Sustainable agriculture demands new efforts in research, development, and implementation. Dedicated stewardship is the first step toward sustainable agriculture. There must be a commitment at the highest levels of government, and this must be coupled with an action program that addresses the needs of farmers in the context of the environment.

**What is Sustainable Agriculture?**
Sustainable agriculture has different meanings for different people. For some, it means continuing present farming methods; for others, the focus is on ecological integrity at the expense of any other concerns.

According to C.A. Edwards of the U.S. Agency for International Development, “Sustainable agriculture is a management system for renewable natural resources that provides food, income, and livelihood for present and future generations while maintaining or improving the economic productivity and ecosystem services of these resources.”

Most definitions of sustainable agriculture include the following institutional values:
- Discriminating use of land resources
- Resource conservation and enhancement of environmental quality
- Economic viability
- Increased and stabilized productivity
- Enhanced quality of life
- Intergenerational equity
- Buffer against risks

In many developed nations, the concept of sustainable agriculture blends basic economic concerns, conservation, and maintenance or improvement of the resource base. The motivation is derived primarily from environmental and ecological concerns.

In developing countries, farmers’ immediate concerns include improving crop yield, increasing crop diversity, and increasing income. Even in these countries, however, the visionary segment of the population and the institutional values of the culture may also focus on efficient cropping systems, pest-control methods,
potable water supplies, support for agriculturally based industries, and related infrastructure.

Consequently, it is important to define the concept of sustainable agriculture in the context of the society in which it exists. An elementary aspect of the concept is that it be based on the value systems of social, political, economic, religious, and other institutions. As the idea of sustainable agriculture expands, however, these institutional values may come into conflict with the values of the individual farmers called upon to practice it.

In the last few years, sustainable agriculture in its broad sense has sought primarily to improve the quality of life in the context of an environmentally sound approach to farming; therefore, the resource base is maintained or enhanced for future generations.

The concept of sustainable agriculture is also a function of the scale of operation—ranging from a single farmer’s field, a farm, or a watershed to an ecosystem, a country, a continent, or the Earth as a whole.

Factors of Sustainable Agriculture
To be effective, sustainable agriculture must include a concept of stewardship. In addition to institutional values that provide the framework for governmental action, the success of sustainable agriculture requires active stewardship on the part of individuals and groups.

Different technologies may be needed and each technology can be assessed to evaluate its appropriateness under specific conditions.

Sustainable agriculture is a function of the following factors, which apply in developed as well as developing countries:

• The economic viability of the enterprise; profitability is the fuel which drives the system, regardless of its size.
• The manageability of the system; it varies from individual farmers and their farms to the policymakers of the country.
• The political desirability of the system; attitudes range from indifference to centralized control.
• The physical resource base; the nature and properties of the land are manipulated through management.
• The applied technology; the response depends on the kinds and levels of inputs. Changes in sustainability are not progressively positive; rather, they tend to advance in fits and starts.
• A dynamic process; the results at any one time become the basis for the next phase of development. The level of sustainability at any one time or place determines the pace of progress.
• The social acceptability; this is determined by the compromise
between individual, cultural, and institutional values.

- The environmental integrity of the system; acceptable levels of both on- and off-site damage resulting from practices must be included in the system.
- The intergenerational equity guaranteed by the system.
- The flexibility of the system to respond to episodic events such as soil erosion, extremes of weather, and fluctuating world markets.

### Constraints To Implementing Sustainable Agriculture

National and international agricultural research centers are stepping up their efforts to improve the productivity of subsistence farming. Emerging technologies—such as agroforestry, alley and multiple cropping, improved genetic material, nitrogen-fixing trees and crops, and biotechnology—hold much promise. New farming systems are more likely to succeed if they accommodate the existing variability in soils.

Several constraints often lead developing countries to resist adopting the concepts and practices of sustainable agriculture.

The overriding constraint may be the absence of economic incentives from the government policymaking level to that of the farmer. Reduction in soil loss or long-term environmental degradation are not tangible inducements for small farmers to adopt sustain-

A second constraint is lack of awareness, not only at the farm level but also at higher levels in the society. Even if the farmers are willing and able, extension services are poor or nonexistent in most developing countries.

A third major constraint is that no system becomes operational if it is not institutionalized. In many developing countries, particularly in Africa, research and development in agriculture are inadequate and suffer from lack of trained personnel, facilities, and motivation. In many African countries, donor-supported research is still the rule. In this situation, it is difficult for a country to build satisfactory research traditions and local expertise; consequently, the benefits are limited to individual projects.

A fourth constraint relates to the information base. Implementing sustainable agriculture assumes that (1) reasons for nonsustainability are known, (2) there is sufficient information on the resource base to target activities that will foster sustainability, and (3) the resource base can be monitored to evaluate sustainability. In practically all develop-
ing countries, these three conditions are uncertain.

In the past three decades or more, international donor support for agricultural research and development focused on improving the genetic potential of crops and related management practices to improve yields—a spinoff of the Green Revolution. Few developing countries have a systematic, detailed soil resource inventory program. Agronomic research programs, including those by western expatriates, have been conducted and are still being conducted on soils about which little is known. In the absence of information on the resource base, it is usually a waste of time and effort to try to institute sustainable agriculture.

A fifth constraint to implementing sustainable agriculture is that appropriate research methodology is not readily available in developing countries. Until recently, not even the basic principles and concepts had been enunciated. Fundamental questions—such as how long should an experiment be conducted, what are the treatments, what are the measurements, and how can the data be analyzed—have yet to be answered.

Reversing the Trends
There are many hurdles to be overcome before a significant number of developing countries have sustainable agriculture programs in place. N.S. Jodha, working in the mountain areas of Asia, reports “a persistent decline in crop yields in many areas. Mining activities have destroyed mountain flora, caused landslides, and choked water channels. In Tibet and Pakistan, highland pastures are overgrazed. High-potential grazing areas are disappearing and cattle are being replaced by small ruminants. The increasing scarcity of fuel and fodder is reflected in the longer distances and time involved in collection. Finally, there is an increasing dependence of people on government subsidies and inferior options.”

Jodha recommends that a reversal of these negative trends should be the primary focus of agricultural development in mountain areas—and this recommendation applies to most tropical ecosystems as well. The responsibilities rest not only with the countries themselves, but also with the international community, particularly donor countries.

Challenge for the Future
The challenge of enhancing productivity while maintaining environmental soundness and attaining intergenerational equity is enormous for the low-input, resource-poor farmers of developing countries. Sustainable agriculture calls for educating farmers; emphasizing the long-term consequences of their traditional methods of agriculture; and helping them develop and implement
innovative, appropriate farming practices. Appropriate incentives are essential.

Without intensified financial and technical assistance, sustainable agriculture in developing countries will be untenable in the immediate future. This essential support could be considered an investment to ensure food security and social stability in the world.

The stability of the global ecosystem requires an unequivocal commitment to long-term support of sustainable agriculture. The alternative to sustainable agriculture is degradation of the resource base, loss of biodiversity, environmental pollution, reduction of the population-supporting capacity for humans and animals, and a general decrease in the quality of life for all living things on this planet.

Because sustainable agriculture cannot be achieved overnight, institution building takes on added significance. Many developing countries still do not have detailed information on the resource base; consequently, data bases must be developed and techniques instituted to monitor resources. Likewise, a cadre of highly trained professionals backstopped by adequate facilities is needed to conduct effective resource inventories.

Equally important is the creation of awareness. Private organizations are generally equipped to provide such services but must have funds to carry out their activities.

As the world population increases, additional land will have to be cultivated, and this gives added importance to sustainable agriculture. Major causes of land degradation—overgrazing on rangeland, overcultivation of cropland, waterlogging and salinization of irrigated land, and deforestation—all result from poor land management and should, therefore, be able to be controlled.

Although effective technologies that prevent or reduce land degradation either exist or are being developed, their application is still constrained by institutional and societal barriers. Lasting solutions can be rooted as much in social and economic reform as in effective technologies. In the Tropics, as elsewhere, the current prospects for institutionalizing development strategies for sustainable agriculture are unique challenges awaiting creative and committed solutions.

References

Agriculture and the Environment 203
International Cooperation To Protect Our Productive Environment

by Julia M. Morris, Program Coordinator for Africa, Forest Service, USDA, Washington, DC

In recent years, people around the world have come to acknowledge the importance of our natural environment and its sensitivity to the effects of humans' actions. Holes in the ozone layer over Antarctica, spreading deserts in Africa, acid rain in eastern Europe, and deforestation in Brazil—all are subjects many Americans hear of daily. At the same time, we are learning that productive agriculture and forestry are necessary for the development of strong economies in all countries.

As global environmental changes cause critical ecological, economic, and social consequences, USDA is increasingly called upon to apply its experience around the world. As political barriers disappear, inter-