



**IMPACT OF FERTILIZER SUBSIDY AND TARIFF POLICIES ON RICE
PRODUCTION AND PRODUCTIVITY IN NIGERIA FROM 1979-2022**

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ABSTRACT

The study was conducted to determine the impact of fertilizer subsidy and tariff policies on rice production and productivity in Nigeria from 1979-2022. The analysis spans three policy eras: the Pre- Growth Enhancement Support Scheme (Pre-GESS) era (1979–2011), the GESS era (2012–2015) and the Post-GESS era (2016–2022). Secondary data used for the study were obtained from FAO, the Federal Ministry of Agriculture and Rural Development and the United Nation’s COMTRADE. Analytical tools used include descriptive statistics, graphical trend analysis, Ordinary Least Squares (OLS) regression, ANOVA and Tukey HSD Post-hoc test to evaluate the contributions of fertilizer distribution and rice tariffs to rice production and productivity. The result reveal significant fluctuations in fertilizer distribution, with the lowest distribution of 371.062 metric tons in 2009 and the highest of 1,850.31 metric tons in 2021. These variations were influenced by policy shifts and changes in subsidy systems. Rice productivity remained low, averaging 2.0–2.5 tons per hectare, far below the global average of 7.5 tons per hectare, due to inadequate fertilizer use. The OLS regression indicated that 96% of the variation in rice production was explained by the model, with the Post-GESS era contributing the most (mean = 9,321,404.16 tons), followed by the GESS era (mean = 6,015,180.00 tons) to rice production. Key predictors, such as rice area harvested and Post-GESS fertilizer distribution, were significant at 1%, while rice import tariffs and GESS fertilizer distribution were significant at 5%. In conclusion, while fertilizer distribution has a significant positive contribution to both rice production and productivity in GESS and Post-GESS periods, significant impact to productivity only took place in Post-GESS period. The study recommended that the government should play effective regulatory role while allowing the private sector handles procurement and distribution of fertilizer; properly regulate cross-border rice trade and deploy surveillance technologies to properly man the borders.

Keywords: Fertilizer; Policies; Rice, Production and Productivity

INTRODUCTION

The United Nation’s 2019 State of Food Security and Nutrition in the World, compiled by Food and Agriculture Organization bemoaned the rise of hunger in almost all African sub-regions, making the continent the region with the highest prevalence of undernourishment, at nearly twenty percent (FAO, 2019). While agricultural production and productivity soared in Asia and Latin America during the last four decades (40 years), they have largely stagnated in Africa, resulting in a rising dependency on imported grains and an increase in the number of undernourished people (Uduji *et al.*, 2019).

Nigerian governments established different programmes and policies to boost production and productivity in the agricultural sector. However, according to Amuritiya *et al.* (2018), these multifarious past national agricultural development policies/programmes have failed to improve the standard of living of millions Nigerian people and economic development of the country. They have also failed to advance productivity significantly. According to Ayinde and Adewunmi (2017), Low fertilizer use is a major factor in explaining the stagnant agricultural productivity in Nigeria.



The Federal Government kept changing fertilizer policies in order to try to answer problems of availability, leakage and arbitrage, but none of these policies succeeded. According to Nwafor (2018), an important resolution of the 2006 Africa Fertilizer Summit was the Abuja Declaration on Fertilizer for African Green Revolution, in which AU member states set out to increase fertilizer consumption to an average of 50 kg/ha by 2015, applying smart subsidy programmes. Consequently, Gross Enhancement Support Scheme (GESS) and Presidential Fertilizer Initiative (PFI) were introduced in 2012 and 2016, respectively.

Rice is one of the most consumed staples in Nigeria, with consumption per capita of 32kg. In the past decade, consumption increased by 4.7%, almost four times the global consumption growth, and reached 6.4 million tonnes in 2017, accounting for 20% of Africa's consumption. Nigeria's rice production rose from 3.7 million metric tons in 2017 to 4.0 million metric tons in 2018. In spite of this, only 57 percent of the 6.7 million metric tons of rice consumed in Nigeria by 2018 is locally produced leading to a deficit of about 3 million metric tons, which is either imported or smuggled into the country illegally (Ugwuja and Chukwukere, 2021). To stimulate local production, the Government banned importation of rice across land borders in 2019. Governments have also deployed policies to bridge the demand-supply gap since independence. These interventions included the Presidential Initiative on Rice in 2007, National Rice Development Strategy I in 2010 and II in 2020 and development programmes such as the Agricultural Transformation Agenda in 2011. Therefore, government has deployed both fertilizer and trade policies to increase production and productivity of rice in Nigeria. United States Department of Agriculture (USDA) (2019) reported that rice yields have remained at an average of 2 tons per hectare, which is about half of the average achieved in Asia. In addition, as population increases, along with rural to urban migration, ensuring food security in key staples becomes critical. Low fertilizer use intensity has been cited as one of the main factors limiting rice productivity growth in Sub-Saharan Africa (SSA).

This frequent interruption of fertilizer policy and trade policies, especially after a change in government calls for an in-depth research to guide policy formulation and implementation in order to keep food production in step with population growth, to promote farmers' fertilizer utilization, their productivity, income and food security. The main objective of this study was to determine the impact of fertilizer subsidy and tariff policies on and rice production and productivity in Nigeria from 1979-2022. The specific objectives of the study were to:

- i. describe the trend of rice production, rice importation and fertilizer distribution (1979-2022);
- ii. determine the contribution of fertilizer distribution in three fertilizer policy eras (pre-GESS, GESS and post-GESS) to rice production and productivity;
- iii. make policy recommendations based on the findings.

MATERIALS AND METHODS

The Study Area

The Study area is Nigeria, West Africa. The country is geographically situated between the Sahel to the north and the Gulf of Guinea to the south in the Atlantic Ocean. Nigeria borders Niger in the north, Chad in the northeast, Cameroon in the east, and Benin in the west. Nigeria is a federal republic comprising 36 states and the Federal Capital Territory, where the capital, Abuja, is located (Lake Chad Basin Commission, 2022). Nigeria is situated between 4 degrees and 14 in northern latitudes, and between 14 and 3 degrees of the eastern longitudes. (Oguntunde *et al.*, 2011).



Study period: This study examines the policy period from 1979 to 2022, dividing the period into three policy periods in relation to the Gross Enhancement Support Scheme. The first policy period was from 1979 to 2011, called pre-GESS policy period in the study. The second period was from 2012 to 2015, described as GESS policy period and the third period was from 2016 to 2022, characterized in the study as post-GESS policy period.

Study data: The data for this study were obtained from secondary sources. Data on rice production and productivity were obtained from FAO and United Nation’s COMTRADE, fertilizer distribution, rice area harvested, percentage rice tariff were sourced from Dorosh and Malek (2016) and Federal Ministry of Agriculture and Rural Development and FAO.

Data analysis:

Descriptive statistics that include mean, standard deviation, skewness, and graph presentation were used to describe the trend of fertilizer distribution, rice importation and rice productivity. OLS regression was used to determine the contribution of fertilizer policy era (Pre-GESS, GESS and Post-GESS policy era) to Nigeria’s local rice production and productivity. Policy eras were represented by the fertilizer distribution in the respective years the distribution fell into.

Following the procedure of (Ayide *et al.*, 2009; Iganiga and Unemhilian 2011; Abula and Mohammed 2013), a model was implicitly specified for rice production as in Equation (6):

$$Y = f(X_1, X_2, X_3, X_4, X_5, X_7) \tag{1}$$

The explicit forms of the OLS regression model is as specified in Equation:

$$Y = \beta_0 + \beta_1X_1 + \beta_2X_2 + \beta_3X_3 + \beta_4X_4 + \beta_5X_5 + \beta_6X_6 + \beta_7X_7 + \dots + e_i \tag{2}$$

Where;

Y = Rice production in ton

X₁ = Rice Area Harvested (Ha)

X₂ = Average rainfall (mm)

X₃ = Average price of fertilizer (N)

X₄ = Pre-GESS fertilizer distribution (ton)

X₅ = GESS fertilizer distribution (ton)

X₆ = Post-GESS fertilizer distribution (ton)

X₇ = Rice import tariff (%)

β₀ = constant

β₁... β₇ = coefficients of the independent variables

X₁...X₇ = independent variables

e_i = error term

Similarly, for rice productivity, the model is implicitly specified as follows:

$$Y = f(X_1, X_2, X_3, X_4, X_5, X_7) \tag{8}$$

The explicit forms of the OLS regression model is as specified in Equation (9):

$$Y = \beta_0 + \beta_1X_1 + \beta_2X_2 + \beta_3X_3 + \beta_4X_4 + \beta_5X_5 + \beta_6X_6 + \beta_7X_7 + U_i \tag{9}$$

Where;

Y = Rice productivity (ton/ha)

X₁ = Rice Area Harvested (Ha)

X₂ = Rainfall (mm)

X₃ = Price of fertilizer (N)

X₄ = Pre-GESS fertilizer distribution (ton)

X_5 = GESS fertilizer distribution (ton)

X_6 = Post-GESS fertilizer distribution (ton)

X_7 = Rice import tariff (%)

β_0 = constant

$\beta_1 \dots \beta_7$ = coefficients of the independent variables

$X_1 \dots X_7$ = independent variables

U_i = error term

RESULTS AND DISCUSSION

Trend of rice production, rice importation and fertilizer distribution in Nigeria

Figure 1 shows the trend of Nigeria’s rice production, rice importation and quantity of fertilizer distributed in the period 1979 to 2022. As shown in the figure, there was a gradual and consistent increase in Nigeria’s rice production in the period under review. However, fluctuations occasioned by policy changes and natural factors are still clearly noticeable. 1979 to 1989 with an exception of 1986 was a decade of consistent increase in rice production. Thereafter, a slight downward trend was recorded in 1990 and 1994 before a gradual rise upward was recorded again. In line with the trend, the lowest (minimum) rice production output of 750,000 metric tons was recorded in the year 1979, while the highest (maximum) rice production output of 10.89 million metric tons was recorded in the year 2017, highlighting a gradual and consistent upward trend in rice output in the period under review.

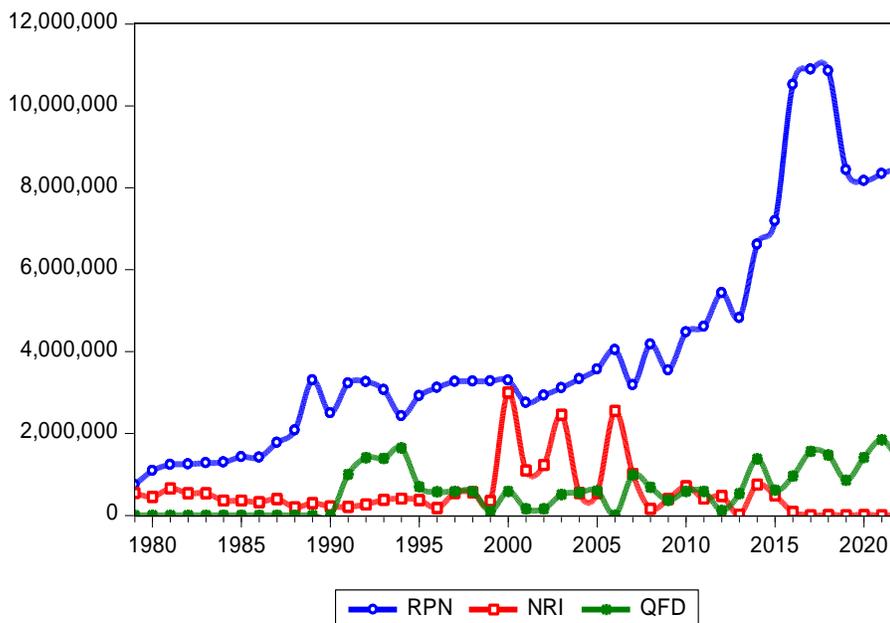


Figure 1 Trend of rice production, Nigeria rice importation and fertilizer distributed.

Source: Source: Computed from 1979 – 2022 time series data

When fertilizer distribution rose from 388 tons in 1979 to 1,044 tons in 1981, rice production rose from 750, 000 tons to 1,241,000 tons. However, even as fertilizer distribution reduced to 763 tons in 1984, rice production increased to 1,300,000 tons in that year. Fertilizer distribution briefly increased to 1,163 tons in 1985 only to decline to 912 tons in 1989, while the



trajectory of rice production took a different path, increasing from 1,300 tons in 1984 to 3.3 million tons in 1989, showing that increased rice production in Nigeria is not necessarily dependent on increased fertilizer distribution in the country in this periods. During this period, the procurement and distribution of fertilizer was centralized by the Federal Government of Nigeria through the Federal Procurement and Distribution Division, which procured imported fertilizer from the port and from the Federal Superphosphate Fertilizer Company Ltd in Kaduna (FSFC). The percentage subsidy in 1979 was 75% but remain 50% from 1980 to 1984 and moved down to 38% in 1985 when 1,163,000 MT of fertilizer was distributed.

In 1991, fertilizer distribution reached the 1 million ton mark as rice production surpassed 3 million tons in that year, and maintain the 3 million point until 1994 when it declined to 2.7 million tons, the year fertilizer distribution increased to 1.4 million tons before coming down to 577,930 tons in 1996. When, between 1995 and 1996, the federal government left fertilizer importation to the private sector, fertilizer distribution dropped to 557,930 MT. In 1997 and 1998 subsidy was removed altogether, and no fertilizer distribution was recorded while rice production was 3.26 million in 1996 and 3.27 million in 1998.

When the Federal Government discontinued fertilizer subsidy and distribution programmes in 1997, adopting a complete privatization/liberalization of the fertilizer sector, fertilizer used dropped to 3kg/ha from 5.6kg/ha in the previous year. The Federal Government reintroduced fertilizer subsidy in 1999, establishing Federal Market Stabilization Program (FMSP) and fertilizer used increased to 6kg/ha. In 2001, 164,000 tons of fertilizer was distributed, and in 2002, 163,700 tones was procured for distribution and subsidized at 25%. Fertilizer distribution continued to fluctuate as the Federal Government continued to implement FMSP until 2009 when Targeted Fertilizer Subsidy Voucher Programme was introduced in some states, in preparation for the Federal Government stated intention to withdraw from fertilizer procurement by 2012 to support the development of private sector agro-dealer networks, marking the end of the Pre-GESS era.

From 2012 to 2016, upward and downward trend in the fertilizer distribution was recorded. This period marked private sector handling of the procurement and distribution of the fertilizer in Nigeria with the fertilizer programme termed Growth Enhancement Support Scheme (GESS). The scheme aimed to modify government intervention roles of direct procurement and distribution of fertilizer to a catalytic regulator for private sector participation in the value chain. In 2012, only 120,097 MT of fertilizer was distributed, but this moved up to 536,095 MT in 2013, and 1,381,818 MT in 2014, however, the figure moved down to 617,857 MT in 2015. In the same period, rice production witnessed appreciable increase, reaching 5.43 million metric ton in 2012, and moving to 7.1 million metric tons in 2015.

Finally, the period from 2016 to 2022, the post-GESS era, also recorded a gradual upward and downward trend, but the highest fertilizer distribution was recorded during this period. This era coincides with the Presidential Fertilizer Initiative (PFI) which aims to revive local blending of NPK Fertilizer in Nigeria by creating the enabling environment for the private sector to invest in local production.

In the post-GESS era, 0.9 million MT of fertilizer was distributed in 2016; 1.5 million MT in 2017; 1.4 million MT in 2018; 0.8 million MT in 2019, and over 1.4 million MT in 2020. In 2021 and 2022, 1.8 million MT and 1.2 million MTs were distributed, respectively. This period also witnessed a rapid increase in rice production reaching 10.88 million metric tons in 2017 before declining to 8.4 million in 2022. According to Balana and Fasoranti (2022), the PFI abolished the subsidy scheme, which cost the public at least ₦60 billion annually and encouraged private sector



investment, revitalizing almost 52 local fertilizer blending plants from the initial four plants at project inception.

Trade policies played considerable roles in the fluctuations of rice production in Nigeria over the years. Obi-egbedi *et al.* (2013) found trade policies characterizing Nigeria's rice economy into four policy periods; pre-ban, import quota, ban, and post-ban periods. In some cases, a single year witnessed two different trade policies. For example, 1979 witnessed both the banning and unbanning of rice import into Nigeria. According to Obi-Egbedi *et al.* (2021), the government banned rice import into the country in October 1978 till September 1979, after which the ban was reversed to issuance of general import licenses without quantitative restrictions in 1980. Nigeria maintained a 20% rice import tariff from 1980 to 1984 and the country's rice import rose from 450,000 tons in 1980 to 657,000 tons in 1981, but dropped to 365,000 tons by 1984. This was the period Obi-egbedi *et al.* (2013) described as the import quota period when the global oil crises generated mounting debt servicing challenges forcing government to try and curb the influx of rice imports into the country. Rice production, on the other hand in this period, increased from 750,000 tons to 1,300,000 tons. During the outright ban period (1985-1995), no tariff was charged as importation was banned, and production rose from 1.43 million tons in 1985 to 2.92 million tons in 1995, however, the United Nation's COMTRADE (2022) still reported import into Nigeria for these years as 320,000 was reported to be imported into the country in 1985 while 374,000 tons was imported in 1995. Moreover, Ugwuja and Chukwukere (2021), reported that during this period, illegal rice importation continually thrived due to the country's porous border thereby limiting the gains of the protectionist policies.

Although the period from 2016 to 2022 also recorded an upward and downward trend, it remains the period with the highest output in rice production. Building on the Agricultural Transformation Agenda of President Jonathan's government, President Buhari's Government put forward the Agricultural Promotion Policy, which among others had an objective of facilitating the government's capacity to meet its obligations to Nigerians on food security, food safety and quality nutrition. The Government also introduced Anchor Borrowers' Scheme as the Agricultural Transformation Agenda Support Program Phase 1 (ATASP-1), which had ensuring food and nutrition security as an objective, became operational in 2016. From the graph, when production peaked in 2017, importation had been banned, although COMTRADE of the United Nations (2022) reported that import of 4,144.57 ton of rice into Nigeria was recorded. The graphical results here contradict the findings of Igberi and Amadi (2017) who found that restricting rice importation had an insignificant effect on domestic rice production. The graphical result above agreed with positive effect of import restriction on domestic production reported by Salik and Aras (2020) who also found a positive but insignificant effect of trade restriction on domestic rice production. Rice production fell from 10.8 million metric tons in 2018 to 8.5 million metric tons in 2022.

Impact of Fertilizer Distribution and Rice Import Tariffs on Rice Production and Productivity

Table 1 revealed the results of Ordinary Least Square (OLS) regression analysis estimates of the effects of fertilizer distribution (Pre-GESS, GESS and Post-GESS) eras and rice tariff on rice production and productivity over the years under review. The OLS regression results revealed coefficient of determination (R^2) value of 0.9554 for rice production and 0.5665 for rice productivity. This implies that about 96% variation in the output of the rice production was explained by the predictor variables in the model while 56% variation in the productivity was explained by the variables in the model. The F-statistic value of 101.0013 and 6.1602 for rice



production and productivity, respectively, which were both significant at 1% level of probability, imply a good fit of the model. Moreover, based on the t-value from the regression estimates, four out of the seven predictor variables specified in the model were significant for rice production, while three variables were significant for productivity. For rice production, rice area cultivated (RAC; 7.14) and post-GESS fertilizer distributed (Post-GESS; 3.32) were significant at 1% level of probability. Percentage Rice import tariff (PRT; -2.18) and GESS fertilizer distribution were significant at 5% level of probability. For rice productivity, only post-GESS fertilizer distribution (Post-GESS; 3.33) was significant at 1% level of probability, while rice import tariffs (PRT; -2.20) and fertilizer distribution (GESS FD; 2.47) were significant at 5% level of probability.

The coefficient of RAC (0.6091) was positive and significant at $P < 0.01$ probability level implying that a unit increase in the area cultivated for rice while holding other factors constant had led to approximately 61% increase in the output of rice production. However, increasing rice area harvested did not add to rice productivity. This conforms to *a priori* expectation because increasing area under cultivation increase output realized from rice production over the period under review. This finding is in agreement with the study of Ikuemonisan *et al.* (2023) who reported that the expansion of cultivated area has been the primary driver of significant growth in rice production in Nigeria, accounting for about 58% of the increase in rice production.

From the Table 1, the Pre-GESS fertilizer distribution was ineffective for both production and productivity, while in the GESS policy period, contribution of fertilizer distribution to both production and productivity were significant at $P < 0.05$ probability level. Besides the ineffectiveness of fertilizer distribution in the pre-GESS policy period, in 2011, a year before the advent of GESS, the FGN spent ₦30 billion (US\$180 million) to reach only 800,000 smallholder farmers with inputs compared to 5 billion (US\$30 million) spent in 2012 at introduction of GESS to reach 1.2 million smallholder farmers in 2012 (Grossman and Tarazi, 2014; Uduji and Okolo-Obasi, 2018). The coefficient of Post-GESS (0.0002) was positive and significant at $P < 0.01$ probability level for both production and productivity, implying that fertilizer distribution post-GESS had a very strong effect on rice production and productivity, confirming improvement in policy effectiveness. According to World Bank (2018), Distribution of affordable, locally produced NPK fertilizer under the PFI increased Nigeria's consumption of fertilizer from 9kg/ha from 2010 to 2015 to 19.7 kg/ha at the end of 2018. AfDB funded ATASP-1 and IFAD VCDP were two of the prominent interventions targeting increased rice production and productivity in the policy periods of ATA and APP thereby cutting across GESS and Post-GESS policy periods.

The coefficient of percentage rice import tariff- PRT (-0.1236) was negative and significant at $P < 0.05$ probability level implying that a unit increase in the percentage import tariff on rice while holding other factors constant had led to about 12% decrease in the output of rice production. This means that rice smuggling replaced formal importation with increase in rice import tariffs since increased tariff leads to reduction in formal importation. Therefore, to fully realize the benefits of tariffs, they must be properly implemented and borders properly manned using technologies like drones. In the similar vein, as production is discouraged by increased smuggling, productivity will decline, hence a unit increase in tariff would lead to 12% decrease in productivity of farmers. This agrees with the findings of Obi-Egbedi *et al.* (2021) who found that high consumption led to high tariff imposition which gives farmers no motivation to increase productivity. However, this finding contradict Ogunlesi *et al.* (2018), which found a positive relationship between policy and agricultural productivity.

Table 1: Effects of Fertilizer Policy Eras on Rice Production and Productivity (Pre-GESS, GESS and Post-GESS)

Variables	Rice production		Rice productivity	
	Coefficient	t-value	Coefficient	t-value
Rice Import tariffs (%)	-0.1236	-2.18**	-0.1241	-2.20**
Rice Area Harvested (Ha)	0.6091	7.14***	0.0698	0.47
Average Rainfall (mm)	-0.1375	-0.83	-0.1379	-0.84
Ave price farmers paid for fertilizer (₦/50kg)	-0.0233	-0.83	-0.0232	-0.83
Pre-GESS Fertilizer Distribution (MT)	-0.0008	-1.43	-0.0008	-1.42
GESS-period Fertilizer Distribution (MT)	0.0002	2.45**	0.0002	2.47**
Post-GESS Fertilizer Distribution (MT)	0.0002	3.32***	0.0002	3.33***
Constant	1.1915	0.60	1.1859	0.60
Diagnostic statistics				
R-squared	0.9554		0.5665	
F-statistics	101.0013***		6.1602***	

Notes: **, *** denotes 5% and 1% level of statistical significance respectively

Test of Hypotheses

Table 2 shows the result of the test of hypothesis to determine whether there is statistical evidence that the association population means for rice production and productivity during different fertilizer policy era are statistically significant. The independent variable which indicates the various fertilizer policy era include the PRE-GESS, GESS and the POST-GESS era. The assumption of normality was evaluated using the Shapiro Wilk test and found tenable for all groups, $P > 0.05$.

The assumption of homogeneity of variances was tested and found tenable using lavene's test, $F(2, 41) = 1.025$, $P = 0.368$ for rice production and $F(2,41) = 0.512$, $P = 0.603$ for rice productivity. The one way ANOVA result reveals that there was a statistical significant differences in the mean of rice production ($F(2,41) = [115.113]$, $P = 0.001$) and also in the mean of rice productivity ($F(2,41) = [6.650]$, $P = 0.003$). In this case, there is significant evidence to reject the null hypothesis (H_0) that there is no significant differences in rice production and productivity during the PRE-GESS, GESS and POST-GESS fertilizer policy era. These differences is also reflected in their mean as the result of the descriptive statistics shows that the POST-GESS fertilizer policy era has the highest level of average rice production (9387708) and rice productivity level (2.20957). This was trail by the GESS fertilizer policy era which rank next with an average rice production and productivity of 6015180 tons and 1.99800 tons respectively, while the Pre-GESS era came last with rice production mean of 2736203 and productivity mean of 1.76912.

Onyekwena *et al.* (2018) observed that before the introduction of GESS the subsidy system in place was characterized by large-scale corruption and inefficiencies, with a large proportion of these inputs not reaching the farmers as a result of the high level of corruption, insincerity and political interruption in the distribution channels. In addition, Grow Africa (2016), noted that problems of fertilizer quality, arbitrage, and timeliness of fertilizer distribution persisted throughout the period.

The high level of rice production and productivity in the GESS and POST-GESS fertilizer policy era can be largely associated with the reform in the fertilizer subsector of the Nigerian agricultural sector, given that the regression results returned a negative contribution of tariff, which represented trade policy, but returned a positive contribution of fertilizer distributed in the GESS and Post-GESS fertilizer policy era. These reforms cutting across the GESS and Post-GESS

periods involved gradual evolution first from universal subsidy in the Pre-GESS period to smart subsidies in GESS period and no subsidy during Presidential Fertilizer Initiative. Onyekwena *et al.* (2018) found that at the commencement of the GESS programme in 2012, the local production of Nitrogen N fertilizer increased by 158.1%, importation of same rose by 22.0%; local production of phosphate P₂O₅ rose by 11.1%, importation by 53.8%; while there was insignificant local production of potash K₂O, but a 70.4% rise in its importation. In response to the scheme, the use of fertilizer expanded.

For the Post-GESS period, Balana and Fasoranti (2022) reported that the Agricultural Promotion Policy (APP) adopted the private sector-led approach through the Presidential Fertilizer Initiative (PFI), effectively abolishing the input subsidy and focusing on blending NPK fertilizer locally, enabling the government to deliver to farmers at a friendly price, thereby improving food production and increasing rural income. These policies aimed to boost local production, improve farmer incomes, and reduce reliance on food imports.

Table 2: Descriptive Statistics, Test of Homogeneity of Variance and One Way ANOVA Significant Level

Descriptive Statistics								
Fertilizer Policy Era	Rice Production			Rice Productivity				
	Mean	Standard Dev		Mean	Standard Dev.			
PRE-GESS	2736203	1044975		1.76912	0.294279			
GESS	6015180	1079341		1.99800	0.288291			
POST-GESS	9387708	1288398		2.20957	0.339495			
Tests of Homogeneity of Variances								
Base on Mean	Levene Stat.	Rice Production			Leven Stat.	Rice Productivity		
		df ₁	df ₂	P-value		df ₁	df ₂	P-value
	1.024	2	41	0.368	0.512	2	41	0.603
ANOVA								
Group	Df	Rice Production		Rice Productivity				
Within Group	2	F-value	P-value	Df	F-value	P-value		
Between Group	41	115.113	0.001	41	6.650	0.003		
Total	43			43				

The post-hoc comparison test of the ANOVA model

Table 3 presented the result of the Tukey HSD post hoc test. Since the ANOVA result shows a significant differences in the mean of rice production and productivity and the P-value of lavene’s test is greater than 5% in the various fertilizer policy era, it is necessarily to conduct a post hoc test of multiple comparison to determine where the differences lies in each case. The post hoc multiple comparison test to evaluate pairwise differences among group means was conducted with the use of Tukey HSD test since equal variances were tenable.

The result reveals a significant pairwise differences between the mean of rice production during the PRE-GESS and GESS fertilizer policy eras (P = 0.001, 95% C.I = [-4677715, -1880238]) and also with that of the POST-GESS fertilizer policy era (P = 0.001, 95% C.I = [-7750882, -5552127]) with probability values less than 5% in each case.

The differences in their pairwise means in terms of rice production during the various fertilizer policy eras can be associated with the emerging results of the fertilizer subsector reforms reported by Grow Africa (2016) and Balana and Fasoratin (2022). The result of the Tukey post



hoc test of multiple comparison in terms of rice farmers productivity level indicates that there is no statistical significant pairwise differences in the mean of rice productivity during the PRE-GESS fertilizer policy era with that of the GESS era as their P-value is greater than 5% (P = 0.332), However there was a significant differences in the pairwise mean of the PRE-GESS fertilizer policy era with that of the POST GESS era where P = 003 and less than the 5% significant level. A pairwise comparison of the GESS fertilizer policy era with the other era indicates no statistically significant differences in rice productivity between the era and that of the PRE-GESS and POST-GESS era. This insignificant difference for rice productivity, which was significant for rice production between the GESS era and other two eras may be attributed to the success recorded with policy reform in GESS and Post-GESS eras that ensure better access to fertilizer by farmers, but it could also be attributed to a more favourable macroeconomic policies operating in these two eras.

Further result of the multiple tests of comparison for rice productivity reveals a pairwise differences between the POST-GESS and the PRE-GESS fertilizer policy era but do not indicate any statistical significant differences between the POST-GESS and the GESS fertilizer policy era. The result of the POST-GESS fertilizer policy era and the GESS era which does not show any differences in terms of the productivity of rice farmers may be associated to the fact that the fertilizer policy reforms were ongoing in the two eras as GESS era had a 50% fertilizer subsidy in place with the private sector in charge of distribution while the Post-GESS era had no subsidy but the private sector playing a more dominant role.

Table 3: Shows the Post Hoc Test of Multiple Comparison

Fertilizer Policy Era	Pairs	Rice Production			Rice Productivity		
		Lower B.	Upper B.	P-value	Lower B.	Upper B.	P-value
PRE-GESS	GESS	-4677715	-1880238	0.001	-0.61625	0.15850	0.332
	POST GESS	-7750882	-5552127	0.001	-0.74492	-0.13598	0.003
GESS	PRE-GESS	1880238	4677715	0.001	-0.15850	0.61625	0.332
	POST-GESS	-5028450	-1716605	0.001	-0.67017	0.24703	0.506
POST-GESS	PRE-GESS	5552127	7750882	0.001	0.13598	0.74492	0.003
	GESS	1716605	5028450	0.001	-0.24703	0.67017	0.506

CONCLUSION AND RECOMMENDATIONS

The study found that the Pre-GESS fertilizer distribution was ineffective for both production and productivity of rice, while in both the GESS and post-GESS policy period, fertilizer distribution contributed significantly to both rice production and productivity. The rice import tariff negatively contributed to production indicating that smuggling replaced formal importation when rice import tariffs moved up. The ANOVA results showed that post-GESS rice production is significantly higher than both the GESS and Pre-GESS policy eras rice production, while the GESS era is also significantly higher than the Pre-GESS era. On the other hand, while Post-GESS rice productivity is significantly higher than both the GESS and pre-GESS, it is only numerically higher than the GESS productivity.

The study recommends that government should play effective regulatory roles while allowing private sector players to handle fertilizer procurement and distribution; properly regulate cross-border trade in rice; and deploy surveillance technologies to secure Nigeria’s borders to prevent rice smuggling. As area expansion only increases production and not productivity, government should role out policies that focus on mechanization, rice irrigation, improved seed varieties and production technologies that will bring about higher productivity.



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