ASSESSMENT OF FERTILIZER SITUATION IN SUB-SAHARAN AFRICA - PRODUCTION AND USE, AS WELL AS ISSUES OF ENVIRONMENTAL QUALITY

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Abstract: *Sub-Saharan Africa (SSA) is a region that is often divided for different types of analysis based on social, economic, cultural, political and historical sub-regional characteristics. For a more productive division for discussion in this paper, SSA is considered as comprised of six distinct regions: East Africa, Sudan-Sahel, West Africa, the Central Africa, Southern Africa and the Islands of the Indian Ocean. Subsistence farming dominates the farming system in SSA. There is little application of technology, particularly with food crops, leading to low agricultural productivity. Consequently, health of African soils has become a constant challenge for farmers and agriculturists in the continent and conflicting interests in the exploitation of soil resources by various stakeholders has led to mismanagement; and in some cases degradation of soils. In this paper also, soil productivity maintenance remains a major environmental issue in countries of SSA, low soil fertility inevitably leads to low agricultural productivity and agricultural development is fundamentally affected by productivity status of land resources. Poor soil management and the fragile nature of tropical soils generally account for heavy nutrient losses through soil erosion and leaching of soil nutrient with adverse effects on environmental quality. In view of this, the paper discusses fertilizer assessment in SSA, production and utilization and how it affects the environment. The growing contrast between the productive roles played by fertilizer in other regions of the world and the very limited use of fertilizer in SSA calls for increased use of fertilizer in SSA if they must experience the green revolution as obtained in other regions of the world.*

Key Words: *Fertilizer assessment, Sub-sahara Africa, Production, Use and Environmental Quality.*

1. INTRODUCTION:

Sub-Saharan Africa (SSA) has the world's fastest growing populations, estimated at 2.7 % a year, compared to 2 % and2.2 % a year in Asia and Latin America respectively (UNEP, 1997). At the same time the per capita food production index shows a decline from 1.0 in 1961 to 0.82 in 2002 while the index in Asia and Latin America increased from 1.0 in 1961 to 1.82 and 1.25 respectively. The population is unevenly distributed with semi-arid areas not as densely populated as some of more fertile areas (Lelo and Makenzi, 2000). The country with the largest population is Nigeria with 136.5 million. It is followed by Ethiopia with 68.6 million and the Democratic Republic of Congo with 53.2 million (Lelo and Makenzi, 2000).

Cash crops tend to be better developed than food crops (UNEP, 1997). Farm sizes tend to be small and decline over time (Ellis, 2005; Nagayets, 2005). Average farm size in four SSA countries (Kenya, Uganda, Tanzania and Malawi) was about 1.55 ha (Ellis, 2005). Generally, the average size of land holdings declined from 1.5 hectares in 1970 to 0.5 hectares in 1990 (Nagayats, 2005). The decline of farm size partially reflects the exhaustion of land frontiers in most SSA countries. It is important therefore to take into account the peculiar needs and concerns of farmers engaged in these various farming systems when developing agricultural technologies or during extension delivery.

Sub-Saharan Africa's rural economy remains strongly based on agriculture relative to other regions. Agriculture in SSA (excluding South Africa) employed 62 % of the population and generated 27 % of the GDP of these countries in 2005. These agricultural production systems are largely based on smallholder farms. Small holder farms, defined as being two ha or less, represent 80 % of all farms in SSA, and contribute up to 90 % of the production in some SSA countries (Wiggins, 2009). A large percentage of these small holders are women, responsible for key components of house hold production such as weeding, harvesting and processing. Further, women often independently grow non-cereal crops for income and are increasingly heading rural households due to male urban migration. As in other regions, SSA agricultural households have varying levels of diversification in income sources beyond agriculture-though agriculture remains the dominant source of livelihood in poorer countries and poor regions within less poor countries.

2. Soil Fertility Decline Trends in Sub-Saharan Africa:

Health of African soils has become a constant challenge for farmers and agriculturists in the continent. Conflicting interests in the exploitation of soil resources by various stakeholders has led to mismanagement; and in some cases degradation of soils. In recent decades, unsustainable land cultivation practices (e.g. inadequate replacement of soil nutrients taken up by crops) have led to accelerated depletion of the natural soil base available for food production (Hossner and Juo, 1999). Soil productivity maintenance remains a major environmental issue in countries of SSA (Oyetunji *et al.,* 2001). Low soil fertility inevitably leads to low agricultural productivity, since agricultural development is fundamentally affected by productivity status of land resources. Poor soil management and the fragile nature of tropical soils generally account for heavy nutrient losses through soil erosion and nutrient leaching in soils (Hossner and Juo, 1999). In countries of SSA, unsuitable soil management activities including deforestation, indiscriminate vegetation removal, overgrazing and use of marginal lands for agricultural purposes often precedes eventual degradation of soil resources and environmental damage (Henao and Baanante, 2006).

Poor cultivation practices have resulted in decrease of soil fertility, reduction of soil organic matter (SOM), and increase in occurrence of acidified soils (Aihou *et al.,* 1998). Decline in soil fertility as a result of land degradation decreases farmland productivity (Amede, 2003). Escalating rates of soil nutrient mining makes nutrient losses highly variable in agricultural areas of sub- humid and humid savannas of West Africa, where they range from moderate to severe loss of nutrients (Henao and Baanante, 2006). Smaling (1993) estimated that annual net nutrient depletion rates per hectare exceeded 30 kg N and 20 kg K in arable soils of several countries in SSA. In many parts of SSA where poor soil conservation methods prevail, long term productivity of soil is projected to decline considerably unless soil management practices improve.

3. Role of Fertilizers in Sub-Saharan Africa Agricultural Production:

The structural transformation paradigm has been the foundation of rural development thinking for four decades. The paradigm argues that agriculture serves as the 'engine of growth' during the early stages of a country's economic development because the sector typically accounts for a high share of economic activity in developing countries and because agricultural activities tend to have strong growth linkages with the rest of economy. Although there has been some agricultural productivity growth in sub-Saharan Africa (SSA) during the past several decades, current growth lags far behind that in other regions of the world and is well below that required to meet food security and poverty reduction goals. In short, SSA has not yet experienced its "Green Revolution". There is ample evidence from experience outside Africa that increased use of mineral fertilizers has been responsible for an important share of worldwide agricultural productivity growth. Some argue that fertilizer was as important as seed in countries where a Green Revolution has already taken place (Tomich *et al.,* 1995), contributing as much as 50 % of the yield growth in Asia. Others have found that one-third of the cereal production worldwide is due to the use of fertilizer and related factors of production (Bumb, 1995).

The general case for increased mineral fertilizer use in SSA is based on the following arguments:

i. Africa's soils are being mined of nutrients at an alarming rate because traditional soil fertility management practices are no longer adequate due to population growth and land pressure.
ii. Organic soil management methods contribute to soil fertility improvement but are inadequate for meeting the rapid and sustainable growth needed in SSA agricultural output.
iii. The only means of both maintaining soil fertility and of achieving the required rate of SSA agricultural growth is to significantly increase the quantities of mineral fertilizers used. Such fertilizers can be employed in combination with organic fertilizers to increase crop output (for food and commercial purposes) and the amount of biomass available for transfer to land on which crops are being grown.

4. Fertilizer Production in Sub-Saharan Africa:

Fertilizers are commodity products, and fertilizer production is a capital-intensive industry. Global fertilizer production in 2002/03 was 146.9 million tons of nutrients of which 5.8 million tons (3.9 %) were produced in Africa. North Africa accounted for 5.0 million tons and South Africa 0.6 million tons while production in SSA was only 177,000 tons of nutrients (Table 1). This represented 3.0% of Africa's total and just 0.1% of global production. Fertilizer production in SSA peaked at 572,967 nutrient tons in 1992/93, comprising 407,111 tons of nitrogen and 165,856 tons of phosphate. The steady decline in production since then has been due to the closure of the National Fertilizer Company of Nigeria, Ltd. (NAFCON) ammonia/urea plant in Nigeria in 1997 and the declining production in Tanzania, Zambia, and Zimbabwe (Vanlauwe *et al.,* 2011).

Aggregate fertilizer production for all of Africa grew by 4.8 % annually from 1970 to 2002, when total production reached 5,791,436 tons for the entire continent - roughly 4 % of world production (Gregory and Bumb, 2006). Growth was most rapid in the 1970s and 1980s, but it slowed during the 1990s. North Africa (primarily Egypt, Morocco, and Tunisia) is the major producing region, accounting for 92 % of African production. The Republic of South Africa (RSA) is the fourth largest African producer (578,400 tons per annum). SSA (excluding RSA) has

always been a negligible producer of fertilizer, with recent production levels at 177,350 metric tons annually (representing about 0.10 % of world output). SSA production has been erratic since the 1960s. Beginning in 1994, structural adjustment and economic liberalization contributed to a sharp decline in production, as loss-making, state-owned and operated factories ceased production in Nigeria, Tanzania, Côte d'Ivoire, and Zambia. Other former producers, such as the Congo Democratic Republic, Mozambique, and Uganda stopped production in the late 1970s or the 1980s. The main SSA producers other than RSA are now Zimbabwe, Senegal, and Mauritius (UNEP, 1997; Weight and Kelly, 1999).

Table 1: Fertilizer production in Africa by region 2002/2003

	N	P_2O_5	K_2O	Total
Sub Region	('000 nutrients tons)			
North Africa	2,648	2,387	0	5,036
Sub-Saharan Africa	110	67	0	177
South Africa	298	280	0	578
Total Africa	**3,057**	**2,734**	0	**5,791**

Source: Gregory and Bumb, 2006

5. Fertilizer Consumption in Sub-Saharan Africa:

SSA displays a combination of high soil nutrient deficits and very low fertilizer use. Fertilizer use in Africa (4.3 million tons total in 2002, with 1.4 million tons for SSA) accounts for 3 % of world consumption, with SSA accounting for less than 1 %. Average fertilizer use intensity is, at 8 kg/ha, significantly lower than in other developing regions of the world. Large discrepancies exist, however, in the use of mineral fertilizers by farmers. At country level, it is observed that notwithstanding the significant differences that exist (even in Zambia, where intensity of use is the highest in Africa), fertilizer application remains less than half that of other developing regions. East Africa is more fertilizer-intensive than West Africa, with the four most intensive fertilizer users in the continent (Zerfu and Larson, 2010; Yamano and Arai, 2011).

6. Factors Affecting Fertilizer Use in Sub-Saharan Africa:

It is recognized that low fertilizer use in SSA stems from a set of failures in input markets, complicated by broader rural development constraints. Many factors contribute to the low use of fertilizer in Africa. The most important of these include:

High cost of fertilizer -Fertilizer prices in Africa are generally higher than in other developing regions because of (a) low volumes, (b) long distances from ports to production zones, (c) poor road and storage infrastructure, (d) low population densities, (e) inadequate and costly financial services; (f) high risks due to policy uncertainty, and (g) graft and corruption. Overall, it is estimated that transport and distribution costs (and various taxes) represent up to 50% of the final retail price in SSA versus 20% only in Asian countries (Bumb, 2009).

Low fertilizer profitability -Low output prices further exacerbate the problem of high fertilizer prices, with the combination often making fertilizer use unprofitable at unsubsidized prices, particularly in cropping systems with low fertilizer response. A comparison of fertilizer/output price ratios (a rudimentary indicator of potential profitability) for SSA, Asia, and Latin America revealed that SSA ratios tended to be less favourable for most of the principal crops (Yanggen *et al.,* 1998).

Risks of fertilizer use -Both production and price risk, influenced by climate and poorly functioning markets, are important factors.

Low fertilizer use efficiency - Standardizing for agro-ecological conditions, there is little evidence to suggest that crop response to fertilizer is lower in Africa than in other developing regions. However, many farmers in Africa lack the land husbandry and crop management skills needed to use fertilizer efficiently.

Non-availability of fertilizer -Fertilizer is often unavailable when, where, and in the formulation needed. Factors limiting supply include an unfavourable business environment, poor transport and communications infrastructure, and inadequate investment in developing human capital. These factors pose considerable obstacles to increasing fertilizer use in Africa, but none is insurmountable. Prospects for increasing fertilizer use are brightest in areas with good agricultural potential that feature medium or high levels of population density, well developed infrastructure, and well-developed output markets.

7. Use of Organic Resources:

The use of organic resources for soil fertility improvement in SSA has been in practice since earliest times; though the strategies by which these materials were applied may differ from recent conventional methods through technology development and adaptive strategies to meet peculiar modern needs. Following widespread popularity of inorganic fertilizer sources used in agriculture since the 1940's, the use of inorganic fertilizer became the natural

complementary option that received the attention of agriculturists in an effort to boost soil productivity. This has achieved a considerable level of success over the years by increasing crop production at accelerated and balanced rates. However, application of inorganic fertilizers has also faced important limitations due to high costs, highly variable nature of soils and inherent low nutrient conversion efficiency (AGRA, 2007). Average fertilizer use rates for countries in SSA are considered too low and ineffective for sustaining crop and soil fertility maintenance (Gruhn *et al.,* 2000). Alternative sources of nutrients are already being sought in several areas in Africa where soil fertility needs to be rebuilt and high cost and supply quantities limit inorganic fertilizer application.

Organic and inorganic fertilizers act as complements rather than substitutes. Organic fertilizer alone cannot solve the fertilization deficit of African soils. First because of its properties: soil nutrient losses occur when plant uptake and nutrient release from fertilizers are not synchronized, e.g., at crop establishment when crops are too young to take up large amounts of nutrients or through erosion and the application of organic fertilizers, animal or green manure, can replenish only some of them (Agwe *et al.,* 2007).

8. Constraints Facing Organic Fertilizers Use in Sub- Saharan Africa:

Decline in soil fertility in SSA is largely attributable to poor soil management practices as earlier stressed; but this is in turn made worse by other factors such as inappropriate land use policies in most developing SSA countries, insufficient commitment to investment in agricultural research, falling agricultural prices, land availability constraints and will defined property rights (Gruhn*et al.,* 2000). These factors also generally affect the applicability of any soil nutrient management system practiced in the region, whether organic or inorganic resource based. Some of the most important constraints limiting development of organic based soil nutrient management systems in tropical SSA include utilization of large labour force required for both processing and transporting of organic materials in bulk quantities as well as large amounts of organic residues often needed to supply adequate nutrients to soils for successful crop production (Palm *et al.,* 1997).

Adequate management of low quality, slowly decomposing organic residues to adjust to growing crop requirements also poses a great challenge. Leaching of nutrients due to erosion also poses as an important problem especially when using high quality, fast decomposing organic resources such as *Tithonia, Crotolaria* and *Sesbania spp*. Acceptability and practical application of organic based systems on large-scale basis by local farmers are yet to be fully adopted as a result of farmers' reluctance to change from familiar methods of soil nutrient management to newer methods. Other constraints include prioritization of use of organic resources in local farmland systems other than soil fertility improvement, lack of supportive institutions, harsh climatic conditions in some agro-ecosystems of SSA (Lele, 1994; Bumb and Baanante, 1996; Meertens, 2003; Chianu and Tsujii, 2005). The future of organic nutrient resource management lies in using isotopic tracers (15N and 32P) in order to measure supply of major elements (N and P) from various organic sources in a wide variety of environments. Better farmer's education, support of local governments and improved logistics are also top priority concerns for sustainable future efforts in proper soil management for countries in sub-Saharan Africa (SSA).

9. Environmental Considerations:

Whereas in developed world, excess applications of fertilizer and manure have damaged the environment, low use of inorganic fertilizer is one of the main causes of environmental degradation in Africa (Bationo *et al*., 2006). Excessive fertilizer use, whether organic or inorganic, can create environmental problems associated with leaching of nitrogen into groundwater and deposition of phosphorous in surface waters through soil erosion (Larson, 1996), especially in regions with continuous high levels of fertilizer applications (often over 200 kg/ha) and large livestock operations. Over-intensification is not a widespread problem in SSA and will not become one; rather, future predictions indicate that the main environmental concerns in agriculture in sub- Saharan Africa will stem from the lack of intensification (Larson, 1996).

Bationo *et al.* (2006) argues that, whereas in the developed world, excess applications of fertilizer and manure have damaged the environment, the low use of inorganic fertilizer is one of the main causes for environmental degradation in Africa. They advocate for increased inorganic fertilizer use which will, in addition to increased productivity, benefit the environment by reducing the pressure to convert forests and other fragile lands to agricultural uses and, by increasing biomass production, helps increase soil organic carbon content.

10. CONCLUSION AND RECOMMENDATIONS:

The inherent lack of fertility of many African soils has been and continues to be exacerbated by widespread nutrient mining, has led to expansion of the agricultural frontier and the opening up of less favourable soils for cultivation. This is a scenario for disaster over the long run, given the difficulty of restoring tropical soils to productive capacity.

- The growing contrast between the productive roles played by fertilizer in other regions of the world and the very limited use of fertilizer in Sub-Saharan Africa (SSA) calls for increased use of fertilizer in Sub-Saharan

Africa if they must experience the green revolution as obtained in other regions of the world. Without nutrient replenishment, many African farmers risk taking their soil resource base beyond a point of no return. Mainly for this reason, there is widespread agreement that the improvements in soil fertility needed to boost agricultural productivity growth, improve food security, and raise rural incomes will require substantial increases in fertilizer use, in combination with accelerated adoption of improved land husbandry practices.

- Proper soil conservation becomes imperative when considering issues regarding soil fertility improvement in SSA. This becomes evident in the light that the lives of a greater percentage of the populace in the region are directly connected to agriculture and agricultural based Industries. Sustainable agricultural production incorporates the notion that natural resources be used to increase agricultural output and income without depleting the natural resource base. Effective soil management ensures nutrient conservation in soils and can lead to steady reclamation of degraded lands in sub-Saharan Africa over long term.

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