedtechnology (Machinery)and land abundance, accounting for 70% of the country's rice. Mohammed et al (2019). Farms located in the Southernregion are substantially smaller than those in the North. No study has illustrated how thisdifference affects rice farms in the country, and this study intend to fill this gap in literature.

Fig. 1. Land preparation for rice production (source: Adeosun, Onyibe and Salako. 2005)

Fig.2. A rice farmer hand spraying his rice farm (source: IITA, 2021)

Material and Methods

In this study, we employed annual time series data spanning the period between 2010 to 2022, specifically, statistical data for the analysis has been obtained from the following; National Bureau of statistics, Central Bank of Nigeria annual reports, International Monetary Fund(IMF) world economic outlook.Apurposive random sampling techniquewas also employed to generate primary data for the study. Questionnaires were distributed to fifty (50) rice farmers in Chikun local government area of Kadunaand fifty (50) rice farmers in Ayamelum Local government area of Anambra state (Alabi 2021). The selection was due to the fact that the

LGAs selected are the major rice producing area in the two states,this will help the study to identify the technological gaps between rice farmers in the northern and Southern Nigeria. This will check the output of each region. A lot of researchers adopted this methods for instance, Chandio, Jiang, Rauf, Ahmad, Amin and Shehzad (2021), adopted both time series and primary data to assess formal credit and climate change impact on agricultural production in Pakistan, also Igbokwe-Ibeto (2019) also adopted both primary and secondary data to examined climate change, food security and sustainable human development in Nigeria: A critical reflection.

Model Specifications

T-test Analysis

A t-test is a statistical test that is used to compare the means of two groups. It is often used in hypothesis testing to determine whether a process or treatment has an effect on the population of interest. The t-test will be used to compare profitability of fish farmers in clusters and isolated fish farmers. The formula for the t-test statistic is presented as follows:

$$t = \frac{\overline{X}_1 - \overline{X}_2}{\sqrt{\frac{S_1^2}{N_1} + \frac{S_2^2}{N_2}}} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots$$

Where:

$\overline{X}_1$ = mean of first set of observation

$\overline{X}_2$ = mean of second set of observation

S_1= standard deviation of first set of observation

S_2 = standard deviation of second set of observation

N_1= total number of observation in first set

N_2 = total number of observation in the second set.

Results and Discussions

Table 4.1 Trend of Rice Production from 2010-2022 in Nigeria

YEAR	PRODUCTION IN THOUSAND METRIC TONS
2010	2,818
2011	2,906
2012	3,423
2013	3,038
2014	3,782
2015	3,941
2016	4,536

2017	4,470
2018	5,247
2019	5,249
2020	5,148
2021	5,255
2022	5,355

Source (IMF World Economic Outlook 2022)

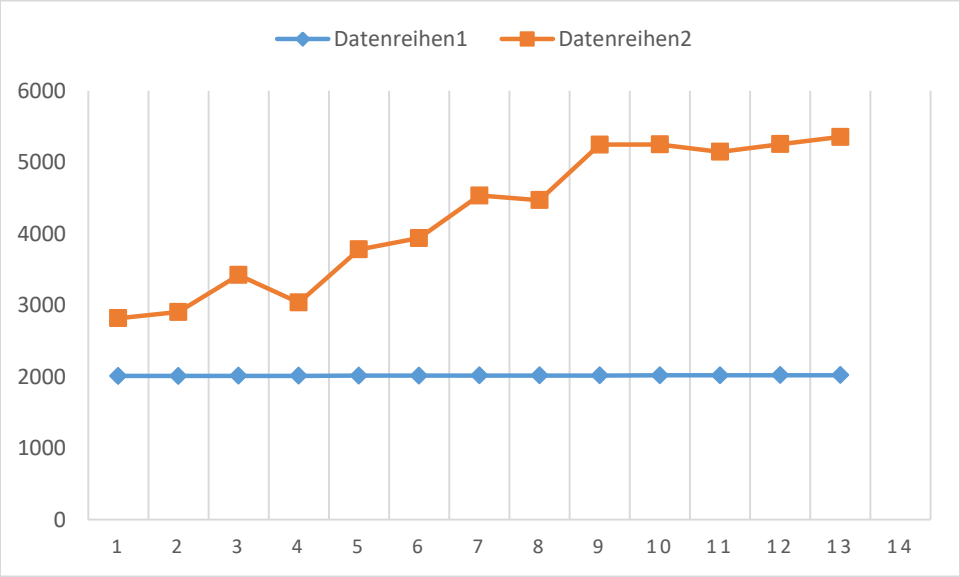

FIG. 1. Trend of rice production in Nigeria from 2010-2022

The table4.1 and figure1 showed a significant and consistent increase in rice production between 2010 and all through 2022. This study also revealed that rice production has been on the increasing trend (upwards)from 2010 and 2011, but during the year 2012 and 2013, rice production in Nigeria experienced a downward trend on rice output as the result of the devastating impact of the 2012 flooding, but rice production immediately sprang up in 2014 and has been on the increase since then. But despite the increase in rice output, the country still depends on import to supplement local production. The result of the study is an indication that with sufficient farm machinery and improved seedlings, Nigeria can be able to achieve sufficiency in rice production so as the meet up with domestic consumption. The result of the study is consistent with the study carried out by Ogunkunle, Olatunji and Taiwo (2022) where he reported that agricultural mechanization has increased the cultivated land, crop yields and farmer's income and also agricultural mechanization had a significant influence on crop production and farmers income. The result of this study is also in consonance with the study conducted by Nwali and Anyalor (2019), the result revealed that farmers who embraced improved technology in cultivating their land are more productive and have more output than those using crude methods of cultivation. Although the study fail to access the impact of rice output in the Kaduna and Anambra states, hence this study.

Table 4.2 Access to Farm Mechanization and Improved Seedlings to Rice Farmers in Kaduna and Anambra States Nigeria.

S/Number	Items	Chikun LGA Kaduna State %	Ayamelum LGA, Anambra State %
1.	Access to tractors and other equipment	38	19
2.	Improved seedlings	10	30
3.	Extension visits	2	1
TOTAL		**50**	**50**

Source (Field Data, 2022)

The result of the table 4.2 indicates that farmers in Chikun Local government of Kaduna state access tractors and other farm implements to a reasonable extent (38%) , the local government area provides farm implements to rural rice farmers at an affordable hiring rate so as to improve rice production in the study area, but in ayamelum Local government of Anambra state, only about 19% of the respondents were able to access farm implements for cultivation and also the high rate (charges) of hiring tractors scared a lot of small scale farmers from using the tractors and other farm implement for cultivation, but rather manual labour are always employed by farmers which also affected output. The study clearly indicates that rice farmers in the Kaduna state have easy access to farm implements than farmers in the Anambra state. The study also revealed that only about 10% of rice farmers in the LGA have access to improved rice seedlings, while a large proportion (30%) of rice farmers in Ayamelum LGA have access to improved seeding which also improve rice output to some extent, it was also observed that extension visits to ricefarmers in both LGAs not encouraging, this study is in agreement with the research conducted by Abdoulaye, Wossen and Awotide (2018), and it was recorded that improved seeds had led to increase productivity/ output, this implies that farmers who adopted improved seedlings experienced a tremendous increase in the yield than the previous years where improved seedlings were not available. The present study was able to check the impact of improved seedling on rice productivity in the study area.A similar study was carried out by Mbarkor, Okezie and ogbumuo, (2013), in Anambra state. The study revealed that farmers who had contacts with extension agents were willing to adopt to new and improved technologies that has helped them to boast their productivity and income.

4.3. Compare the relationship between rice Production in Kaduna and Anambra states

One-Sample Statistics				
	N	Mean	Std. Deviation	Std. Error Mean
Rice Output in Chukun LGA of Kad. state	13	334.3846	168.03796	46.60535
Rice output in Ayamelum LGA of Anambra states	13	299.0769	147.86112	41.00930

Source: Filed Survey (2022)

Table 4.3 revealed the mean output of rice production in Chikun LGA of Kaduna state and Ayamelum LGA of Anambra state. This result of the study showed that the mean output of rice production in Kaduna state is significantly higher**(334.385**) than the mean outputof rice production in Anambra state**(299.077).** The reason for this is because of the easy access to farm machinery and equipments farmers in Chikun LGA of Kaduna state enjoy and access farming equipments with ease , farmers are provided with farming implements and improved seedling at an affordable prices which has to some extend boast rice production in Kaduna state. Although rice farmers in Ayemelum LGA of Anambra state have access to some of the machineries and improve method of cultivation, but the amount charged for hiring some of the equipments are high and as a result, some of the rice farmers could not afford to hire these equipments. In some instances some of the machinery are not readily available for farmers to access, this may result to low output yield. This study is in agreement with the work conducted by Peng, Zhao and Liu (2022), on the impact of agricultural mechanization on agricultural production and income and the result revealed that agricultural mechanization has a significant impact on agricultural output in their study. Although the study did not make any comparism within region but this study made a comparism to know which of the region is highly affected in terms of production. During the study, it was observed that Kaduna state has a fertile soil that supports rice cultivation.

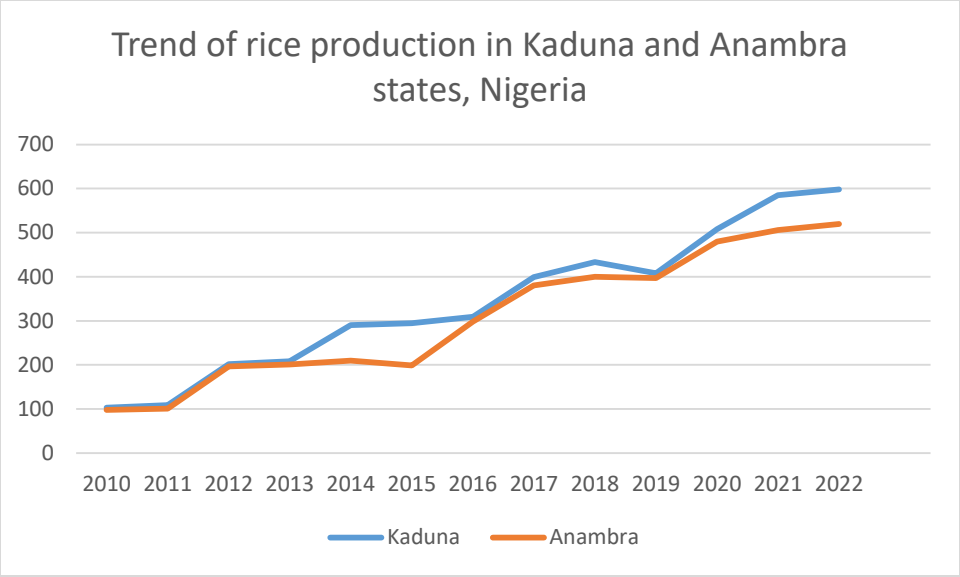

FIG. 2 Trend of Rice production output in Kaduna and Anambra states of Nigeria

The result in figure 2 revealed that output of rice production is relatively higher in chikun LGA of Kaduna state, than what is obtainable in Ayemelum LGA of Anambra state. The result showed an upward and progressive trend of rice output in both Kaduna and Anambra states. But the higher trend is seen in the output of rice farmers in Kaduna state. This is as a result of easy accessibility of farm machineries, such as tractors, planters, harvesters and other improved methods of cultivation and land preparation. Although some of the small scale farmers could not access some of the implements this has been the major challenges affecting rice production in developing countries. Rice production in Anambra state has also experienced an upward trend in the output, but the study observed that rice farmers in Anambra state do not have easy access to farm machinery to some extent. Sometimes the amount charged for a farm implement is outrageously high that farmers cannot afford. This study agrees with the report of a daily trust newspaper (May,2021), which stated that "high cost of hiring tractors is causing concern to farmers in Anambra, Taraba and Kogi states. Findings also revealed that many farmers cannot afford to hire tractors for land preparation and planting. The Guardian news Nigeria (Aug., 2022) as reported by Akinfenwa that farmers have been struggling to cope with the rising cost of inputs logistics and farm machineries, this development has made small scale farmers in Nigeria to scale down their activities.

Conclusion and Recommendations

Rice has become one of the major staple foods in Nigeria, but the local production is probably low due to high cost of hiring farm equipments and lack of easy access to improved seedlings and farm machineries, among other factors. As a result, Nigeria has become the highest rice importer in SSA not until the present administration of President Muhammadu Buhari's policy that has encouraged local rice production to a reasonable extent. In an attempt to reduce importation, self-sufficiency in rice production has become a priority policy. In this study, we focus on the effect of farm mechanization on rice production in Nigeria, comparing the output of rice farmers in Kaduna and Anambra states. Our time response graph showed an upward trend of rice production output in Nigeria, the result as revealed that rice farmers in Kaduna states have easy access to tractors and other farm machineries and also comparatively larger rice farms and household size, while in Anambra used more selected input and improved seedlings they also have access to some of the farm equipments at a high interest rate. The result of the independent t-test showed a relatively higher mean output of rice farmers in Kaduna state than the mean output of rice farmers in Anambra state. Although both region are experiencing low output. Our results suggests that the problems in Kaduna state are

managerially and financially induced while those in Anambra state are more technologically and financially induced.

Recommendations

- This study suggests that there is a need to enhance the area under cultivation, improve the irrigation system, provide timely supply of agricultural credit to farmers at flexible interest rates, change planting dates, apply recommended doses of fertilizers, and diversify crop cultivation. Furthermore, environmental pollution affects rice production
- The study recommends that Extension services targeted at rice farmers should consider improving technologies that will culminate in increased rice production while taking cognizance of the key role of economic incentives.
- Government needs to create an enabling environment that ensures that every rice farmer will be willing to adopt mechanize methods of production.
- In terms of priorities, the government should concentrate on addressing challenges around land tenure and ownership providing rural infrastructure and extension services.

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