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Replenishing Soil Fertility in Africa

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A Fertilizer-Based Green Revolution for Africa

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Abstract

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On average, <5 kg ha^{-1} of mineral fertilizer nutrients are applied to food crops in sub-Saharan Africa, the lowest rate in the world. Population pressures have caused traditional systems of shifting cultivation to break down. Soil nutrients are being depleted at an alarming rate, leading to environmental degradation and food insecurity. To reduce poverty and assure food security, African agriculture must grow at 4 to 5% per year, more than twice the rate of recent decades. This growth is unattainable without using significantly greater quantities of mineral fertilizers. Excellent agronomic response to fertilizers has been observed in >600 000 half-hectare, on-farm demonstration plots in the major food crops in 12 countries. In Ethiopia, with the increased use of mineral fertilizer, improved seed, better extension advice, and favorable rainfall over most of the country; record harvests of the major food crops have been achieved over the 1995–1996 and 1996–1997 seasons. The country has become food self-sufficient and advanced closer to the goal of food security. Attention must be given to improving the efficiency of use and supply of fertilizers to make them more affordable to farmers. Equally important is the role of agricultural research and development in devising technologies and strategies that ensure the sustainability of food production to meet the demand of an ever-increasing population. Priority on the agenda should be given to developing nutrient management practices in which all nutrient sources are judiciously integrated and losses to the environment are minimized.

Between 1997 and 2020, population in sub-Saharan Africa (hereafter referred to as Africa) will more than double to over 1.1 billion people (Dyson, 1995; Rosegrant et al., 1995). Investments by national governments and the international community have been insufficient to arrest poverty, assure food security, and reduce environmental degradation in this continent. Indeed, if present trends continue, food insecurity, malnutrition, and resource degradation will increase, and by 2020, it is conceivable that Africa will need to import between 50 and 70 million tonnes per year of foodstuffs (mainly cereal grains) to meet the demands of the increased population (Dyson, 1995; GCA, 1996). Almost certainly, Africa will not have the economic resources to procure such huge volumes of food on a commercial basis nor will the international community be willing to provide it as concessional sales or food aid.

Since most of the poor in Africa are rural, and agriculture is their mainstay, it follows that agricultural development must be the central strategy for economic growth and poverty alleviation (Birdsall, 1995). It also is important to stress that hunger, poverty, and environmental degradation in Africa are intimately correlated, and that any action to reduce poverty and hunger will assist in minimizing environmental degradation as well (Cleaver & Schreiber, 1994).

The critical role of agriculture in Africa's development is not universally accepted by many governments. Consequently, in most countries, agriculture has been growing more slowly than population, which has resulted in decreasing incomes in real terms. The major cause of the poor performance of the agriculture sector is not a dearth of improved agricultural technology that can empower the small-scale farmer to increase productivity. Rather it is poor economic and agricultural policy; inadequate investment in infrastructure and rural education; insufficient agricultural services, such as research, extension, credit, input supply, and

marketing; and low investments in rural health care (Cleaver & Donovan, 1995).

In most regions of the world, increases in food supply over the past two decades have resulted mainly from raising yields. The only major exceptions are Africa and the *Cerrado* of Brazil, where most of the growth in production has occurred because of expansion of the cultivated area (Borlaug & Dowswell 1994; Dyson, 1995). It is widely perceived that technology-based agriculture has largely bypassed Africa. Where land is plentiful, *slash and burn* shifting cultivation persists, and this is still common in much of Africa. However, where population pressures have reduced the fallow period, a sedentary low-yield agriculture has arisen. But no matter what the variations in the agricultural system, the common base is that plant nutrients are the minimum factor for crop production (Jansson, 1995). Traditional agriculture results in mining soils of plant nutrients by removing crop residues, leaching, and soil erosion (Smaling et al., 1997, this publication). According to Stoorvogel and Smaling (1990), about 200 million ha of cropland in Africa have lost 660 kg N ha^{-1}, 75 kg P ha^{-1}, and 450 kg K ha^{-1} during the last 30 yr, primarily by removing crop harvests (Bumb, 1995; Sanchez et al.,1997, this publication). These figures amount to a loss of plant nutrients in the range of about 8 million tonnes N-P-K annually.

Traditional farming systems in Africa are responsible for the loss of 4 million hectares of forest that are cleared annually to give room or substitute for the cropland that has become unproductive because of nutrient depletion. This practice is leading to disastrous environmental consequences, such as soil erosion, weed invasions, impoverished postfire-climax vegetative ecosystems, and loss of biodiversity (Borlaug & Dowswell, 1995). The solution is clearly not to expand food production horizontally to keep pace with population growth at the cost of environmental degradation. Instead, the solution is to provide adequate soil nutrients by increasing the use of mineral fertilizer, combined with organic inputs that build up organic matter in the soil, and the complementary practices of using improved seeds and proper plant population, weed control, and other cultural practices.

Fertilizers have played and will continue to play an important role in increasing the food supply for future generations. It is estimated that around 50% of the annual global food harvest comes from the application of mineral N fertilizer alone (Dyson, 1995). The judicious use of mineral fertilizers can play a critical role in preventing resource degradation that results from nutrient mining, and from the exploitation of fragile lands or the clearing of habitat-rich forests. In Africa, fertilizer consumption on food crops is the lowest in the world—probably no >5 kg ha^{-1} of nutrients, when fertilizer use on cash crops is subtracted from aggregate statistics.

Increased fertilizer use in Africa can create a win-win situation, by promoting more efficient crop production and reducing soil degradation. Mineral fertilizers should be at the core of strategies to restore soil fertility and raise crop productivity, although their use should be a part of integrated systems of nutrient management in which organic fertilizer sources are included. Organic sources of nutrients, however, will be complementary to the use of mineral fertilizers, and not the other way around. Exclusive use of organic fertilizers will increase food production at best by 2% yr^{-1} (Hiyami & Ruttan, 1985), well below the population growth rate, and not even close to the 5 to 6% required to reduce poverty and assure food security. The World Bank's 1989 long-term perspective study (1990 to 2020) to permit gradually improved food security and increased rural incomes set agriculture growth in Africa at 4% a year (Cleaver & Schreiber, 1994). Because the overall performance of Africa for 1990 to 1996 did not attain the 4% target, many people including Cleaver (1996, personal communication) say that 5% per year agricultural growth is probably necessary to have a significant impact on poverty reduction. With population growth around 3% per year, this would be only a 2% net increase in per capita production.

It also is important to mention that sources of organic manure are limited in most African countries. Even in Ethiopia, where livestock numbers are significant, manure is primarily used as a cooking fuel and rarely to improve the fertility of the soil. Moreover, use of other organic sources, such as green manures, presupposes growing the manure crop at the expense of a food or cash crop (Giller et al., 1997, this publication). Finally, alley cropping and agroforestry approaches to maintaining soil fertility are knowledge-intensive, nutrient management systems that have met with limited success, especially where poverty and hunger force farmers to employ desperate short-term survival strategies that take precedence over longer term sustainability practices. Hence, efforts should be made to increase the efficient use of mineral fertilizers through sound policies and education, to attain economic growth and food security targets while minimizing the damage to the resource base.

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In 2006, The Rockefeller Foundation and the Bill and Melinda Gates Foundation partnered to launch the Alliance for a Green Revolution in Africa, or AGRA, based on a shared vision that investing in agriculture is the surest path to reducing poverty and hunger in Africa. AGRA works across the continent to help millions of smallholder farmers boost their farm productivity and incomes. AGRA is supporting and partnering with both the public and private sectors to develop the systems that ensure sustained availability, delivery and adoption of improved seeds and fertilizers, with a particular focus on getting these inputs into the hands of women farmers, and taking innovative crop varieties and soil and crop management techniques to

scale.