USAID AFRICA BUREAU FERTILIZER INFORMATION SHEET

Background –
Low soil fertility is a problem throughout most of Sub-Saharan Africa (SSA). Moreover, the drastic reduction in fallow periods and the almost continuous cropping without soil fertility restoration has depleted the nutrient base of most soils. By the mid-late 1990s, all SSA countries were demonstrating a negative annual nutrient balance [1]. Countries that have the highest nutrient loss rates are the ones where fertilizer use is low and soil erosion is high. These areas include the East African highlands and a number of countries in West Africa.

Low soil fertility is also a driving force behind the conversion of natural areas for agricultural extension. It is generally accepted that agricultural intensification is the only viable means to conserve key natural areas while increasing food security for the continents growing population and generating economic growth through improved agricultural productivity. Land degradation undermines the ability of countries to move in this direction, and the loss of soil nutrients is the most important contributing factor to the land degradation process. The use of inorganic fertilizers is a critical part of the strategy to stop land degradation, restore soil fertility and better manage the soil resources that are fundamental for sustainable agricultural and economic development.

Fertilizers and USAID Environmental Procedures (22 CFR 216) –
Fertilizers are frequently lumped together with pesticides under the generic heading of "agro- or agrichemicals." From an environmental compliance perspective (22 CFR 216), as well as from a field-level implementation point of view, this is inappropriate, because it implies that fertilizers require the same level of scrutiny reserved for pesticides. Whereas pesticides are subject to clearly defined environmental review procedures [22 CFR 216.3(b)(1)], and an approval process to promote safer use and integrated pest management, such procedures do not apply to fertilizers (procurement procedures do apply to quantity bulk purchase). As with any technology, however, it is recommended that fertilizers be thoughtfully employed according to best practice, promoting integrated soil fertility management, within the context of the prevailing biophysical and socio-economic conditions, as well as the desired outcomes. This fact sheet was developed to assist in that regard.

Importance of Water Management to Nutrient Uptake –
Proper water management is important for maximizing crop use of nutrients. About 97% of crop nutrient uptake is from soil solution (water-soluble nutrients), which makes water by far the most important nutrient or fertilizer delivery medium. This also means that, for the most part, nutrient mobility is directly linked to water movement. In sandy soils, nutrients move more quickly through the root zone and soil profile than in other soil types, and excessive water application (or heavy rainfall) can lead to nutrient loss through leaching. Run-off is most serious on loamy-sands or sandy loams that often have a strong surface crust formation. In heavier soils (clays), if nutrients are not adequately incorporated into the soil, the chances for surface runoff in the event of heavy rains or over-irrigation are increased. Sound water management is especially important in rainfed conditions (common throughout SSA). Overall, good water management leads to a more efficient use of fertilizers and increased nutrient uptake and vice versa.

General Soil Fertility Trends in Africa --

- Farmers who have taken measures to conserve moisture or increase soil organic matter are more likely to use inorganic fertilizer. When farmers in some areas have capital, they often invest first in increasing moisture retention and/or increasing soil organic matter and secondly in inorganic fertilizer.
- Farmers increase their use of fertilizer when investing more money in fertilizer is seen to be the best available option. This increase may result from changes in any of the following: fertilizer

price, crop price, fertilizer availability, water availability, seed availability, knowledge about fertilizer use, or cropping pattern.

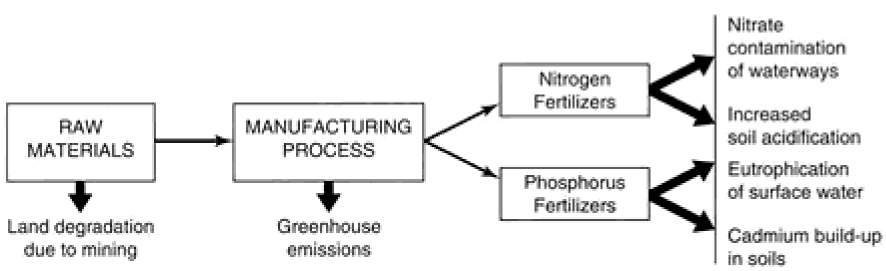
- In West Africa, integrated soil fertility management is progressively adopted. It concerns the combined use of soil amendments and inorganic fertilizer, leading in time to improved soil fertility and increased fertilizer use efficiency and profitability. The nutrient losses to the environment are decreasing.
- Given past and current use rates, USAID's fertilizer-related activities in Africa are unlikely to cause environmental problems.

Fertilizer Application guidelines --

- Before applying fertilizers, obtain an assessment of soil conditions (fertility).
- Indiscriminate use of chemical fertilizers should be avoided.
- Different kinds of fertilizers are required in order to maintain a given level of soil fertility. This depends on site-specific factors, including the soil type, the nutrient requirement of the crop and the various sources of available nutrients. Nitrogen and Phosphorous are the most important nutrients lacking in SSA soils.
- Fertilizer application has to be considered in the context of the overall farming system. This includes the use of organic manure and residues, soil cultivation and crop rotation and water harvesting. Collectively, these factors influence the efficiency of nutrient use.
- When fertilizers are used, it is very important to apply the correct amount for the given situation. The challenge to the farmer is to match as closely as possible the input of nutrients to the nutrient uptake of the crop, thereby minimizing losses. Over fertilization is both costly (wasteful) and potentially harmful to the environment. To apply the correct amount, the farmer has to define his production goal.

Potential negative environmental effects of fertilizers --
Excessive application of nutrients over time can cause pollution. Such losses may occur when nutrients run off the land caused by heavy rainfall, are leached through the soil, beyond the root zone, eventually reaching the groundwater, or escape into the atmosphere as volatile gases.

Aspects of environmental impact can be illustrated as follows:



(Taken from Incitec Fertilizers)

Nitrogen fertilizers: Inorganic nitrogen fertilizers are readily converted by soil organisms to nitrate in the soil. The nitrogen in soil organic matter and organic fertilizers becomes available more slowly. Nitrates may be readily leached if not used by crops or other vegetation. Leaching is particularly likely in sandy soils following heavy rainfall. Leached nitrates may contaminate underground water. This is of concern if the water is to be used for human or livestock consumption, as high concentrations of nitrate may affect health.

Nitrogen fertilizers can also accelerate the natural process of soil acidification. Some fertilizers (e.g. anhydrous ammonia and urea) may initially raise the soil pH at the site of application but in the long term acidify the soils. This occurs when ammonium is converted to nitrate. Acid produced in the nitrification process is used if the nitrate is taken up by plants or soil organisms, but if the nitrate is leached beyond the root zone, acidification occurs. Soil acidification reduces the availability of the trace element molybdenum, fosters the development of aluminum, iron and manganese toxicity and increases nodulation failure in legumes. Lime may be required where acidity is a problem (obtained from naturally occurring calcium carbonate) or the use of acid tolerant plant species can be considered. An illustrative list of crops with acid tolerant varieties include: rice, cassava, mango, cashew, citrus, pineapple and cowpeas.

Phosphorus fertilizers: Excess amounts of phosphorus have been associated with algal blooms and the eutrophication of lakes and waterways. In most waters, phosphorous functions as a growth-limiting factor because it is usually present in very low concentrations. Algae only require small amounts of phosphorous to live. Excessive phosphorus over-stimulates the growth of algae, which could deplete the water of the dissolved oxygen that is vital to other aquatic life. Phosphorus is relatively immobile in the soil, so conservation and cultural practices which reduce soil erosion can significantly reduce phosphorus inputs into water bodies and the water table.

Phosphorus fertilizers contain various impurities from the phosphate rock and acid used in manufacturing the fertilizer. Cadmium increases is the greatest concern as its compounds are toxic to human beings. Cadmium increases are most noticeable in certain crops e.g. potatoes and leafy vegetables (lettuce and spinach) and in the organs (kidneys and liver) of animals. Almost all phosphate fertilizers contain traces of cadmium, and the concentration of cadmium varies considerably from source to source. At this time, there are efforts underway in West Africa to develop viable processes to remove cadmium from phosphate rock. Exports of rock phosphate represent a vital source of revenue for a number of developing countries in Africa.

Fertilizer Effects on Soil Biology: Good soil consists of 93% mineral and 7% bio-organic substances. The bio-organic parts are humus (85%), roots (10%) and soil organisms (5%). Most of the soil organisms are decomposers (bacteria and fungi), which are responsible for nutrient retention in soil. In order for nutrients to become available they must be mineralized by the interaction of decomposers and organisms that feed on the decomposers (protozoa, nematodes, micorarthropods and earthworms). Plant growth is dependent on microbial nutrient immobilization. When the number of decomposers declines in soils, more nutrients are lost into the ground and surface water. Heavy treatments of chemical fertilizers can kill decomposers and other soil organisms, which will lead to a reduction in nutrient retention and possible surface and ground water contamination.

A summary of best management practices for soil fertility and health --

- Practice Integrated Soil Fertility Management (ISFM) – the use of both organic and inorganic sources of nutrients rather than either alone;
- Use of legume cover crops (plus phosphorous) and green manures by fallow rotation or intercropping;
- Promote agroforestry practices – in addition to soil conservation and production benefits, agroforestry transfers/cycles nutrients from within the soil profile (deeper levels to surface);
- Use conservation tillage rather than deep plowing (although conservation tillage can be harmful for production systems in certain regions [2]);
- Use farm site manures and household wastes, with or without composting;
- Choose crops and associated plants that have high nutrient use efficiency.

End Notes:

1. Henao, J. and Baanante, C. 1999. Estimating rates of nutrient depletion in soils of agricultural lands of Africa. Technical Bulletin. IFDC – T 48. IFDC, Muscle Shoals, Alabama. 76p.
2. Hoogmoed, W. 1999. Tillage for soil and water conservation in the semi-arid tropics. Phd thesis, Wageningen University, Holland.

Additional Reading:

Wallace, M.B. 1997. Fertilizer Use and Environmental Impacts -- Positive and Negative: A Review with Emphasis Upon Inorganic Fertilizers in Africa. Winrock.

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Kelly, V.A., Crawford, E. and Jayne, T.S. 2003. Agricultural input use and market development in Africa: Recent perspectives and insights. Policy Synthesis, no. 70. USAID, Bureau of Agriculture and Food Security and the Office of Sustainable Development.

The Soil Foodweb: Its importance in ecosystem health. www.rain.org/~sals/ingham.html

Swift, M. Soil Biodiversity Principles, Tropical soil and biology fertility programme. www.unep.org/bpsp/Agrobiodiversity/agrobiodiversity%20thematic/soilbiodiv.pdf.

European Fertilizer Manufacturers Association. Agriculture, fertilizers and the environment. www.efma.org/Publications/EUBook/Section13.asp.

The PotashCorp. Fertile Minds Program. http://www.fertile-minds.org/support/cdrom_available.php.

Incitec Fertilizers. http://www.incitecfertilizers.com.au/environmental_facts.cfm.

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