Title
Constraints and new opportunities for achieving a green revolution in Sub-Saharan Africa through Integrated Soil Fertility Management

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Introduction

African soils have an inherently poor fertility because they are very old and lack volcanic rejuvenation. Inappropriate land use, poor management and lack of input have led to a decline in productivity, soil erosion, salinization and loss of vegetation. Africa is burdened with a US$ 9.3 billion annual cost of desertification. An estimated of US$ 42 billion in income and 6 billion ha of productive land are lost every year due to land degradation and declining agricultural productivity. African soil mining balances are often negative indicating that farmers mine their soils and about $ 4 billion per year is lost due to nutrient mining. Soil moisture is perhaps the overriding constraints to food production in much of Africa and only 14% of Africa is relatively free of moisture stress.

The extent of such losses is of sufficient importance that steps such as recapitalization of soil fertility, increased use of inorganic fertilizer, and more efficient recycling of biomass within the farming system are being taken. As a result of the above problems, scientists have concluded that soil-fertility depletion in smallholder farms is the fundamental biophysical root cause of declining per capita food production in Africa, and soil fertility replenishment should be considered as an investment in natural resource capital.

Whereas the over-application of inorganic and organic fertilizers has led to environmental contamination in a number of areas in the developed world, insufficient application of nutrients and poor soil management, along with harsh climatic conditions and other factors, have contributed to the degradation of soils in Sub-Saharan Africa (SSA). The average intensity of fertilizer use in SSA, excluding South Africa, is about 9 kg/ha. Intensity has generally been highest in Southern (16 kg/ha) and Eastern (8 kg/ha) Africa countries and lowest in the Sudano Sahel (4 kg/ha) and Central Africa (3 kg/ha) (Kelly 2006). The diagnostic studies of fertilizer use in Africa have suggested that fertilizer use is low in Africa for four interrelated reasons:

- The low returns to fertilizer use due to agro-climatic conditions and current farming methods;
- The lack of information about fertilizer among retailers, farmers, and extension agents such as price information and best practices;
- The high costs of fertilizers due to foreign production, large units, and costly transport; and
- The inconsistent and adverse policy environment created by shifting government and donor subsidy policies that undermine private investment.

Paradigm Shifts in Soil Fertility Management

Many of Africa's soils are derived from granite through millennia of weathering and contain inherently low levels of plant nutrients (Bationo et al., 2006). Soil fertility is highly variable and so is the response to inputs. Soil fertility is highly heterogeneous with large on-farm variation from field to field and nearly as much variation on a local level as across all of Africa. In addition, many soils have low response when fertilizer is applied alone. This low “agronomic efficiency” can be raised through complementary management of soil structure and organic matter.

Over the years, the paradigms underlying soil fertility management research and development efforts have undergone substantial changes because of experiences gained with specific approaches and changes in the overall social, economic and political environment. During the 1960s and 1970s, an external input paradigm was driving the research and development agenda. The appropriate use of external inputs, be it fertilizers, lime, or irrigation water, was believed to be able to alleviate any constraint to crop production. Organic resources were considered less essential. Following this paradigm, together with the use of improved cereal germplasm, the 'Green Revolution' boosted agricultural production in Asia and Latin America in ways not seen before. However, application of the 'Green Revolution' strategy in sub-Saharan Africa (SSA) resulted only in minor achievements because of a variety of reasons (IITA, 1992) including the diversity of the agro-ecologies and cropping systems, variability in fertility, weak institutional arrangements, and lack of enabling policy.

In the early 1980s, the balance shifted from mineral inputs only, to low mineral input sustainable agriculture (LISA) under which organic resources were believed to enable sustainable agricultural production. After a number of years of investment in research activities evaluating the potential of LISA technologies, several constraints were identified both at the technical (e.g., lack of sufficient organic resources) and the socio-economic (e.g., labour intensive technologies) levels. This led to the Second Paradigm for tropical soil fertility, which recognized the need for both mineral and organic inputs to sustain crop production, and emphasized the need for all inputs to be used efficiently (Sanchez, 1994). The early 1980s and 1990s led to the emergence of the Integrated Natural Resource Management (INRM) research approach and ultimately the Integrated Soil Fertility Management (ISFM) paradigm. Although technically ISFM adopts the Second Paradigm, it recognizes the important role of social, cultural, and economic processes regulating soil fertility management strategies. A critical lesson from all this work is that a highly context-specific approach is required which takes into account the fertility status of the soil, the availability of organic inputs and the ability to access and pay for mineral fertilizers. However, making the necessary investments in soil fertilization to derive benefits including adequate returns on investments depends on output markets and the market value of farm products. This varies across Africa, within regions and even within villages and fields.

Lessons from Long-Term Experiments

Long term experiments (LTE) have played a key role in understanding the changes in soil fertility resulting from changes in land management practices. Results from these experiments indicate that there are positive crop yield responses following application of mineral fertilizers on impoverished soils. This potential is recognized by large-scale farmers in Kenya, Zambia, and Zimbabwe who have been able to sustain relatively high yields of cereals such as maize for periods of up to 30 years on the same piece of land. Results from these experiments also indicate that yields decline following continuous application of mineral fertilizer alone. Such declines might result from (i) soil acidification by the fertilizers, (ii) mining of nutrients as higher grain and straw yields remove more nutrients than were added, (iii) increased loss of nutrients through leaching as a result of the downward flux of nitrate when fertilizer N is added, and (iv) decline of soil organic matter (SOM).

On the other hand, application of organic inputs either as animal manure or crop residues increased yields, but in many cases yield tended to decline with application of only organic inputs. In addition, application of organic materials is insufficient to meet the crop requirements for large scale application and food production. The combined use of mineral fertilizers and organic inputs increased yields and maintained stable yields for the duration of the experiments pointing to the need to integrate both the mineral and organic fertilizers for sustained crop production. Long Term Experiments (LTE) that integrate legumes (grain and herbaceous) also contribute to improved soil fertility through biological nitrogen fixation and higher productivity.

The Way Forward

Investment is needed to support adoption of sound land management practices by smallholder farmers. It is critically important to empower farmers in basic principles of crop nutrition and management since simple techniques such as correct planning distance and more precise fertilizer placement can double crop yields. Since Africa's staple crops are varied and are cultivated in highly diverse ecological zones, it is important that farmer education be adapted to local conditions and recommended practices be appropriate to farmers' choices in that locality. This calls for the existence of sound and functional technical support from the extension systems, both public and private.

High rates of fertilizer have long been recommended, but the systems to supply them are not in place. African markets are small and the prices charged by multinational fertilizer suppliers for the small lots imported into African countries are high. Domestic production is also small. Transportation costs from ports to the interior are high and other marketing charges, including profits to wholesalers and retailers, are high. Farmers often end up paying double or triple the import price. There are relatively few dealers selling agricultural inputs to smallholders, and they have limited capital, little ability to extend credit, and limited business acumen. Farm prices of fertilizer in Africa can be reduced by about 15% through country-specific strategies combining improved procurement, improved retail networks, reduced tariffs, disseminating competitive price information, local blending, and logistics coordination.

African countries could benefit from the more favourable economies of scale by establishing functional regional fertilizer procurement facilities. This will improve procurement systems (bulk importation) and transportation. Additional savings can be achieved by local bagging, local blending of imported materials, and eventually, local granulation. The African Development Bank (AfDB) is currently spearheaded the establishment of an African Fertilizer Financing Mechanism (AFFM) to held countries access fertilizers at competitive prices.

Agrodealers are critical to farmers' access to affordable quantities of appropriate fertilizer in their local environments. With business support to increase access to working capital, improve marketing of farm inputs and basic record keeping, agrodealers are becoming the private sector entities that are the smallholders' source for a range of inputs. Innovative financing through microfinance institutions and banks could provide opportunities for the agrodealers and enterprising farmers to access credit guarantees for increased investments. Initiatives on agrodealer development are being implemented by organizations such as CNFA and IFDC

through support from AGRA and other organizations. Components on innovative financing have also been established by AGRA and IFAD and other partners for leveraging funds with banks such as Standard Charted Bank (Tanzania, Ghana, Mozambique, Uganda), Equity Bank- Kenya, National Bank- Tanzania.

Africa is endowed with numerous phosphate ore deposits, which are a potential source of phosphate fertilizers. However, few of these deposits have been developed, mainly due to their size and quality, limited domestic markets and depressed phosphate prices in the global fertilizer market, which do not justify investments and operating costs. Catalytic support is needed for private sector led nutrient/supplement mining, fertilizer manufacturing and blending investments, through supporting development of potential economically viable opportunities to reduce cost of production of local nutrients and amendments and/or production of more locally appropriate fertilizer blends.

The use of smart subsidies offers opportunity of improving farmer access to inputs for increased agricultural production. Smart subsidies lower the price or improve the availability of fertilizer to farmers in ways that encourage its efficient use and stimulate private input market development. Key characteristics of market-smart subsidies are, firstly, that they do not distort the price of fertilizer relative to other inputs so that farmers will use fertilizer in an economically efficient manner and, secondly, that incentives for farmers and input suppliers are shifted in a way that will contribute to a strengthening and deepening of the private input supply system in the long-term. There are indications of success from experience in Malawi, Nigeria, and Afghanistan on the use of subsidies. Several other countries in Africa (Kenya, Tanzania, Rwanda, Uganda, Ghana, and Mozambique) have started subsidy programs for their smallholder farmers. Optimal design of these programs is needed to ensure impact and reduce excessive cost and chance of corruption, and the eventual end of subsidies is needed.

Global Initiatives on Soil Fertility in Africa

There is general consensus that Africa needs to tackle the problem of widespread soil fertility constraints if it is to achieve its unique Green Revolution. The Soil Fertility Initiative was launched at the World Food Summit in 1996 and from 1998-2001, the Food and Agriculture Organization of the United Nations (FAO), International Centre for Research in Agroforestry (ICRAF), International Food Policy Research Institute (IFPRI), International Center for Soil Fertility and Agricultural Development (IFDC), USAID, and the World Bank conducted consultations in 20 African countries and developed national action plans for soil fertility. The Abuja Declaration, following from the African Fertilizer Summit of 2006, set the scene for major investments in boosting fertilizer supplies. CAADP – the Comprehensive African Agricultural Development Programme – has been active in supporting the follow-up to the summit, particularly through its work on improving markets and trade. AGRA – the Alliance for a Green Revolution in Africa – has launched a major new Soil Health Programme aimed at 4.1 million farmers across Africa. Other initiatives abound – the Millennium Villages programme, Sasakawa-Global 2000, the activities of the Association for Better Land Husbandry, among many others. All see soil fertility as central, although the suggested solutions and policy requirements are very different. Collective action is required by all actors along the production to

marketing value chain to address the challenges of soil fertility in Africa. The value chain approach promote by AGRA will be presented and its successful implementation is the hope of million of small scale farmers that need to be lifted out of chronic poverty, hunger, malnutrition and low income.