Consultative Group on International Agriculture Research
An Evolving Research Agenda: Soil Health, Fertility and Conservation

Since its establishment in 1971, the CGIAR research portfolio has evolved from a narrow focus on crop breeding for increased productivity of staple food crops to a broader research agenda that encompasses other factors for agriculture productivity, such as soil health and water resource management. Today, CGIAR research recognizes natural resource management and conservation as key components in the drive to enhance sustainable agricultural productivity. For example, many Centers are focusing their work on finding new management options for protecting and improving the health and fertility of soils. Some of the resulting technologies, outlined below, help farmers adapt to harsh growing conditions and contribute to lowering greenhouse gas emissions by reducing tillage and increasing fertilizer-use efficiency.

Fertilizer trees: An effective approach for restoring and maintaining soil fertility in drylands is the planting of leguminous "fertilizer trees," which capture nitrogen from the atmosphere and make it available in the soil. Researchers at the World Agroforestry Centre have shown in the drylands of southern Africa that these trees, when grown with crops or in fallows, can boost maize yields dramatically. Moreover, once farmers have made the initial investment in establishing the trees, rural communities can handle seed multiplication and extension on their own. Since the late 1990s, when a few hundred farmers began testing the technology, it has spread and is now used by an estimated 200,000 maize farmers.

Zero till: "Zero-tillage" technology is spreading rapidly in South Asia's rice-wheat systems. This technology, by reducing mechanized soil tillage and retaining crop residues in the soil, conserves soil and water, while also raising crop productivity. Promoted by a regional consortium with assistance from CIMMYT and IRRI, the technology has also cut farmers' production costs by lowering fuel consumption for tillage. The combination of reduced soil disturbance and increased retention of crop residues results in lower carbon emissions as well. Close to half a million farmers in India, Pakistan and other countries of the region now apply this resource-conserving technology on more than 3.2 million hectares, with economic benefits so far estimated at US$147 million.

Fertilizer micro-dosing: A variety of new practices, are better enabling farmers in Africa's Sahel region to raise soil fertility. Organic matter and nutrient content are generally low in this region, because growth of vegetation is limited and much of it is removed for feed, fuel and construction. There is ample evidence, though, that fertilizer can boost the productivity of dryland agriculture when rainfall is adequate. However, applying normal doses of fertilizer increases the risk of soil acidification and is cost prohibitive for most farmers in the Sahel. The use of organic matter such as livestock manure and crop residues, is effective, but supplies of these materials are limited.

A safer and more economical alternative is to apply small quantities of inorganic fertilizers in the hole where seed is sown, a practice called "micro-dosing." Practiced by thousands of farmers in Burkina Faso, Mali, Niger and Zimbabwe, micro-dosing helps crops mature more rapidly and escape the worst effects of drought. This and other options are the focus of collaborative research involving the International Crop Research Institute for the Semi-Arid Tropics (ICRISAT), the International Center for Tropical Agriculture (CIAT), the International Food Policy Research Institute (IFPRI) and their national partners. The research has demonstrated that, by practicing micro-dosing, farmers can significantly improve crop productivity and boost their profits.

This work has also shown that micro-dosing may be combined, to good effect, with other measures, such as mulching with crop residues and the placement of small amounts of mixed organic/inorganic fertilizer in soil mounds formed for planting. In Niger, farmers who have adopted these practices are obtaining cash for purchased inputs through an innovative agricultural credit program called “warrantage.” Introduced from Asia, the program is being promoted with hundreds of farmer organizations. Another innovation aimed at making fertilizer more accessible to small farmers involves the creation of links between them and large-scale fertilizer dealers. Such arrangements could contribute importantly to reducing rural hunger.

Precision manuring: Livestock manure, like inorganic fertilizer, is important for raising soil fertility in the African drylands, and there is much scope for making its application more efficient. Toward this end the International Livestock Research Institute (ILRI), ICRISAT, and their national partners are helping agro-pastoralists find more efficient ways to integrate livestock and cropping.

Results indicate that farmers can better manage rates of manure application on cropped areas simply by rotating the night-time tethering sites of their animals. Through this strategy of “precision manuring,” they can concentrate manure application on the “bad spots” or “tired soils” that are most in need of transfusions of nutrients and organic matter. The practice is especially useful for poor farmers, since they don’t have enough land to simply ignore areas of declining soil fertility. Village-level management of precision manuring shows promise for enabling dryland communities to fine-tune the management of agro-pastoral systems across whole landscapes, resulting in higher and more sustainable yields.

Cultivating cactus: This activity, promoted by the International Center for Agricultural Research in the Dry Areas (ICARDA) and its national partners, is gaining ground across North Africa and Central and West Asia. Production of spineless cactus (*Opuntia* spp.), a multipurpose plant, helps boost local supplies of animal feed, which translate into increased income for small farmers, while at the same time helping prevent wind erosion and stabilize sand dunes. Cactus is also a popular food, consumed fresh or processed into jelly, jam and juice. It has medicinal uses as well.

Infra-red spectroscopy: Using infra-red light to detect minute differences in soil composition and structure, a process known as infra-red spectroscopy, the new technique provides farmers with precise, timely information about how to improve depleted soils and boost crop productivity. Scientists at the World Agroforestry Centre (ICRAF), in cooperation with private sector researchers at Analytical Spectral Devices of the United States and the German company Bruker Optik, have adapted the technology to African farm conditions. It is currently being used in Western Kenya as part of the Millennium Villages Project, and in a World Bank initiative to halt land degradation and restore thousands of hectares of degraded farm land to production.

The effectiveness of the technique was first demonstrated in 2000 when scientists uncovered massive soil erosion pluming into Lake Victoria. The problem, they note, was all but unrecognized until the cost-effectiveness of IR made it possible to conduct a diagnostic surveillance survey. In a more recent test, IR was used to pinpoint soil degradation in the 3,500 km 2 Nyando River Basin to assist Kenyan scientists set targets for a World Bank-Global Environment Facility initiative.