

# Organic and Inorganic Fertilizers in Food Production System in Nigeria

Emylia T. Jaja<sup>1</sup> Lucretia I. Barber<sup>2</sup>

1.Department of Plant Science and Biotechnology, Rivers State University, Port Harcourt

2.Department of Food Science and Technology, Rivers State University, Port Harcourt

## Abstract

Food production systems must operate to be socially acceptable, environmentally sustainable and economically viable. As the availability of land and water resources is rapidly declining, there is need to increase the productivity of remaining natural resources, including energy while at the same time observing nutritional and environmental needs of our people. The single most efficient and cost-effective input that can increase the productivity of land in Nigeria is fertilizer- be it organic or inorganic. Fertilizer can increase food, root/tuber, nuts/vegetables and grain production, release marginal lands from production and reduce environmental degradation including the risk and uncertainty associated with the production of agricultural products. Efficient management of plant nutrients ensures that fertilizers are used in the most environmentally acceptable and sustainable way and that crops are supplied with all essential plant nutrients at the appropriate time and in the required quantity to avert environmental pollution. Site specific nutrient use, integrated plant nutrient supply, nutrient placement including fertigation and synchronizing nutrient supply with demand, etc are some of the means by which fertilizers can be used more efficiently. All these will help to make more economical the use of natural resources, protect the environment and improve public image of farming and the fertilizer industry in Nigeria especially now that the land fallow systems which helped in building soil fertility have reduced to one or two year rotation.

## Introduction

Fertilizers which can be organic or inorganic, feeds the world through increasing and improving the soils fertility and in turn feeds the crop plants. If the world is not to go hungry, fertilizers will continue to play the key role in food production. No country in the world has been able to increase agricultural productivity without expanding the use of fertilizers.

Fertilizer is any organic or inorganic material of natural or synthetic origin that is added to a soil to supply one or more plant nutrients essential to the growth of plants.

Several field research reports have indicated that high and sustainable crops yields are only possible with integrated use of mineral fertilizer with organic manure (Satyanarayana *et al*, 2002). Complementary application of organic and inorganic fertilizers increase nutrient synchrony and reduces losses by converting inorganic nitrogen to organic forms (Kramer *et al*, 2002). The integration of organic sources and synthetic sources of nutrients do not only supply essential nutrients but also have some positive interaction with chemical fertilizers to increase their efficiency and thereby reduce environmental hazards. There are two broad categories of soil amendments:- organic and inorganic soil amendments. Organic Amendments come from plants and or animals whereas. Inorganic amendments, on the other hand, are either mined or man-made "(Davis and Wilson, 2008). Organic matter improves soil aeration and water infiltration, and it also improves both water and nutrient-holding capacity of soils. They increase water retention by the soil and are important in maintaining soil tilth (Sarka and Siegh 2002). Accordingly, Ball *et al*, (2005) explained that organic fertilizers are also responsible for the formation of soil aggregates which are *very essential in maintaining soil fertility*. Livestock manure supplies all major nutrients (N, P, K, Ca, Mg, S,) necessary for plant growth, as well as micronutrients (Tremblay *et al*, 2011). Manure application in a given year will influence not only crops grown that year but its residual effects will continue to influence crops in the succeeding years, because decomposition of the organic matter is not completed within one year (Bayu *et al*, 2006). Application of organic materials as fertilizers provides growth regulating substances and improves the physical, chemical and microbial properties of the soil (Belay *et al*, 2001). With regard to factors influencing adoption of fertilizer, lack of knowledge on use of and market information on fertilizer due to limited access to fertilizer and specific extension services is found to be perhaps the most limiting factor irrespective of fertilizer type. Empirical literature suggests that fertilizer use is sensitive to changes in its price as well as the price of crops to which it is applied (Griliches, 1958; Roberts & Heady, 1982; Ariga & Jayne, 2010). According to Morris *et al*. (2007), the demand for fertilizer is often weak in Africa because incentives to use fertilizers are undermined by the low level and high variability of crop yields on the one hand and the high level of fertilizer prices relative to crop prices on the other. However, Smaling *et al*. (2006) noted that farmers in Africa require 6 -11 kg of grain to purchase one kg of nitrogenous fertilizer compared with about 2- 3 kg of grain in Asia. Adequate soil fertility is essential for sustainable crop production in Nigeria to sustain the ever increasing population. Tropical soils are however, inadequate in soil nutrients because of the

nature of the parent materials. Thus, the application of fertilizer or manure for the improvement of soil fertility is an integral part of crop production. Plant roots require certain conditions to obtain these macro and micro-nutrients from the soil.

The soil must be sufficiently moist to allow the plant roots take up and transport the nutrients. In line with this, the soil moisture content, pH and temperature must fall within an optimum range for the nutrients to be release-able from the soil particles. Sometimes, correcting improper watering strategies will eliminate nutrient deficiency symptoms. This invariably affects the acceptability and market value of the vegetable, fruits roots, tubers, grains and other farm products. In the articulation of this paper, therefore, journals papers, books and interviews were used.

### **The role of organic and inorganic fertilizer in sustainable food production in Nigeria:**

In the need to sustain human, food has to be made available for the sustenance of life. In this regard, there is need to use fertilizer to increase crop yield.

Both organic and inorganic fertilizers provide plants with nutrients needed to grow healthy and strong. However, each contains different ingredients and supplies these ingredients in different ways. Organic fertilizer works overtime to create a healthy growing environment while inorganic fertilizer provides rapid nutrition (Miller, 2008). Organic fertilizer contain only plant or animal based materials that are either a by - product or end - product of naturally occurring processes such as manures, leaves and compost. Inorganic fertilizer also referred to as synthetic fertilizer is manufactured artificially and contains mineral or synthetic chemicals.

It is important to recognize that fertilizer is not panacea for all of the problems that afflict Nigerian agriculture and promoting fertilizer in isolation from other needed actions will have little lasting impact (Morris *et al* 2007). Nigerian land degradation problems can be attributed to many causes, but analysts generally agree that one of the contributing factors is failure of most farmers to intensify agricultural production in a manner that maintains *the environment and improve* soil fertility. Presently, Nigeria is estimated to have lost 57kg/ of soil per hectare per year during the 2002-2004 cropping season and fertilizer use intensity in 1996- 2002 is 5.6kg/ha and percentage increase is 73% (Smaling *et al* 2006). Furthermore, past efforts at promoting increased fertilizer use include direct subsidies that reduced the price of fertilizers' for farmers, in addition to government financed and also the managed input credit programmes; centralized control of fertilizer procurement and distribution activities and centralized control of key output markets (with the goal of stabilizing prices and linking input and output marked to ensure smoother credit management). Some of these processes are left or commissioned to be carried out by state Agricultural Development Programmes (ADPs) through their extension agents and their supervisors.

Organic fertilizer when available can, and should be an integral component of soil fertility management strategies; but organic fertilizer alone will not be sufficient to support the sustained high productivity and production levels that will be necessary to feed Nigeria's rapidly growing population. This is due to space and time variability in production and utilization. Among several problems in Nigerian agriculture are the disappearing fallows, deforestation and land degradation. Land degradation refers to the temporary or permanent reduction in the product of land and this is attributable to continuous utilization of cultivable land with inadequate soil fertility renewal. As a renewal energy source, organic manure when applied synergizes with the soil to uplift soil fertility to a sustainable basis. It improves soil biological life, water retention and aeration as soil is a living body.

Inorganic, mineral, chemical or synthetic fertilizer contains straight single<sub>a</sub> nutrient: nitrogen, phosphorus or potassium and compound or mixed fertilizers which contained more than one of these macro nutrients and trace elements while organic sources are animal manure, household waste plant materials including crop residues and compost. The two have impact in Nigeria agricultural development. According to Margulis, *et al.* (2006), soils in Nigeria are not highly productive, owing to poor moisture retention capacity and low organic carbon and organic matter because no soil type in Nigeria contributes to high productivity. This is pushing farmers into a fragile equilibrium in which use and conservation are crucial to avert further degradation. Indeed, the 1990 Global Assessment of soil degradation (GLASOD) estimates that 27% of global land surface had some form of degradation (Yusuf and Ukoje, 2012).

In previous years in Nigeria, DFID (2005) undertook a review of annual field surveys which showed a decline in yield of maize in 26 states, cassava in 10 states, millet in 8 states, and rice in 13 states from 1996-2004. Bolorunduro and Aribido (2001), reported that sustainable agriculture means that natural ecosystems are enhanced rather than threatened, rural based social structures are strengthened rather than fragmented and local resources are preferred. The authors recommended soil conservation by farmers, improvement of degraded land and integration of livestock, fishery and crop production to facilitate ecological restoration, disease control use of same in solving other agro-related problems. As encapsulated by Shweta and Kumar, (2007), unsustainable agricultural practices include burning of plant residue for their disposal; excessive use of agrochemicals produced from non-renewable sources; disruption of complex soil process by conventional agricultural practices,

such as unnecessary tillage, application of unbalanced chemical fertilizers and pesticides to soil; poisoning of food chain due to use of toxic pesticides and, excessive irrigation, leading to soil salination and ground water depletion.

In order to improve the soil fertility and produce healthy crops with good yields, application of organic fertilizers as a component of sustainable agriculture apart from soil mineral provision contribute to soil quality by improving the structure, chemistry and biological level of soil. These help to improve and shape the overall health of agricultural soils. Another advantage is gradual release of nutrients and reusing soil organic matter content. This is based mostly on locally sourced materials with little or no dependence on external inputs; it is one of the eco-supportive infrastructures advocated by Yusuf and Ukoje (2012) for sustainable rural development. A disadvantage of organic matter is that when decomposition is rapid, more nutrients are released but release of soil organic matter on the other hand is favoured by slow decomposition. The decomposition of organic matter operates with moisture and temperature which cannot be controlled hence nutrient may be released when plants do not need them. However, limited availability of organic matters is characteristic of many regional soils hence it cannot meet crop nutrient needs all alone.

The advantages of inorganic fertilizers are that nutrient content is known and they release nutrient quickly because other materials need not to be decomposed. Hence timing of nutrient uptake can be predicted very well. The disadvantages of inorganic fertilizers are high cost and long-term environmental damage which perhaps outweighs the advantages considering the poverty level of Nigerian farmers and the fragility, of the farming ecosystem. According to Adesina (2012), fertilizer use per hectare in sub-Saharan Africa is the lowest in the world. Also it is always easy to estimate or establish yield increase due to other inputs (agro chemicals, irrigation, mechanization, labour and yield increase due to adoption of modern/improved high yielding varieties) but that of sustainable inputs is usually silent.

From the foregoing scenario, the principal driving force in improving soil biology is improving the levels of soil organic matter. It is considered that the most cost effective method in this regard is the bulk application of animal manures, green manures (straw, hay) as well as farm manufactured composts if available. The application of specialized products that are “rich in beneficial organisms” will only be successful in their intended effect if there is an existing adequate level of organic matter present in the soil. Through heavy applications of manures and composts the indigenous and over time introduced populations of soil organisms will gradually improve the soil fertility levels. Therefore, soil being a living body will improve both in health and productivity. However while applications of manures and composts will! over time improve levels of soil organic matter and therefore soil biology (provided of course that organic inputs exceed outputs) they will still need to be supplemented with inorganic fertilizers in order to satisfy the annual nutritional requirements of the crops as well as indirectly supplementing the nutritional requirements of some other soil organisms. The use of inorganic fertilizers particularly for nitrogen and potassium are still therefore necessary. For phosphorus nutrition, it is possible that an annual heavy application of chicken litter will be adequate while this will also serve to supply a significant amount of organic matter.

Other farm management practices that are recommended in regards to improving levels of soil organic matter and subsequent beneficial effects are canopy management in the form of selective pruning and also the encouragement of ground covers such as smother grass. Canopy management practices that maintain trees at a height which allows for sufficient light penetration to the orchard floor will encourage greater retention of ground covers. The growth and retention of ground covers as well as assisting with the control of soil erosion will also directly improve levels of soil organic matter. Selective pruning helps to allow more light to penetrate through tree canopies to the orchard floor and thereby assisting with the achievement of optimal yields and ground cover retention will also act as when mulched or chipped on site directly return organic matter back to the soil and help to improve soil fertility levels.

Ultimately the major reasons behind farmers applying “organic” products to their soils is because of either a desire to improve crop yields through an improvement in soil health or to simply improve soil health first and crop yields second. An optimal level of soil health initially starts with soil organic matter as this is the primary source of food used by soil organisms. The application of specialized products therefore that promote micro-organism populations and subsequently the associated soil activities may have questionable benefit when they are applied to soils that have an existing low level of soil organic matter.

Generally organic manures require large amounts to have desired effects. Extra investment in labor for harvesting (green manures) and preparation of cattle manure is required. Unavailability of seed for green manures is one of the major limitations. Also, the quality for most organics has to be enhanced by combining with expensive mineral fertilizers. Furthermore, green manures occupy lands at a time where other food crops could be grown. On the other hand, mineral / inorganic fertilizers require high purchasing power and availability is an obstacle, especially in remote areas where the resource poor farmers reside. Mineral fertilizers need to be applied seasonally and there is seriously high risk in low rainfall and very high rainfall areas where they are applied.

## Conclusion

Fertile soils are paramount in crop production and soil amendment using manure and inorganic fertilizers helps to increase crop yields in Nigeria. Lack of or inadequate access to extension services that provide technical advice is a major constraint to increased adoption of fertilizer use in most rural communities in Nigeria.

Fertilizer use, access to credit and use of irrigation are closely linked - yet, in Nigeria, farm-household access to these complementary services is low especially in the Southeastern part of Nigeria. Therefore, any successful intervention to promote fertilizer use in Nigeria will have to be accompanied with complementary inputs and technical services - as a comprehensive package. Even though available records persistently indicate that chemical fertilizer consumption has been declining hence food output, the contributions of non-chemical alternatives have been largely overlooked. Agricultural scientists, especially agronomist and plant Scientists, breeders, ecologists, pedologists and soil scientists should collaborate with social science tests and other researchers on rural livelihood options to enhance development of soil improvement adaptive strategies that will not only lead to improve yield but also economic sustainability for rural people and environmental sustainability.

The Nigeria agricultural system despite the evidenced reduced utilization of chemical fertilizer has not failed woefully at least in rural areas where reliance on imported basic food stuff is minimal. This gives a ray of hope for sustainable agricultural input capacity development; hence farmers should be empowered through education and enlightenment on compost development, vermicomposting, nitrogen fixation by plant and other sustainable input utilization techniques. By this a lot of financial resources will be saved and judiciously used by both individual resource poor farmers and local, state, and federal government agricultural development units. This is in addition to the unanticipated benefits of integrated solid waste management in rural and urban centers of Nigeria. Apart from reducing the multifaceted transportation-political-bureaucratic bottlenecks and corruption associated with chemical fertilizer distribution, real rural empowerment and poverty reduction will be achieved.

The importance of organic manure is not a debatable issue; its role is very well established to improve soil health, but for the on impoverished soils of Nigeria as at today, organics alone cannot meet the crops' high nutrient needs. Farmers are reluctant to prepare compost and too, dung is being used as fuel and the crop residues as fodder not because of ignorance but because there is no other alternative for fuel and fodder especially in Northern parts of the country. However, serious attempts and policies are yet to be put in place to ensure sufficient use of nutrients in a balanced and efficient manner taking care of all the nutrient deficiencies and meeting crops' nutrients needs to achieve preset yield targets. Soil fertility is therefore, one of the major constraints to have maximum economic yield

There is no doubt that organic products are beneficial, however; there is no such thing that too much is enough. All nutrients whether they originate from organic or inorganic forms go through the same processes and transformations in the soil thus meaning that organic products when applied at excessive rates can cause just as much harm to the environment as inorganic products. Furthermore, a lack of certainty as to the exact nutritional breakdown of specific organic products may exacerbate this factor with the end result potentially being a net detrimental effect to the environment as opposed to the intended beneficial effect.

## References

- ADESINA, A. (2012), Unlocking the potential of Agriculture in SS Africa Nigerian's transformation Agenda for Agriculture. A paper presented at the 'symposium on "Ground food" New placed, new technologies at Johns Hopkins University of Advanced international studies.
- ARIGA, J., & JAYNE, T. S. (2010). *Factors Driving the Increase in Fertilizer Use by Smallholder Farmers in Kenya, 1990-2007*. Retrieved from [http://siteresources.worldbank.org/AFRICAEXT/Resources/2586431271798012256/Kenya\\_fertilizer\\_june\\_2010](http://siteresources.worldbank.org/AFRICAEXT/Resources/2586431271798012256/Kenya_fertilizer_june_2010).
- BALL BC, BINGHAM I, REES RM, WATSON C, LITTERICK A (2005). The role of crop rotation in determining soil structure and crop growth conditions: Canadian J. Soil. Sci. 85 (50): 557-578
- BAYU W, RETHMAN NFG, HAMMES PS, ALAMU G(2006). Effects of farmyard manure and Inorganic Fertilizers on sorghum Growth, Yield and Nitrogen use in a semi- arid area of Ethiopia. J. Plant Nutri. 29(2):391-407.
- BELAY, A, CLASSENS, AS, WEHNER, FC, DE BEER JM (2001). Influence of residual manure on selected nutrient elements and microbial composition of soil under long-term crop rotation. South African J. of Plant and Soil, 18:16.
- DAVIS JG, WILSON CR (2008) choosing a soil amendment. Colorado State University, Extension bulletin. No.7.235.
- DFID (2005), *The sustainability of Economic Growth- Harnessing Nigeria's Renewable Natural Resources for Economic Growth*. Processed GRILICHES, Z. (1958). The Demand for Fertilizer: An Economic Interpretation of a Technical Change. *Journal of Farm Economics*, 40, 591-606. <http://dx.doi.org/10.2307/1235370>
- KRAMER AW, DOANE TA, HORWATH WR, KESSEL CV (2002). Combining fertilizer and inorganic inputs

- to synchronize N supply in alternative cropping systems in California. *J. Agric. Econ. Environ.* 91:233 -243.
- MARGULIS, S., PILLAR, P., RULA, G., AND CHEE, N. (2006), *Nigerian Rapid country Environmental analysis* Washington, DC, The World Bank
- MILLER, R. (2008). Inorganic fertilizer verses organic fertilizer.
- MORRIS, M. L., KELLY, V. A., KOPICKI, R. J., & BYERLEE, D. (2007). *Fertilizer Use in African Agriculture: Lessons Learned and Good Practice Guidelines*. Washington D.C.: The World Bank. <http://dx.doi.org/10.1596/978-0-8213-688Q-0>
- ROBERTS, R. K., & HEADY, E. O. (1982). Fertilizer Demand Function for Specific Nutrients Applied to Three Major U.S. Crops. *Western Journal of Agricultural Economics*, 265-289.
- SARKA, AK, SIEGH RP (2002). Importance of Long Term Fertilizers Use for Sustainable Agriculture in Jharkhand. The Second International Congress on Balancing Food and Environmental Security-A Continue Challenge, New Delhi, India, 26-30 November 2002. *Fertilizer News* 2002; 47:107-117.
- SATYNARAYANA VM, VERA PV, MURPHY VRK, BOOTS KJ (2002). Influence of Integrated use of farmyard manure and inorganic fertilizer on yield and yield components of irrigated lowland rice. *J. Plant Nutri.* 25 (10): 281-2090
- SHWETA AND KUMAR, K. (2007) 'Role of organic farming, in sustainable agriculture' in Trivedi, P.G. (ed) *Organic farming and Mycorrhizae in Agriculture*, I.K International Publishing House, Pvt Ltd, New Delhi pp 73-76
- SMALING, E, TOURE, M., DE RIDDER, N., SAGINGA, N., & BREMAN, H. (2006). *Fertilizer use and the environment in Africa: friend or foes?* Background Paper Prepared for the Africa fertilizer summit, Abuja.
- TREMBLAY N, BOUROUBI MY, VIGNEAULT P, BELEC C (2011) Guidelines for in-season nitrogen application for maize (*Zea mays* L.) based on soil and terrain properties. *Field Crops Res.* 122:273-283. doi: 10.1016/j. fcr.2011.04.008
- YUSUF, O.R. AND UKOJE, J.A. (2012), 'The Imperative of "Eco- supportive" Infrastructure for Sustainable rural livelihood in a changing Climate' in Iliya, M.A, Abdulrahim, M.A, Dankani, I.M and Opponkumi, A (eds) *Climate Change and Sustainable Development*. Proceedings of the 52nd Annual conference of the Association of, (Nigerian Geographers ANG) held at Usman Danfodiyo University, Sokoto.