Proceedings

Agricultural Research and Development for Sustainable Resource Management and Food Security in Kenya

End of Programme Conference

Kenya Agricultural Research Institute
11 - 12 November 2003
SCALING UP OPTIONS FOR IMPROVING SOIL FERTILITY IN WESTERN KENYA: THE CASE OF COSOFAP

A. Njui, Q. Noordin, Z. Magara, B. Jama, and G. Ayaga

Introduction

Over the last 12 years, the World Forestry Centre (ICRAF) and its collaborators in the Western Kenya region have been evaluating and disseminating agricultural technologies, including agroforestry interventions, for improving soil fertility and farm productivity and for enhancing welfare impacts. Farmers and communities have been key participants in this research/development continuum. All the partners are members of the Consortium for Scaling up Options for Increasing Farm Productivity (COSOFAP) in Western Kenya. Great impacts on farm productivity and livelihoods have been realized.

Key achievements have been reported in developing and disseminating integrated soil fertility management (ISFM) options. Examples are short-duration (6-12 months) improved fallows with leguminous nitrogen-fixing species, such as Sesbania sesban and Crotolaria grahamiana; biomass transfer of Tithonia diversifolia (which completely decomposes within 72 hours) that can be grown around and within farms to make boundaries or contour hedges; and the combination of phosphorus fertilizers (including the reactive Minjingu phosphate rock) with improved fallows, tithonia and farmyard manure. These options that can increase yields of maize 2 to 3 fold were tested and adopted by thousands of farmers in pilot sites in Vihiga and Siaya Districts. Besides yield improvements, other benefits that have accrued from improved soil fertility management strategies include Striga hermonthica control, fodder, and production of fuel wood and stakes for climbing beans.

The above technologies are adoptable and ready to transfer to farmers. The focus on these technologies is based on farmers’/communities’ needs and priorities in Western Kenya. Fairly high adoption rates have already been documented within the last 5 years. Thousands of farmers are now adapting and adopting various soil fertility technologies and examples of impact (biophysical, socio-economic and institutional) have been noted at the plot, farm and watershed level.

In addition, more than 15,000 farmers in Western Kenya are now using integrated soil management options that have multiple benefits that include fuelwood production in situ; nitrogen fixation and recycling of other nutrients; deep nitrate capture; pest management; soil and water conservation; and carbon sequestration. Tree fallows accumulate all essential nutrients that they absorb from the soil, including micronutrients. Such nutrients are returned to the soil to fertilize subsequent crops of maize, and these result in significant increases in yield (Sanchez and Jama 2002).

The current challenge is to scale up these options and their benefits to the millions of potential beneficiaries in the region. The key constraints to achieving this goal are the weak institutional delivery mechanisms: lack of effective participation of farmers and other clients in development and lack of extension of technologies.

ICRAF’s programme in Western Kenya catalyses collective action among its partners to help address these problems. In consultative workshops on technology development and dissemination organized by ICRAF, the staff has found that there is a strong need to strengthen farmers’ and partners’ capacities in agricultural production for increased crop yields.

This paper presents some highlights of the collaborative approach that ICRAF and its partners in Western Kenya have undertaken, highlighting challenges and opportunities for
advancing impacts towards replenishing soil fertility and improving livelihoods. This is done by first providing a brief description of the consortium, followed by highlights of the integrated soil fertility management (ISFM) options being scaled up. Next, the various applications in the region are discussed and the key lessons learnt while operating within the context of a consortium.

The Consortium of Partners in Western Kenya

As a member of COSOFAP, ICRAF has coordinated the consortium since its inception in January 2001. The consortium has more than 60 partners active in Western Kenya, consisting of farmer groups and associations, non-governmental organizations (NGOs), community-based organizations (CBOs), research and development organizations (including the Kenya Agricultural Research Institute and Kenya Forestry Research Institute), and the extension branch of the Ministry of Agriculture and Rural Development. The major aim of the network is developing and disseminating options for improving farm productivity, including agroforestry.

COSOFAP partners joined efforts upon realization that each partner’s success was limited to a few pilot sites and that efforts to cover more ground and people were hampered by the uncoordinated nature of the various research and development organizations in the region. This resulted in duplication and fragmentation of effort and, hence, low adoption rates of options and/or poor impact. There was also lack of fora for joint activities and information sharing sessions. To correct this situation, there was need for the organisations to forge strong partnerships and to add value to each other’s programs. Thus COSOFAP was formed.

Consortium members are organizations and institutions interested in promoting improved farming practices in a sustainable manner. COSOFAP’s goal is to alleviate poverty among resource-poor farmers in Western Kenya by increasing farm productivity through environmentally sustainable means. To do this, it develops and disseminates various options for improving farm productivity, including agroforestry. It also works to improve and increase farm productivity through networking of research and development partners so that appropriate natural resource management options and information are made available. The consortium also strives to develop community self-reliance by supporting communities as they identify needs and understand the benefits of alternative interventions, and by paying some costs associated with acquiring necessary skills or information to move forward. The consortium also distributes to extension providers, farmer trainers and other farmers extension leaflets that present new findings from research and development partners and farmer evaluations of technology options. These materials are distributed during field days, exchange visits and workshops.

Integrated Soil Fertility Management (ISFM) Options

The consortium partners have developed various options, including integrated nutrient management strategies for managing soil fertility, diseases and pests such as *striga* (*Striga hermonthica*) that are often associated with declining soil fertility. Two key interventions are improved fallows and biomass transfer. Leaving land fallow with natural weeds is a common practice among farmers to improve soil fertility and crop yields. For example, surveys conducted in Vihiga, Siaya, and Kisumu Districts of Western Kenya show that 52% of the farmers leave their land under natural fallow for at least one cropping season per year, mainly during the short rainy season. Ten to fifty percent of the total land holding might be left to fallow in order to improve the soil fertility or because of insufficient labour. To facilitate the soil fertility initiative activities, COSOFAP has undertaken the lead in bulking and distributing quality and quantity germplasm.
Improved Fallows

Several publications from the East and Central Africa (ECA) regions highlight the science and practice of improved fallows in that region. Natural fallows of 1-2 seasons generally do not improve soil fertility and crop yields significantly in Western Kenya, although this effect is likely to be site- and fallow-specific. Natural fallows can, however, be improved by the deliberate introduction and planting of fast growing trees and shrubs, preferably leguminous ones. Fallows of leguminous trees or shrubs accumulate nitrogen in their biomass through biological N₂ fixation, capture of subsoil nitrogen not utilized by crops, and interception of nitrogen leached beyond the crop rooting zone (Buresh and Tian, 1998). The improved fallows can also be used in combination with inorganic fertilizers.

Leguminous trees and shrubs such as Sesbania have been reported to fix large quantities of nitrogen (Rao et al., 1990). Planted fallows with deep-rooting trees or shrubs can also access and recycle subsoil nitrogen unavailable to crops (Jama et al., 1998). Build-up of subsoil nitrogen can be as high as 70 to 315 kg N ha⁻¹ in oxisols and oxic alfisols such as those in Western Kenya, where the soils possess substantial anion exchange capacity, where net N mineralization exceeds N uptake by the crop, and where high rainfall can leach nutrients to the subsoil (Hartermink et al., 1996; Buresh and Tian, 1998). Nitrogen accumulated in the aboveground biomass of planted tree fallows is returned to the soil upon clearing and incorporation of the fallow biomass into the soil for subsequent cropping. Additionally, fallows increase labile fractions of soil organic matter, which supply nutrients to crops following fallows (Barrios et al., 1997).

The choice of species for planted fallows and systems depends on the adaptation of the species to the biophysical and socio-economic conditions of a given site. Several species with potential for planted fallows in ECA have been identified and appropriate management practices for their integration into the farming system have been developed. Some of the promising species are Crotalaria grahamiana, Tephrosia vogelli and Sesbania sesban. Sesbania is native to the area and is particularly popular with farmers for its soil fertility improving properties and as firewood. The other species are recent introductions. These species are relay-cropped with maize 4 to 5 weeks after maize is sown.

Relay-cropping minimizes negative effects of the trees on the crop while at the same time allowing the trees to benefit from husbandry practices provided to the crops, such as fertilizer application and weeding. It also permits tree growth to be extended for two seasons. When the crop is harvested at the end of the first season (July—August), the trees are left to grow during the second (6 month) season until they are cut in February or March and the cropping cycle is repeated. The cycle is repeated as long as necessary to improve the fertility and productivity of the soil. Once the trees are cut, the wood is removed and the leaves and small twigs are left on the field and incorporated into the soil during land preparation. Depending on how much weed control was achieved during the fallow period, it is possible to plant the next crop with little or no tillage after the fallows are cut.

Control of Striga hermonthica

Sesbania sesban and other tree fallows have decreased the soil seed pool of the parasitic weed Striga hermonthica by 50% in Western Kenya. Although the processes are not well understood, it is suspected that the fallows excrete substances that stimulate germination of striga seeds followed by subsequent death of the seedlings due to lack of a suitable host (suicidal germination) (Gacheru et al., 2001). Repeated fallows result in the gradual elimination of this very damaging weed, partly because striga does not thrive in soils that are rich in nitrogen. In addition, tree fallows shade out many other common weeds by providing a continuous tree canopy during dry seasons.

Tithonia Biomass Transfers

The Mexican sunflower Tithonia diversifolia accumulates high concentrations of nutrients in its leafy biomass that mineralize very
Scaling up options for improving soil fertility in Western Kenya

rapidly when incorporated in the soil. *Tithonia* is widely distributed along farm boundaries in the humid and subhumid tropics of Africa, generally at elevations between 500 and 2000 m, and is a common fallow species in the uplands of Southeast Asia and Latin America as well (Jama et al., 2000; Gachengo et al., 1999). *Tithonia* biomass transfers have been shown to double maize yields without the application of mineral fertilizers in a wide variety of farmer trials conducted in cooperation with NGO’s in Western Kenya.

*Tithonia* leaves decompose rapidly in the soil, providing a source of soluble carbon that enhances nutrient cycling (Gachengo et al., 1999). In addition to providing nutrients, *tithonia* applied at 5 tonnes of dry matter ha\(^{-1}\) reduces P sorption slightly and increases soil microbial biomass of carbon, nitrogen and phosphorus. Given the large additions of soluble carbon and nutrients to the soil when *tithonia* leaves decompose, these processes may enhance phosphorus cycling and therefore the conversion of mineral forms of phosphorus into organic ones.

It is important to note that the transfer of *tithonia* biomass from hedges to cropped fields constitutes the redistribution of nutrients within the farm rather than a net input of nutrients from outside the system. External inputs of inorganic fertilizer are eventually required to sustain production of *tithonia* when biomass is continually cut and transferred to agricultural land.

The economic benefits of *tithonia* will likely be higher at sites with both nitrogen and potassium deficiencies because *tithonia* effectively supplies potassium, which is frequently not present in the fertilizers available in the local markets. Farmers in Eastern Uganda are using *tithonia* to fertilize bananas, a crop with high potassium requirements.

COSOFAP Activities in Support of Replenishing Soil Fertility in Western Kenya

Within the Western Kenya region, COSOFAP has focused on the highlands, where high population pressure and the associated problem of small and often fragmented land holdings has led to environmental degradation. This has resulted in declines in soil fertility and land productivity. In general, the soils are phosphorus deficient, in part due to their medium to high P fixing capacity and in part due to depletion through cropping for long periods of time with few or no inputs (Smaling et al., 1997). To a lesser extent, the soils are also nitrogen and potassium deficient.

To mitigate these problems, several programs and projects to develop and disseminate options for improving farm productivity (in particular soil productivity) were initiated in Western Kenya over the last 10-15 years. Some of the major programs include:

- A pilot project on soil fertility recapitalisation and replenishment in Western Kenya, which is a collaborative project between KARI-KEFRI-ICRAF
- The African Highlands Initiative, an ecoregional program with a benchmark site in Western Kenya
- The Legume Research Network Project (LRNP)
- Sustainable Community-Oriented Development Project (SCODP)
- KARI-Kisii, with the Participatory Research in Integrated Agro-ecosystem Management (PRIAM) project
- KARI-Kakamega, with the PLAR (Participatory Learning Action Research) Project

A number of organizations have also initiated projects to address soil fertility research. These include: KARI, with activities on potassium research; ICRAF, working on
agroforestry research and development; the Kenya Forestry Research Institute (KEFRI); the International Centre for Research on Maize and Wheat Improvement (CIMMYT); Tropical Soil Biology and Fertility Programme (TSBF); and the International Centre for Research in Insect Physiology and Ecology (ICIPE). COSOFAP activities are built around the research of these organisations.

To achieve its objectives of improving farm productivity and incomes, COSOFAP supports field demonstrations, exchange visits and study tours, development and/or multiplication of extension materials, and capacity building through short training courses and field days. These activities promote the use of new technology and the participatory process.

All the activities of the partners are conducted through the use of Interactive Learning Sites (ILS). Learning sites (see Figure 1) are information exchange sites where partners and farmers come together and share their experiences and observe on-going technologies at demonstration sites. These locations, dotted strategically all over the Western Kenya region, were or are supported by previous and on-going projects. Examples of such centres are schools, Farmer Field Schools (FFS), National Agricultural and Livestock Extension (NALEP) focal areas, ICRAF/KARI/KEFRI pilot villages, and KARI-Kisii Adaptive Research Farms.

**Lessons Learnt**

During the implementation of its strategies, the consortium of partners has learnt that:

- Partnership appraisal is a critical phase because it is important to identify critical and willing partners. It is essential to recruit active involvement of partners with diverse approaches and options.
- Buy-in is very critical during the early stages, and getting early commitment from decision-makers is essential. Through COSOFAP, the partners have learnt that institutions can be mutually beneficial.
- It is vital to start small then expand and become more inclusive.
- Options and processes must be scaled up.
- All key stakeholders must be involved from the beginning of a project.
- Initially, it is advisable to hold monthly meetings at least for the first six months. A dynamic secretariat is key to running the daily operations of the partnership. Currently COSOFAP lacks a permanent

![Diagram](image)

**Figure 1. COSOFAP – Interactive learning sites of the consortium partners**
Scaling up options for improving soil fertility in Western Kenya

- Monitoring and evaluation processes should be developed and put in place quickly.
- Quality and adequate quantity of germplasm should be in place to support the activities of the partners, particularly at the interactive learning sites.
- Not all organisations will join; therefore, synergy must be created.
- Links should be established with national strategies, such as the National Agricultural and Livestock Extension Programme of the Ministry of Agriculture, to facilitate targeting the farmer.
- There must be transparency and accountability, particularly in use of resources channelled to the partnership.

Way Forward

Similar initiatives or dissemination pathways should be established in other parts of the country. Currently, discussions are under way between the World Agroforestry Centre (ICRAF) and KARI sub-regional centre representatives in Machakos, Embu and Mtwapa on the possibilities of starting consortia for these regions. Plans are at the inception stage.

Additional research institutions should be incorporated at the regional level, especially the International Centre for Research on Maize and Wheat Improvement (CIMMYT), ICIPE, the International Potato Centre (CIP), the International Centre for Research in Semi-Arid Tropics (ICRISAT), and the International Plant Genetic Research Institute (IPGRI), to enhance linkages and information sharing between institutions.

The mandate/scope of the consortium should be increased to include activities in addition to soil fertility and agroforestry.

The challenges faced in implementation of activities should be regarded as opportunities to address emerging problems and issues.

Linkages with other networks and consortia in Kenya and in neighbouring countries should be enhanced, especially with the Integrated Soil Productivity Initiative through Research and Education (INSPIRE), a network in Uganda, and Mwanza non-governmental organization network (MWANGO) in Tanzania.

References


