Farming Systems

A large part of IITA's work focuses on African farming systems-the real-life interactions between agriculture, livestock, the environment, and socioeconomic conditions that enable farmers to successfully grow their crops and raise their animals, and the problems that prevent them from doing so.

As the population increases in sub-Saharan Africa, so the need to produce more food from the land is increasing. In the past, soils could be left for fallow periods between cropping, to allow natural replenishment of nutrients. Now cropping is intensifying, and soil fertility is rapidly declining. The problem is compounded by weeds, which are often favored by poor soils, and then compete with the crop plants. Deforestation, in an attempt to increase land available for farming, adds to the problem by increasing soil erosion as well as reducing biodiversity. Widespread poverty in the region means little hope of purchasing sufficient inputs such as chemical fertilizers. The result is declining crop yields, degradation of the natural resource base, and increasing poverty and hunger.

In view of these constraints, IITA scientists have been working with farmers and national scientists to identify appropriate solutions to increase productivity in a sustainable way. A number of promising technologies have been developed, and adopted with some success. Some of these technologies are described below; however none is advocated as the sole solution-a combination of improved crop, livestock, and resource management methods is usually the key.

Crop rotation systems

Two or more crops grown alternately on the same land can result in significant yield improvements. The success of these systems depends on the choice of crops, the use of suitable varieties, the cropping sequence, and management practices. Advantages of crop rotation systems are improved soil fertility, especially where legumes are included, complementary use of nutrients, better pest and disease control, organic matter restoration, and improvement of soil physical properties. For example, rotating an improved nitrogen-efficient maize variety with an improved soybean variety can, with optimum use of fertilizer, dramatically increase maize yields. This combination also suppresses *Striga*, a parasitic weed that is becoming a serious threat to agriculture in sub-Saharan Africa.

Cover crops

As an alternative to leaving land fallow, cover crops can be planted in rotation with food crops. The cover crops protect and improve the soil, and help control weeds, reducing the need for laborious hand weeding or use of chemical herbicides. They can also provide the farmer with fodder for livestock. IITA has experimented with several cover crop species. The most promising are legume species, such as *Mucuna*, *Pueraria*, and *Centrosema*, which add nitrogen to the soil, reducing the need for fertilizers. Cover crops may be harvested to provide animal feed, or left on the soil to break down and add nutrients to the soil (known as "green manure").

Cover crop database (Lexsys)

Crop-livestock systems

Successful crop-livestock systems provide fodder for animals as a byproduct of the harvest or from the cover crop, while the animals provide much needed organic inputs for the soil, in the form of manure. IITA collaborates with the International Livestock Research Institute

(ILRI) on research to improve these systems in sub-Saharan Africa. An example of this collaborative work is the development of "dual-purpose" cowpea varieties, that provide nutritious grain for humans as well as good quality fodder, while at the same time improving the soil and suppressing weeds. Another recent finding is improved strip cropping of cereals and cowpea, where 2 rows cereal : 4 rows cowpea gave up to 300% better returns than the traditional 1 row : 1 row system. This was found ideal for crop-livestock integration, and feeding of residues from the improved system resulted in higher weight gain in sheep.

Multistrata systems

Multistrata systems combine annual and perennial crops, allowing farmers to reap benefits in the form of annual food crops while the longer term, income-generating crops are establishing. The systems mimic natural forest structure where vegetation forms several strata. Examples include growing a wide range of food crops with fruit trees, cocoa, palms, or timber trees. The system is proposed as an alternative to slash-and-burn agriculture in the humid forests, with the aim of providing ecological benefits as well as diversifying the farming system and increasing farmers' incomes. It has been shown that the reintroduction of mixed fruit/cocoa agroforests into secondary shrubland can help in the amelioration of global warming by sequestering substantial additional carbon; and it also encourages the re-establishment of much greater biodiversity within the flora and fauna. This research at IITA is based at its Humid Forest Ecoregional Center in Cameroon.

More information

The following IITA projects include work on farming systems:

Protection and enhancement of vulnerable cropping systems

Improvement of high-intensity food and forage crop systems

Development of integrated annual and perennial cropping systems

Impact, policy, and systems analysis

Project 12: Improvement of high-intensity food and forage crop systems

With phosphorus (P) and potassium (K) applied, cowpea yields at Adingnigon on "terre de barre" plateau (dominant soil Nitosols) in the southern Benin benchmark were still low in spite of a good variety and adequate protection from insects. Organic matter addition gave a dramatic increase in grain yield from 131 kg/ha in 1999 to 539 kg/ha in 2000.

The cowpea cultivar IT-90K-59 was tolerant to low-P soil and was able to deplete the stable P fraction (non-Olsen-P) in the rhizosphere in P-deficient soils in the derived savanna in Nigeria.

The response to P addition was related to the Olsen-P content for most soils in the derived savanna and in the northern Guinea savanna villages, showing an inflection point near 12 ppm Olsen-P.

Evidence from trials with 15N-labelled fertilizer indicated that although direct interactions between nitrogen (N) fertilizer and particularly low quality organic matter were substantial, this was not consistently reflected in improved synchrony between N fertilizer supply and uptake by a maize crop. The impact of direct interactions between N fertilizer and high quality organic material, whether incorporated or surface applied, was shown to be minimal.

Medium- and late-maturing soybean resulted in an addition to the soil of 4.2 kg N/ha, whereas the early-maturing varieties resulted in depletion of the soil N reserve by 5.6 kg N/ha in a cereal–legume rotation.

An efficacious cultivar of soybean reduced Striga hermonthica parasitism on a succeeding maize crop and the effect was increased by P application to the soybean in 3 farmers' fields in northern Nigeria.