Fertilizer use and farmer productivity in Nigeria: The way forward – A reflection on empirical studies conducted on the profitability of inorganic fertilizer use for key cereals in Nigeria

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Based on studies by L.S.O. Liverpool-Tasie, **B.T. Omonona,** A. Sanou, and W. Ogunleye

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- **Introduction**
- Uncontrolled population growth in Nigeria has made intensification of crop production inevitable.
- In 1960 Nigeria's population was estimated to be 45.2 million people. In 2015, the estimated number of people in Nigeria had grown to 182.2 million, a 303.1% increase in 56 years.
- Experts claim that by 2050, Nigeria is estimated to be the third most populous country in the world with a population of 399 million people, as it has one of the highest growth and fertility rates.
- Moreover, as the Minister of Agriculture says, present rate of farming is not able to satisfy the needs of such number of people. So it can lead to starvation unless innovative ways of farming are not used.
- Increasing the use of modern inputs including fertilizer is key for raising agricultural productivity and reducing poverty in Nigeria, particularly and Africa more generally.
- However, use of inorganic fertilizer is considered low due to:
  - limited or untimely availability of the input (Carlsson et al., 2005; World Bank, 2006)
  - imperfect markets (Abrar et al., 2004), and
  - lack of agronomic knowledge (Asfaw and Admassie, 2004) among others
- The perceived low fertilizer use has led to the assumption that it is profitable to use higher rates than is currently being used.

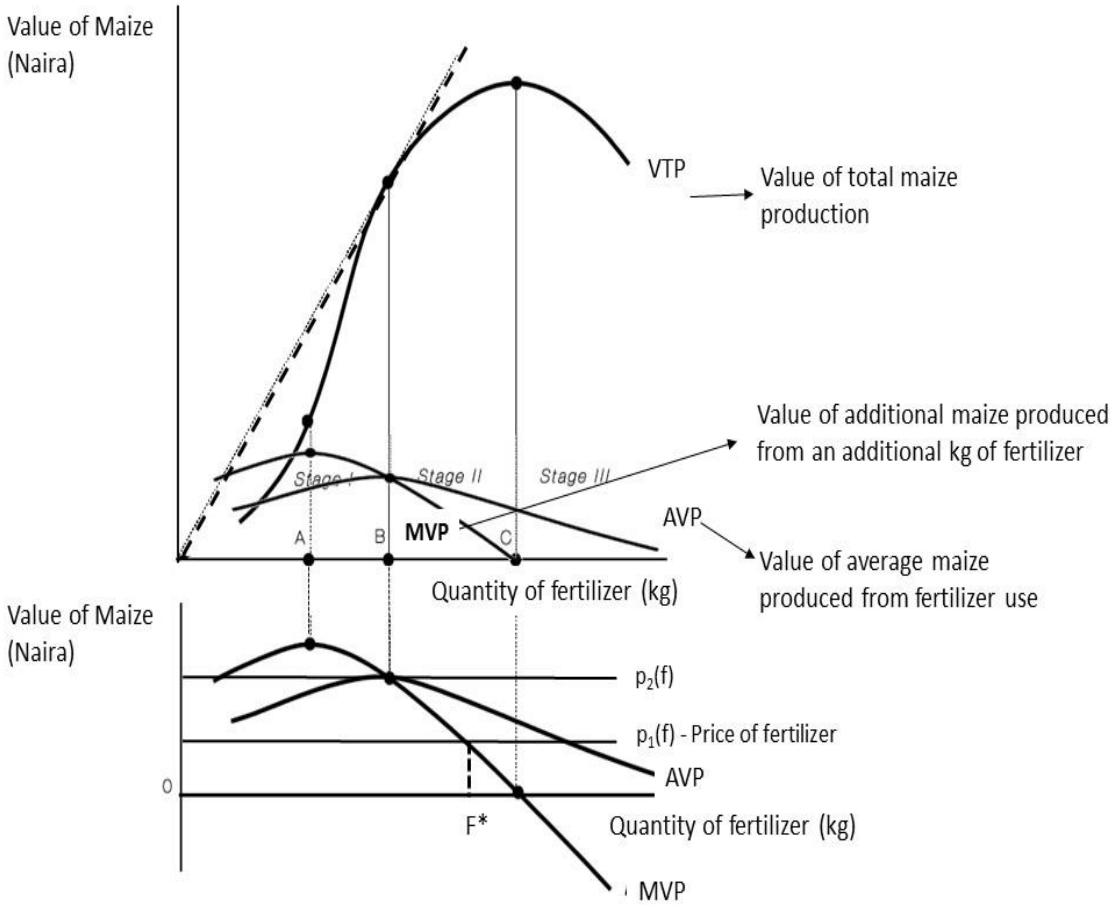
- Based on recent empirical evidence from Nigeria (Liverpool_Tasie, 2017; Liverpool-Tasie et al, 2016 and Omonona et al, 2016), increasing the quantity of fertilizer used by smallholders is not likely to successfully drive this process.
- We (scientists from UI and MSU) attempted to answer the question of whether '*increasing fertilizer use among cereal farmers in Nigeria is a profitable proposition'.*
- *We made use of rice, maize and sorghum.*
- Rice is now a staple food for Nigerian and indeed over half the world's population (IRRI, 2013).
- Nigeria is the second largest importer of rice, driven by
  - population growth,
  - neglect of agriculture (crude oil factor)
  - urbanization and
  - a preference for rice
- Average rice yields in Nigeria are quite low (said to be between 1 and 2.5 tons per hectare against potential yields of 5-6 tons per hectare) and rice farmers still rely on traditional practices.

- Maize is one of the three most important cereal grown in Nigeria along with sorghum and millet (USAID, 2010). Being a priority crop under the flagship agricultural programs of the Nigerian government since 2012, maize farmers have received intentional support in terms of access to subsidized fertilizer and improved seeds.
- Every part of the maize plant has economic value: the grain, leaves, stalk, tassel, and cob can all be used to produce a large variety of food and non-food products.
- In Nigeria, the growing demand for maize is also partly attributed to its use for poultry feed and those of other livestock (IITA, 2008).
- Sorghum is one of the most important cereals in the world. It is the fifth largest cereal in terms of area of production. Sorghum is a staple cereal food crop for more than 500 million people across the globe (Prasad and Staggenborg, 2011).
- At the global level, Nigeria is the third highest producer after United States and India (FAOSTAT, 2012).
- Nigeria is the largest producer of sorghum in West Africa accounting for around 71% of total output in the sub-region (Ogbonna, 2011).
- Sorghum is a key cereal consumed by the majority of the Nigerian population (NAERLS, 1997). In the Northern States, about 73% of the total caloric intake and 52.3% of the per capita protein intake are contributed by sorghum alone (Samm, 2009).
- As important as sorghum is in household and industrial consumption, its yields in Nigeria (and most of Sub Saharan Africa (SSA)) are low and relatively constant. According to Atokple (2010), the area harvested to Sorghum in Africa has nearly doubled, but yields averaging 800 kg/ha have not increased.

- **Methodology**
- The studies made use of the Nigeria Living Standard Measurement Study-Integrated Survey on Agriculture (LSMS-ISA), 2010/2011 and 2012/2013 .
  - It is a nationally representative panel data set with detailed agricultural information at the plot level. This makes it possible to address specifically the profitability of fertilizer use in a production function framework.
  - The LSMS-ISA data set includes geo-referenced plot locations and Global Positioning System (GPS)-based plot areas.
  - It also includes plot-level information on input use, cultivation and production.
  - The first visit each year collected information on planting activities, while the second collected information on post-harvest outcomes.
  - The paper focuses on all plots on which rice, maize and sorghum were grown in the main agricultural season in each survey year.
- To tackle this questions about fertilizer profitability, the authors considered:
- the agronomics of fertilizer use (e.g. how much more cereal does a farmer get from applying one additional kg of nitrogen)
- the economics of fertilizer use (e.g. how much does it cost to buy and transport fertilizer to the farm) for the production of these cereals in Nigeria.

Profitability of applied nitrogen for cereal production

A risk-neutral, profit-maximizing farmer will find it profitable to use fertilizer if the value of the MPP of cereal produced (i.e., the marginal value product, MVP) is higher than the corresponding unit price of fertilizer.



- For our profitability analysis, we used various production functions to obtain the MPP and APP of applied nitrogen for the different cereals.
- For rice, controlled function approach (Tobit and Correlated Random Effect) was used to correct for endogeneity of nitrogen use.
- For maize, the fixed effect model was used to control for endogeneity of nitrogen use
- For sorghum, true fixed effect stochastic frontier panel model was used to control for endogeneity of nitrogen use.
- We used average value cost ratio and marginal value cost ratio
  - AVCR is the price of maize * the APP divided by the price of nitrogen.
  - MVCR is the price of maize * the MPP divided by the price of nitrogen
- The study adopts the following criteria in determining profitability of fertilizer use:
- for *risk-neutral farmers, the MVCR should be equal to or greater than 1;*
- for *risk-averse farmers, MVCR should be equal to or greater than 1.5 or 2.*

- **Key findings**
- Marginal Physical Product (MPP) of applied nitrogen for these crops is quite low. It is about 8kg for maize,9kg for rice and between 0.61-1.05kg for sorghum.
- As a consequence, increasing fertilizer use alone might not be sufficient to increase their yields to desired levels in Nigeria.
- The proportion of cereal plots for which nitrogen application is profitable at the observed fertilizer acquisition prices and rice selling price is quite low.
- In both years (2010 and 2012):
  - It is only profitable for about 35% of all rice plots assuming farmers are risk neutral.
  - For maize, it is between 50 and 55% while for sorghum, it is 8.2 and 12.4%.
- This percentage reduces significantly and continuously as farmers' aversion to risk increases from 1.0 to 1.5, 2.0 etc
- However, the percentage of profitable plots can be increased if any of the following happens:
- MPP is increased through yield enhancing technologies
- Unit price of output is increased, *ceteris paribus*
- Unit price of nitrogen is reduced, *ceteris paribus.*
- A reduction in prices occasioned by subsidy is less effectual than a reduction in transportation cost as subsidy reaches only a few farmers in the first instance.

- **Why transportation cost of fertilizers?**
- Nigerian farmers face very high transportation costs traveling to procure fertilizers from agro-dealers or markets, largely because of poor rural infrastructure and far distances.
- These costs are a major fraction of the total acquisition cost of fertilizers for rural farmers.
- The two main modes of transport (used by almost 90% of respondents who purchased fertilizer) are motorcycles and minibuses/cargo tricycle and the average farmer is about 70Km from the market.
- Consequently, the average transportation cost paid by farmers to transport a bag of fertilizer from the market was about N350 for those using motorcycles and N450 for those using minibuses/cargo tricycle.
- Lowering transportation costs increases the proportion of profitable cereals' plots, even more than subsidy on fertilizer can achieve.

- **The Way Forward**
- Two major issues are necessary for profitability and increased productivity.
- **Reducing transportation cost** through:
  - A general improvement in rural roads and transport infrastructure
  - Reducing the distance farmers travel to purchase fertilizer and other inputs – **village promoters**
  - *These are sales agents for input dealers as well as vehicles to transfer knowledge about new technologies to rural farmers.*
- The National Fadama Development Project III (Additional Financing) has piloted the use of Advisory Services and Input Consultants (ASICs) to drive the advisory services component of the project.
- ASICs (had a minimum of MSc in Agronomy) supported participating farmers to ensure:
  - quality land preparation,
  - quality inputs,
  - quality cultural practices,

  - quality pest and disease management,
  - all necessary on-farm processing,
  - Keeping of records
  - quality and timely delivery of output to off-takers
  - raise red flags to draw the attention of the Project to critical issues that would militate against the project objective of ramping up production and sustainably increasing the income of the farmers.
- The ASIC were attached to 5 – 10 clusters of farmers cropping about 150 -200ha of the value chain crop
- Preliminary assessment of the ASICs across the various States has shown that this is a laudable strategy because the ASICs were always on ground to guide farmers on good farm practices that would not have been implemented.

- **More attention to understanding and addressing soil health**
  - inherent nutrients loss and soil acidification due to continuous cultivation
  - proper soil tests are necessary that can clearly indicate the nutrients that are lacking in the soil and the appropriate inorganic fertilizer to be applied.
  - currently used methods are expensive (analyse one soil property at a time and is chemical reaction based)
  - As a consequence, it is out of reach of small farmers.
- Learn from the Indian Agricultural Research Institute (IARI)'s Pusa Soil Test and Fertilizer Recommendation kit (digital soil analysis).
- It helps farmers in testing 12 parameters of soil
  - available organic carbon (OC), nitrogen (by calculation) (N)
  - available phosphorous (P)
  - available potassium (K)
  - available zinc (Zn)
  - available sulphur (S)
  - available boron (B)
  - available iron (Fe)
  - available manganese (Mn)
  - electrical conductivity
  - pH
  - Lime requirement test for acid soil
  - Gypsum requirement test for alkaline soil

- And recommends crop-specific fertilizer dose for 100 crops within a short time and at a centre nearby, and
- thus helps them to achieve higher yields, increase their income and keeps soil fertile.
- It is a digital and programmable device and thus has a high rate of accuracy.
- It is easy to use and with just two days of training, extension agents, agro dealers, farmers and other agencies working in a community can be equipped to provide this service in rural communities.
- **Other areas necessary for addressing constraints to fertilizer profitability for efficiency include:**
- increasing farmer access to and use of good quality complementary inputs
  - improved seeds,
  - machineries and equipment for irrigation and land preparation
- improving farm management practices :
  - the timing of fertilizer application,
  - Use of the right type and quantity of fertilizers
  - Use of the correct method of application (broadcasting vs. dibbling)
  - weeding and pest control,
  - crop rotation and
  - intercropping.