Sustainable land management and soil productivity improvement in support of food security in sub-Saharan Africa

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Introduction

Land degradation will remain an important global concern because of its adverse impacts on agricultural production, food security and the environment. Inappropriate land management, particularly in areas with high population densities and fragile ecosystems, further increases loss of productivity of resource - poor farmers. This in turn affects their food security and livelihood.

Large areas of sub-Saharan African soils, in particular, are affected by various types of degradation, including fertility decline. Soils in most SSA countries have inherent low fertility and do not receive adequate nutrient replenishment. Consequently, yields are relatively low despite the high potential for improvement.

The major problems of soil productivity in SSA are:

- **Population growth:** population has to date increased faster than the increase in production.
- **Pressure on land:** cultivated areas are increasing (mostly on marginal lands) to compensate the low yields from existing cultivated land.
- **Food production:** yields in many areas remain low and most farmers cannot purchase inputs.
- **Land degradation and soil fertility decline:** soils are exploited without restoration of soil fertility. See Land Degradation Assessment in Drylands (LADA) web site.
- **Droughts:** climate patterns are changing, leading to an increased incidence of droughts and floods in some areas.
- **Land rights:** insecurity of tenure is a major impediment to land management and conservation, and hence to food security. See FAO's land tenure web site
- **Technology:** there is a lack of well-adapted technologies and irrigation is not yet a viable option in many places; there is also a lack of economic incentives for farmers to adopt soil productivity improvement technologies.

Soil fertility management - a main issue for food security and agricultural development in SSA
As the main source of economic activity in SSA is agricultural production, declining soil productivity means not only that less food can be grown but also that production of cash crops for export is endangered. It is therefore essential that production and soils be managed in a sustainable way, so that the present generation is fed and soil conditions are improved to support future generations.

Issues related to major problems of soil fertility management in SSA, managing soil fertility in different agro-ecological zones, need for action for sustainable soil fertility management, as well as succesful experiences in land management and sustainable agricultural development initiatives are provided in **two recent FAO publications**:

"Soil fertility management in support of food security in sub-Saharan Africa" Download [55 pages, 1148 kb]

"Land and Agriculture: A compendium of recent sustainable development initiatives in the field of agriculture and land management" Download [59 pages, 2083 kb]

Need for action for sustainable land management and soil productivity improvement

The importance of holistic and integrated approaches
Almost all of sub-Saharan Africa needs to increase the production of food crops, and this need will become more urgent during at least the next twenty-five years. Part of the need will be met by the cultivation of more land, but most of the need must be met by raising the productivity of land already cultivated. The productivity of much of the new land is likely to be low, as most land of high production potential is already cultivated. Measures to increase the productivity of both presently cultivated and new land are urgently needed.

To meet the rate of population growth, yields must grow at a rate considerably greater than today, even to maintain present low nutritional standards. The extra yield must also be obtained without causing further degradation of the soils, and indeed the fertility of the soils will have to be raised.

First and foremost, the farmers (men and women) will need to make the necessary changes, and governments must assist them in developing their farming practices in such a way that production is increased on a sustainable basis.

Ensuring that the options for increasing productivity are available is a task for scientists concerned with agricultural production and land management. Social scientists and economists must also participate in the research to ensure that proposals for change are economically viable and socially acceptable. Also, all the factors involved in improving soil fertility and soil productivity should be integrated. Measures to prevent degradation as well as methods to increase productivity must be included. Integrated and holistic approaches (and not segmented technical interventions) of soil and nutrient management for conserving soil quality and enhancing its productivity are required.

Many long- and short-term experiments in SSA, and elsewhere in the tropics, have shown the need to maintain soil organic matter as well as nutrient status. The organic matter provides a balanced supply of macro- and micronutrients and helps maintain and improve the physical and biological condition of the soil.

Soil Fertility Initiative
In support of the larger goals of poverty alleviation, food security and environmental protection, the Soil Fertility Initiative (SFI) was launched in 1996 with support from the World Bank, FAO, the CGIAR, IFDC and other multi-and bi-lateral donors. The major objective of the SFI is to improve the productivity of cultivated land and the revenue of farmers in SSA through a combination of technology adaptation and policy reform.

Current common understanding of the SFI
Participants in the informal SFI Consultation (Rome, November 1998) agreed that the SFI activities should result in short-term economic benefits to farmers as well as in the longer-term restoration of the nutrient capital in the soil. Policy and institutional improvements are essential to the success of SFI.

- The SFI must be country-driven and national ownership should be ensured from the onset. National institutions and farmers' groups need to be the driving forces of the SFI in each

country. All stakeholders should be involved in all phases of action. The formulation of National Action Plans and their implementation will need international facilitation and external expertise. Such Action Plans will serve as a basis for mobilizing necessary human, institutional and financial resources. A network consisting of a broad range of partners is needed for SFI to succeed.
- The SFI will increase the benefits from existing programmes. Incremental funding, however, would not be excluded if governments commit themselves to the restoration and management of soil fertility, through the SFI action plan, as an element in an overall strategy for sustainable food security.
- In many African countries, national and international actors are working to enhance food security in the framework of the Special Programme for Food Security (SPFS). The SFI should promote a focus on the actions to restore, maintain and increase soil fertility in ongoing and new programmes, supported by multilateral and bilateral donors, NGOs, national and international agricultural research centres. Close links and coordination with the ongoing SPFS should be established or reinforced.
- National enabling policies and infrastructure are needed to remove market, economic, institutional and legal constraints, in order to provide the farmers with effective opportunities for responsible land management and input use. Supporting government action is thus essential for successful land productivity improvement.
- Where there is a consensus that land husbandry approaches to soil productivity enhancement are appropriate, adjustments are needed in the way in which research is organized, so as to bring specialists and stakeholders, working on the different aspects of soils and land management, together in interactive teams.
- It is also necessary to shift extension away from the prescription of uniform packages to farmers and promote extension methods that help farmers in making their own assessment of constraints and options for improving soil productivity within their particular farming situation, and that encourage farmer experimentation. This has led to a particular interest in exploring how the farmer field school approach can be broadened to help farmers cope with the wide-ranging agronomic, technical and economic issues related to soil productivity.

In each of the countries where the SFI process is operational, momentum has been gathering and a number of national experts have been involved in developing the concepts and are keen to pursue them. In most countries, even the modest step-by- step process of the SFI is confronted with funding constraints, although the main donors appear to be supportive in principle.

Support at the political level varies among countries, and will probably not emerge strongly until concrete results are seen on the ground. The greatest danger facing the programme is that this momentum could be quickly lost because of a lack of funds to move forward. There is a need to review, country by country, opportunities to include SFI related activities into ongoing projects and programmes. This review should take place once a consensus is reached on the overall strategy to restore soil fertility.

Promoting integrated land management and soil productivity improvement through Farmer Field Schools

Innovative participatory extension approaches such as farmer field schools can increase the capacity of farmers to respond adequately to changing farming situations. Farming circumstances are continually being transformed by periodic changes in technical, economic, social and environmental factors that force farmers to change their production and/or management practices. It is the farmer’s ability to take advantage of new opportunities and to cope adequately with new problems that will determine his success in improving and sustaining the productivity of his farm. To achieve this, farmers need to test and evaluate management options in line with their biophysical and socio-economic environment. A farmer’s capacity to respond to changing circumstances becomes all the more important where farmers have no access to regular and reliable technical support from extension agencies. A second objective of the FFS approach is to increase farmer's knowledge and skills in improved soil and nutrient management practices.

Conducting a FFS for the purpose of enabling farmers to learn the principles and practices of integrated soil and nutrient management should be an essential part of a long-term and dynamic strategy for sustaining and enhancing agricultural productivity.

The focus should not just be on diagnosing the nature and extent of the various land degradation and fertility decline processes locally at work and seeking ways to combat them. The FFS should also focus on the rehabilitation, conservation and sustainable management of the land and water resources, leading to enhanced, land productivity and improved living conditions at farm and community level.

More information:

Guidelines and Reference Material on Integrated Soil and Nutrient Management and Conservation for Farmer Field Schools - Download [164 pages, 9.2 MB]

Documents section

Important components and principles of integrated land management

Organic resources and soil biological functions
Major beneficial effects of the use of organic materials to replace nutrients that are removed from the land, essentially by harvested crops, and to improve soil quality and health have been demonstrated throughout the world in both smallholder and industrial agricultural systems. Soil organic matter plays a central role in enhancing and sustaining soil productivity while contributing to improved soil structure and water retention, thus allowing effective use of water and nutrients by plants, and maintaining water quality through its filtering effects. It also contributes to carbon sequestration. Of vital importance, soil organic matter provides the food source for soil biological activity, especially soil macro-fauna (such as earthworms) which maintain soil structure and porosity and improve water permeability and the wide range of soil microbial populations, which decompose organic matter and promote nutrient availability and uptake by plants. See also **FAO's web site on Soil Biodiversity**.

Integrated plant nutrition systems
FAO promotes an **integrated plant nutrition systems** (IPNS) approach that involves mobilization of all available organic sources, augmented as required by mineral sources, to facilitate synergy and ensure balanced nutrient availability for sustainable crop production. This requires integrated approaches for the management of soil, water and crops and where possible livestock, which provide valuable manure and make good use of crop residues. Nonetheless in many smallholder farming systems there are conflicts over the use of the precious crop residues for soil cover and organic matter replenishment, livestock feed, housing and craft materials and energy source. These materials are unlikly to be used to replenish soil nutrients and enhance soil organic matter content where there are other needs.

There are many actions that farmers can take to maintain and greatly improve and rebuild the quality and health of their soils, especially soils that have been under cultivation for a long time. However, it may take several years to overcome soil production constraints such as compaction, hardpans, loss of soil aggregation, low porosity, water permeability and organic matter and to restore a well functioning and healthy soil. The challenge is to develop and promote soil management practices that enhance soil organic matter restoration and nutrient use efficiency and ensure profitability. See **FAO's programme on IPNS** .

Organic and Conservation Agriculture
There are currently two great opportunities which depend on restoring organic matter and soil health. Firstly, **organic agriculture**, which relies on recycling of nutrients and biological control of pests, weeds and diseases, hence eliminating the use of chemical inputs, provides enhanced value for organically certified products that meet consumer preference. Secondly, **conservation agriculture** relies on reduced or zero tillage systems (which maintains a cover of surface residues and cover crops avoiding the rapid organic matter decomposition induced by tillage) through which the seed is directly planted. Both enhance soil biological activity thereby maintaining soil structure, enabling water infiltration and reducing soil erosion and enhancing plant nutrient uptake. See **FAO's sites on organic agriculture and conservation agriculture**.

Integrated soil management principles
In low and medium intensity production systems, which are prevailing in sub-Saharan Africa, management practices that increase nutrient recycling, the use of organic sources of plant nutrients and fertiliser use efficiency should receive greater attention. For example:

- improving crop rotations: legumes grown as a food crop or live mulch (cover crop) can be successfully rotated with a crop which produces high biomass or intercropped with tree species (e.g. alley cropping) in order to provide N ,enhance organic matter content and prevent soil erosion;
- maximising organic matter production through green manure, cover crops and agroforestry;
- enhancing natural processes of nutrient cycling (soil micro-organisms, plant roots, predator insects) through managing plant-soil-pest-predator interactions;
- soil cover (mulch, cover crops) to supply nutrients, reduce weeds and labour, reduce heat and nutrient losses and enhance functions of soil biota and plant roots;
- no or reduced tillage, which in addition to the benefits of soil health and enhanced productivity, also reduces labour and energy costs while enhancing water quality, soil conservation and carbon sequestration;
- selection and breeding of crop species with higher nitrogen use efficiency, resilience to deficiencies and nitrogen fixing capacity; and,
- maximising crop, soil and animal biodiversity to reduce disease and pest outbreaks and maintain a balanced nutrient supply, provide resilience and multiple benefits (through OM decomposition, nutrient cycling and enhanced soil structure).

Biological nitrogen fixation
Above all, the natural process of **biological nitrogen fixation** (BNF) constitutes an important source of nitrogen for crop growth and protein production in many soils and ecosystems. It provides a major alternative to the use of commercial nitrogen fertiliser in agriculture. Biologically fixed N_2, either asymbiotic, associative or symbiotic, is considered a renewable resource, which should constitute an integral part of sustainable agro-ecosystems globally. Limitations to BNF include poor biophysical conditions in degraded soils, soil moisture constraints and P, Ca, Mg and Mo deficiencies as well as high soil acidity (Aluminun toxicity) or salinity.

Several opportunities to enhance BNF inputs are available across different agro-ecosystems and socio-economic conditions and should be promoted. These include:

- inoculation to increase effective symbiotic and associated organisms in the system (Rhizobium bacteria and arbuscular mycorrhiza) and reduce N fertiliser needs;
- screening and selection of well-adapted high BNF legume species;
- crop management practices that enhance biological processes of N fixation and recycling: green manures (e.g. vetch, berseem and sweet clovers), no-tillage with cover crops and improved rotations, enriching long-term fallows (e.g. Tephrosia), intercropping, live mulch and alley cropping as alternatives to traditional bush fallow; and,

- combining such practices with soil moisture conservation and water harvesting in drier areas.