ANALYSIS OF NITROGEN FERTILIZER CONSUMPTION IN WEST AFRICA

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ABSTRACT: This study employed the fixed and random panel effects to formulate panel regression models for Nitrogen Fertilizer consumption in Nigeria and other 15 selected Economic Community of West African countries. Four (4) World Development Indicators (WDI) variables (quantity of Nitrogen fertilizer consumed, Imported, Exported and Produced)(2000-2014) were used for the study. The result of the analysis shows that there was variation in fertilizer consumed with Nigeria consumed, imported and produced highest volume of Nitrogen fertilizer under the period, while Guinea Bissau consumed least and produced least volume. The fixed effect regression shows that the coefficients of Nitrogen fertilizer imported, exported and produced found to be statistically significant at % (p>0.01) respectively. While the coefficient of Nitrogen fertilizer produced was negative, indication of low production in the region. The study recommended that government should prioritize local production of fertilizer by creating enabling environment to the few fertilizer plants so as to encourage local production.

Keywords: Fertilizer, Consumption, Importation and Production, West Africa.

1. INTRODUCTION

Fertilizer is part of the technological trinity (improved seed, irrigation and fertilizer) which created the Green Revolution in Latin America and Asia, its adequate and efficient use is one of the main components in achieving food security [1]. Fertilizer consumption measures the quantity of plant nutrients, and is calculated as production plus imports minus exports. Fertilizer consumption as a share of production shows the agriculture sector's vulnerability to import and energy price fluctuation [2]. Most fertilizers that are commonly used in agriculture contain the three basic plant nutrients - nitrogen, phosphorus, and potassium, while some contain certain "micronutrients," such as zinc and other metals that are necessary for plant growth. Some chemical compounds used for fertilizers have other industrial applications the consumption data may overstate the quantity available for crops. Fertilizers and soil amendments are largely derived from raw material, composts and other organic matter, and wastes, such as sewage sludge and certain industrial wastes. FAO defines arable land as land under temporary crops (double-cropped areas are counted once), temporary meadows for mowing or for pasture, land under market or kitchen gardens, and land temporarily fallow; land abandoned as a result of shifting cultivation is excluded.

Insufficient use of fertilizer has hindered growth in agricultural productivity and to some extent threatened the quality of soil and its continued fertility in a number of Sub-Saharan African countries. In Nigeria, there has been considerably evolution in Agricultural sector since the country gain her independence. The government adopted an agricultural policy in 1998 after a long period of hiatus in policies that had objectives of ensuring food security for the population by developing local production, unable to proffer solution to the enervating food security and fertilizer usage among rural farmers in Nigeria. Fertilizer consumption (kilograms per hectare of arable land) in Nigeria was 10.88 as of 2014. Its highest value over the past 12 years was 16.18 in 2013, while its lowest value was 4.21 in 2007. Fertilizer consumption measures the quantity of plant nutrients used per unit of arable land. Fertilizer products cover nitrogenous, potash, and phosphate fertilizers (including ground rock phosphate) [3]. The Food and Agricultural Organization, (FAO) adopted the concept of a calendar year (January to December) for the purpose of data dissemination. Some countries compile fertilizer data on a calendar year basis, while others are on a split-year basis. The introduction of new crop cultivars starting in the 1960s, that showed good response to fertilizer applications lead to increasing in global use of nitrogen fertilizer and phosphorus particularly in Europe and North America. The share of fertilizer consumption in the developing world increased from 20% in the 1970s to 43% in the 1990s.
NPK fertilizer consumption reached 178 million tonnes in 2010 and is expected to increase up to 231 and 263 million tonnes by the years 2030 and 2050 respectively [4], unless there is a substantial increase in fertilizer efficiency. Nevertheless, only 30–50% of applied nitrogen fertilizer [5, 6] and approximately 45% of phosphorus fertilizer is taken up by crops, and significant amounts of the applied nitrogen and phosphorus remain in the soil after the harvest of crops, although this varies depending on the fertilizer practice that is followed, crop species, rainfall, and irrigation management. Such non-point nutrient losses pollute soil resources, harm off-site ecosystems, water quality and aquatic ecosystems, and contribute to changes in atmospheric composition by increasing greenhouse gas emissions. Despite, Nigeria being the largest market for fertilizer in west Africa sub-region, 45percent, representing total consumption (in nutrients base), followed by Burkina Faso, Cote d'Ivoire, Ghana and Mali for 2005-2009 year, yet the average nutrient fertilizer consumption was estimated at around 2.0 kg/ha in 2009 [7, 8], which is below the regional average of 4.0 kg/ha and compared to other developing regions of the world. The bulk of fertilizers consumed in this region are still imported despite the strength of its market and demand in the country especially Nigeria. Farmers pay exorbitant price for fertilizer and accessibility of the fertilizer is another herculean task for the rural farmers. The high price paid for fertilizer might have due to the upward price fluctuation in the international market, resulting from the oil and food crises [8-10].

In Nigeria, fertilizer importation declined drastically between 1993 and 1997 following the disengagement of the FGN from fertilizer production and importation, in response to the market liberalization policy and the elimination of subsidies [11]. This disengagement caused problems with the supply of fertilizer since the private sector was not prepared to take over the responsibility of importations and distributions. In retrospect with Nigeria, during the 1997/98 farming season, the fertilizer market suffered shortages resulting in low agricultural production. These low fertilizer importations and consumption levels lasted until 1999, when consumption started increasing again, at least temporarily. Also, between 1990-2009 period, the average quantity of fertilizer imported and consumed was about 252,000 nutrients metric tons per year (MT) with a high and low that wavered between 69,000 MT in 2004 and about 498,000 MT in 2008 [8, 9]. After a period of continuous private sector investments to fill the void left by the government, the FGN reintroduced subsidies in late 1990s at a 25-percent level and resumed production and importation. Since then, there has been a slow but erratic upward trend in fertilizer importation and use in Nigeria, attributed to the effect of the FGN stabilization policy on farmers’ fertilizer demands. This policy had the unexpected effect of constraining farmers’ specific demands to relatively small quantities, according to the amounts of fertilizer subsidized and supplied by the government. This is in opposition to relying on the capacity of the private sector to supply larger quantities, according to farmers’ actual needs. In view of this, there is urgent need to increase the quantity of fertilizer consumed both on nutrient based and quantity based. This paper will look at the effect of nitrogen fertilizer on the quantity exported, imported and quantity produced, bearing in mind the gap in fertilizer produced in sub-Saharan Africa countries. The rest of the paper is organize as follows; the next section reviews some fertilizer polices in Nigeria follow by methodology and result of data analysis and lastly the result, summary of major findings and recommendations from the study.

2. FERTILIZER USE REVIEW IN NIGERIA

A retrospectical review of fertilizer policies in Nigeria showed inconsistent and unguided policies in the agricultural sector in general. Many policies have been formulated right from the pre-structural adjustment period (1970-1985), the Structural Adjustment Period (SAP) in 1986 and the post structural adjustment period. Up till 2012 agricultural transformation agenda (ATA), through the Growth enhancement support scheme (GESS) which received a global applause in reforming the fertilizer supply and distribution to rural farmers across the country [12]. The ATA, through the Growth enhancement support scheme was aimed at providing inputs (Fertilizer, seeds) to farmers at half reduced price, while the remaining half will be by the state and federal government. Though, the scheme still failed in achieving in eliminating food insecurity in country (FMARD 2016). A dig insight into the cause of farmers’ low rate of fertilizer usage shows that the fertilizer supply does not adequately meet farmers’ demand. In fact, the total potential demand for fertilizer among farmers in Nigeria is currently estimated at 3.5 million MT per year [2]. However, supply of fertilizer to farmers is estimated at only a fraction of this potential (0.6 million MT in 2010, or 17% of demand), leaving a market lacuna of 2.9 million MT per year [13]. Why are fertilizer companies not taking advantage of this market opportunity? Also, why are other entrepreneurs not competing to enter the market for private sales? In 2009, Notore, a leading fertilizer company in Nigeria, sold only 16% of its supply through retail markets in Nigeria, and exported another 6% to Cameroon, and the remaining 78% was sold to the government. With such an easy, one-
stop buyer of large volumes at hand, these major suppliers have jostled for public contracts, thereby avoiding the relative hassle of developing relationships with multiple distributors who sell to the retail market, and this constitute a barrier to the farmers [13].

The Nigerian fertilizer market comprises about five large companies that produce and/or import fertilizer, plus another roughly 25 companies that opportunistically import fertilizer to fulfill government contracts as part of a diversified product portfolio [14]. New entrants into the private fertilizer market would face significant barriers to enter due to the limited production facilities in Nigeria, a company seeking to import a vessel of fertilizer faces a 10,000–30,000 MT investment, as opposed to investing in only a 30 MT truckload supply available locally [13]. For such a costly investment, companies prefer the security of a government contract to ensure profit. In view of these and other challenges, many policies reviewers have drafted, formulated and present papers on why the fertilizer supply in Nigeria has persistently failed in achieving the desired objectives. Therefore, there is a need for increase in fertilizer usage all over the Africa countries, and importation of fertilizer should be reduced so as to make local production a priority. This will go a long way in addressing food shortage and create job openings for ever increasing population. Workable and sustained policies should be put in place to ensure that the fertilizer sector work. Fertilizer use in Nigeria averages 8-10kg/ha [15]. If all our production stays in Nigeria, we can raise fertilizer use rate to 100kg/ha [16]. If this is required when Nigeria does not want to export food or cash crop at all, then a higher rate should be expected if we are to consider exporting products, in order to meet up with the NEEDS agricultural crop production target. [17] With the current application rate, Nigeria is still far from achieving this [17].

3. METHODOLOGY

3.1. Data Source

Data for this study were obtained from database of the World Bank group of World Development Indicators. The data consist of 16 countries from West Africa countries. The countries are Benin, Burkina Faso, Cameroon, Chad, Cote d’Ivoire, Gabon, Gambia, Ghana, Guinea, Guinea Bissau, Liberia, Mali, Niger, Nigeria Senegal and Sierra Leone. The data were pooled together to extract the information for this study. The collection was 2000 to 2015, spanned through 16 years. The World Development Indictors data is a data base that contains all the indices of development across the globe.

3.2. Method of Data Analysis and Model Specification

The panel data analysis used in this study take into account the transversal information and the time period of fifteen years, in order to determine whether the variable of interest has an effect on fertilizer consumption (FC). This methodology has the advantage of being able to take into account the individual characteristics of each country. The basic model for the determinants of fertilizer consumed FC, which is our dependent variable following Kolapo, et al. [18] and Gujarati and Damodar [19] is below;

$$FC_{it} = \beta_0 + \beta_1 FI + \beta_2 FE + \beta_3 FP + U_{it}$$  

Where;
- $FC_{it}$ = total fertilizer consumed in the country "i" in the time period "t"
- $FI$ = total fertilizer imported (tonnes)
- $FE$ = total fertilizer exported (tonnes)
- $FP$ = total fertilizer produced (tonnes)
- $U_{it}$ = Term of random disturbance

The Panel data used, took into account the transversal information and the time period of (15) fifteen years, in order to determine whether the variable of interest has an effect on fertilizer consumption. This methodology has the advantage of being able to take into account the individual characteristics of each country. A Panel Data Regression analysis was chosen instead of simple or multiple regressions because it has the advantage of providing more informative data, more variability, less collinearity among variables, more degrees of freedom and efficiency [19]. Besides, it is best suited to study dynamics of change and more complex behavioural models and has the capacity of enriching empirical analysis in ways that may not be possible for ordinary regression or multiple analyses [20]. A high coefficient of determination will indicate objectivity.

This model has a balanced panel data, in that it enables the observation of all the individual units in all the periods of time (Ti = T for all i), and it is considered short. The error term is undertaken as
independent. The individual effects are incorporated into the general model in order to capture the characteristics of each country, which are assumed as fixed on the time:

$$FC_{it} = \beta_0 + \beta_1 FI_{it} + \beta_2 FE_{it} + \beta_3 FP_{it} + U_{it} \quad (2)$$

Where $\beta_i$ = individual specific effects

At this stage of the analysis, the model is subjected to the Hausman test [21] in order to determine the most appropriate method, out of the fixed or random effect. This test takes as a null hypothesis that if the individual effects are random, the estimators should be similar, because they are consistent. On the other hand, in the alternative hypothesis, the estimators differ. The Fixed effects model is appropriate for this study because its estimators are consistent where a long panel is involved and are preferred to random effects estimators, also the individual error components $\epsilon_i$ and one or more regressors are correlated, then the random effects estimators are biased, whereas those obtained from fixed effects model are unbiased. Even if it is assumed that the underlying model is pooled or random, the fixed effects estimators are always consistent.

4. RESULTS PRESENTATIONS AND DISCUSSION
Table 1. Estimates of OLS, Fixed and Random Effects Regression Models

<table>
<thead>
<tr>
<th>Variables</th>
<th>OLS</th>
<th>Random Effect</th>
<th>Fixed Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(b)</td>
<td>(b)</td>
<td>(b-B)</td>
</tr>
<tr>
<td></td>
<td>Fixed effect</td>
<td>Random effect</td>
<td>Difference</td>
</tr>
<tr>
<td>Fertilizer Exported</td>
<td>-0.723***</td>
<td>-0.722***</td>
<td>-0.723***</td>
</tr>
<tr>
<td></td>
<td>(0.028)</td>
<td>(0.028)</td>
<td>(0.028)</td>
</tr>
<tr>
<td>Fertilizer Imported</td>
<td>0.951***</td>
<td>0.952***</td>
<td>0.951***</td>
</tr>
<tr>
<td></td>
<td>(0.007)</td>
<td>(0.007)</td>
<td>(0.007)</td>
</tr>
<tr>
<td>Fertilizer Produced</td>
<td>0.846***</td>
<td>0.843***</td>
<td>0.846***</td>
</tr>
<tr>
<td></td>
<td>(0.013)</td>
<td>(0.013)</td>
<td>(0.013)</td>
</tr>
<tr>
<td>Constant</td>
<td>65.3566</td>
<td>65.357</td>
<td>63.9844</td>
</tr>
<tr>
<td></td>
<td>(122.0702)</td>
<td>(122.070)</td>
<td>(123.4451)</td>
</tr>
<tr>
<td>No. of Observations</td>
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<td>672</td>
<td>672</td>
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<td>No. of Groups</td>
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<td>42</td>
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<tr>
<td>R-squared</td>
<td>0.988</td>
<td>0.987</td>
<td>0.987</td>
</tr>
<tr>
<td>F Statistic</td>
<td>16,717.560***</td>
<td>53,754.250***</td>
<td>16,717.560***</td>
</tr>
</tbody>
</table>

Source: Stata Output, 2019

Note: *p<0.1; **p<0.05; ***p<0.01

Table 2. Hausman Specification Test

<table>
<thead>
<tr>
<th>Variables</th>
<th>(b)</th>
<th>(B)</th>
<th>(b-B) Difference</th>
<th>S.E.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Fixed effect</td>
<td>Random effect</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fertilizer Exported</td>
<td>-0.723</td>
<td>-0.723</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Fertilizer Imported</td>
<td>0.952</td>
<td>0.952</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Fertilizer Produced</td>
<td>0.843</td>
<td>0.843</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Source: Stata Output, 2019

Chisq = 3.6542, df = 3, p-value = 0.3013
Alternative hypothesis: one model is inconsistent, we use fixed effect

5. DISCUSSION OF RESULTS

Fig (i) and (ii) above shows the panel plotting of Nitrogen fertilizer consumed and imported among the countries. Nigeria consumed and imported most among the country, maybe this is due to the large size of the country. The data description shown that variation exists in the data set; with all the countries imported a total of 4981409MT consumed 6244662MT, exported 1409787MT and produced 2934258MT respectively under the period 2000 to 2015. While only three (3) countries Nigeria, Senegal, Cote d’Ivoire
exported Nitrogen fertilizer, and only four (4) countries, Nigeria, Senegal, Cote d’Ivoire and Cameroon produced their only Nitrogen fertilizer. Nigeria is the highest consumer, exporter, imported and producer with (3340506MT, 944000MT, 2074106MT and 2338100MT) under the period, while Guinea Bissau consumed the least quantity (8197MT) equivalent to the quantity imported. On considering this with world consumption and production, it shows that the Nitrogen fertilizer consumption in the region is still very low, and the non-existence of many fertilizer producing companies in the region calls for concern. Though, Notore and Indorama plant that was recently commissioned in Nigeria cannot cater for the ever increasing population and food production in the region.

Table 1 above shows the estimates of fixed and random effects regression to determine the effects of Nitrogen fertilizer consumption on the quantity of Nitrogen fertilizer imported, exported and quantity produced from 2000 to 2015. Fixed and Random effects were used to determine the effects of consumption of Nitrogen fertilizer on the explanatory variables (Nitrogen Fertilizer imported, exported and produced). The OLS regression results shows that the coefficients of Nitrogen fertilizer produced, exported and imported were statistically significant at 1% (1<0.01) respectively, with the coefficients of Nitrogen fertilizer produced negative. The coefficients of Nitrogen fertilizer imported, exported and produced were statistically significant at 1% (1<0.01) respectively. This indicated that the quantity of Nitrogen fertilizer consumed is affected by the quantity produced, imported and exported. The coefficient of Nitrogen fertilizer produced was negative as expected, a confirmation that the quantity produced is very low to the quantity consumed. The fixed and random effects models indicated that there was no variation in the estimates of the two models, even with Hausman specification test. In such a scenario, the fixed effect regression is appropriate because its estimators are consistent where a long panel is involved (42). Also the individual error components \( \epsilon_i \) and one or more regressors are correlated.

6. CONCLUSION AND RECOMMENDATIONS

This study is modeled Nitrogen fertilizer consumption in Nigeria and West Africa countries, using panel data analysis. Empirical evidence from the study revealed that nitrogen fertilizer consumed in this region was imported from other countries based on the data available. Only two countries exported fertilizer under the period of this analysis. The results further showed that fertilizer consumption is affected by the volume of imported fertilizer, exported quantity and the quantity produced in the country, unfortunately, nearly all the countries in this analysis imported fertilizer for their local consumption. This is one of the major factors that affect industrialization in this region; as the large volume of money spent on importation can be spend on another area of the economy of the region.

The government of Nigeria and other West Africa countries should make policies that will enhance local production of fertilizer in their respective countries so as to discourage importation and encourage local production. An enabling, conducive and market friendly environment should be created for the few indigenous or local producers like Indorama, Notore chemical industry, Brass fertilizer, Virgin Beauty etc. so as to encourage their production and continuing support among local farmers. Also, farmer and cooperative associations should be encouraged to patronize the few indigenous companies, so as to enhance their production. Federal ministry of Agriculture of the in each country should make bold legislative laws to support the local production and enforce its uses among farmers, and such a law should be made to totally discourage importation so as to help the economy of the region.

REFERENCES


