# Benefits from TropSoils Research

***Resource-management technologies for sustainable agriculture***

**Natural resources**, with soils as the foundation, are the long-term capital on which nations build and grow. Every country has an endowment of soil, water, mineral, plant, and animal resources. When soil resources degrade below the level necessary to sustain a civilization, the results are catastrophic.

## The TropSoils Goal

The goal of TropSoils is to develop and adapt improved soil-management technologies that are agronomically, ecologically, and economically sound for developing countries in the tropics. To accomplish this goal, TropSoils has focused on researchable constraints to sound *natural-resource management* and *sustainable agricultural production*. The *outreach* thrust transfers these technologies into useable knowledge for policymakers and diverse user groups.

## TropSoils' Global Program

***Thrust 1: Natural-Resource Management*** *(the management, conservation, and enhancement of those natural resources which are most critical to meeting food, fiber, fuel, and shelter requirements, as well as preserving genetic diversity and attenuating climatic change)*

• *Land-Clearing Pressure.* Population pressure in the tropics places extreme production pressure on fragile soil resources. As farm numbers increase, the soil recovery period shortens and soils rapidly degrade to nonproductive levels. Farmers must clear more land to grow the same amount of food. Highly populated countries have little under-used land available. TropSoils has developed sustainable production technologies to reduce land-clearing pressure. After identifying production constraints, TropSoils has demonstrated that forty-three consecutive crops can be grown—without yield reduction—on a fragile soil in the humid tropics.

• *Inadequate Resource Inventory.* Policies to achieve sustainable agriculture production must be based on an adequate technical inventory of the soil resource base. These inventories are often incomplete or not available. TropSoils works collaboratively to collect reliable information on the production capability of soil systems, effects of forest conversion on soil dynamics, and indigenous technology.

• *Landscape Restrictions.* Arable tropical landscapes are often rolling or steep, and are susceptible to water and wind erosion. TropSoils production technologies are being integrated with indigenous technologies to improve the management of entire watersheds. This comprehensive approach conserves soil and water and increases the sustainability of agricultural production.

• *Climate Variability.* In tropical regions, rainfall and temperature extremes have influenced chemical and biological evolution of the soil resources. TropSoils research for production sustainability integrates fertility with water-use efficiency for semiarid regions and nutrient management practices to minimize losses for the humid tropics.

***Thrust 2: Sustainable Agricultural Production*** *(the successful management of resources for agriculture to satisfy changing human needs while maintaining or enhancing the natural-resource base and avoiding environmental degradation)*

• *Soil Acidity.* Most tropical soils are very acid—low in exchangeable bases with toxic levels of available aluminum and manganese. TropSoils research provides options for managing acid soils using crop selection and soil amendments where they are available. A computer-based decision-support system developed by TropSoils guides users to recommendations on liming and crop selections and provides a method for economic evaluation.

• *Nutrient Deficiencies and Losses.* Tropical soils are generally low to deficient in primary and secondary plant nutrients and thus possess a limited potential for sustained production. Continuous cultivation of these soils results in low yields, soil degradation leading to land abandonment, rainforest destruction, and encroachment onto marginal semiarid lands, which can result in desertification. TropSoils research quantifies the nutrient requirements for rejuvenating soils and sustaining production. It also provides insight into soil biology and nutrient cy-

cling—both of which are necessary for low- or high-input management of these tropical soil systems.

• *Soil Physical Limitations.* Soils in the tropics are characteristically highly weathered and low in organic matter. Traditional management systems often lead to soil physical degradation, loss of productivity, and agricultural expansion onto less desirable soils. Often physical degradation of soil surfaces results in poor water infiltration, rainwater runoff, and accelerated erosion. Quantifying processes of physical soil degradation is necessary before reclamation practices can be formulated. TropSoils research on the use of legume fallows and green manures offers management options to prevent degradation of soils and to rejuvenate those which are already degraded.

• *Topographic Limitations.* Tropical landscape configurations impose special challenges to the development of soil-management technologies for sustainability and the conservation of soil resources. Soils on these landscapes are especially susceptible to water and wind erosion, resulting in permanent degradation. Cropping systems, soil fertility, and other sustainable soil-management practices must be integrated into the socioeconomic structure, human requirements, indigenous technologies, and physical characteristics of the landscape. Texas A&M's topographical-limitations program in Niger uses a interdisciplinary approach to integrate these components into an agricultural watershed. Each watershed in the tropics will offer unique challenges and must be characterized individually.

• *Water Stress.* Moisture stress, natural or imposed, can result from either excess or inadequate amounts of water. Crop selection to fit a soil-moisture regime will resolve part of the constraint. TropSoils develops techniques for water harvesting, for overcoming constraints that prevent roots from reaching subsoil moisture, and for managing nutrients to increase water-use efficiency. Placing lime deep in acid Indonesian soils has ameliorated subsoil acidity, permitting roots to reach moisture. Food yields increased and the risk of crop failures decreased as cropping intensity rose from two to three plantings and harvests annually.

### *Thrust 3: Outreach*

• *Number and Diversity of Soils.* Discrete soil types in the tropics number into the thousands. While certain management problems are common to many sites, solutions appropriate for one location may be inappropriate for another. When Soil Taxonomy or Fertility Capability Classification (FCC) are used as a basis for transfer, it is possible to extend TropSoils technology from a limited number of research sites to a large number of users' fields.

• *Lack of Local Expertise, Information.* Many developing countries lack soil scientists, agronomists, educators, and others to collaborate in TropSoils activities. TropSoils has provided opportunities for more than 100 soil scientists from developing countries to earn graduate degrees. This was the first step in developing a Central and South American network of collaborating scientists.

• *Information-Knowledge Gap.* Research results traditionally pass through a lengthy process of consensus-building—including peer review, publishing, and institutional acceptance—before reaching users. TropSoils develops decision-support systems and adapts geographic information systems to capture new technologies that can be integrated with indigenous knowledge to hasten technology transfer to individual farmers and diverse land-management units.

• *Lack of Skills and Research Capabilities.* A constraint to implementing activities in natural resource management and sustainable agricultural production in developing countries is the shortage of trained professionals to formulate appropriate policies and programs. TropSoils has provided training programs, backstopping, and educational support to overcome these constraints.

## For More Information

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