Agricultural biological diversity

The current trend of economic growth in some important emerging economies, allied to an ever expanding human population, is causing a sharp increase in the demand for agricultural products. This fact and a fierce competition to gain the opening markets of the globalized economy are giving rise to the incorporation of new areas, as well as an intensification of agriculture throughout the world, and especially in the frontier areas of the tropics. Such a tendency requires a concentrated effort toward the development and actual use of management practices that could warrant a more sustainable exploitation of both natural and man-modified habitats.

As has been the case in the last decades, agricultural policies still emphasize high productivity on a short-term basis, triggering soil erosion, water contamination, loss of cultural and biological diversity, and other environmental problems, directly affecting the welfare of mankind. These impacts depend on the technological level and production system adopted. Furthermore, by relying on a reduced number of crops, and on few varieties within these crops, and by extending monoculture to vast extensions of land, modern agriculture homogenizes landscapes, erodes the genetic diversity of domestic and wildlife, and eliminates diversity altogether.

The new challenge for agriculture in the expanding global economy is to achieve stable production on a sustainable basis, by introducing technologies and management practices that would ensure a healthy environment, stable production, economic efficiency, and equitable sharing of social benefits. Biodiversity is a nondetachable part of the concept of sustainability. As we shall see, biodiversity is essential for agricultural production, as agriculture should be for biodiversity conservation.

Importance of biodiversity to agriculture

Biodiversity is a key to the balanced functioning of agricultural production systems:

- A diverse genetic pool is a safeguard against pests and environmental stress, being the source of genetic resistance;
- diversified crops are a protection against uncertainties of the market, especially in the case of less capitalized growers;
- a diverse environment offers a shield for agroecosystems against perturbations, natural or man-made. The diversity of species and habitats confer alternative structures and functions, lending resilience to agroecosystems under environmental pressure.

Biodiversity offers a host of unreplaceable services and goods for agriculture, granting opportunities for enhancement in productivity and environmental quality. Some of these benefits are presented below.

The present proposal was approved by the Brazilian Government and offered by its delegates to the Subsidiary Body on Scientific, Technical and Technological Advice (SBSTTA), of the Convention on Biological Diversity (CBD), at its Second Meeting held in Montreal, Canada, from 2 to 6 of September, 1996.

Reservoir of natural biological control organisms

Biological control programs have brought savings of up to US$ 200 million per year for soybean growers in Brazil alone, taking into account only insecticide savings, since *Baculovirus anticarsia* began to be used against the velvetbean caterpillar, *Anticarsia gemmatalis*. A successful biological control program in Brazil, based on release of parasitoids for control of the sugarcane borer, *Diatraea saccharalis*, eliminated the need of chemical control against this pest since 1975. With this program, the percentage of attacked internodes was reduced from 7 to 2%, on average, representing savings over US$ 100 million/year. Other Latin American countries have also successfully adopted biological control against this insect pest. Environmental conservation considerations would multiply these benefits. Many other examples could be added (1), and special attention should be paid to the natural control exerted by the soil microflora as antagonists of plant pathogens.

Maintenance of natural cycles

Living organisms play an important role in the stability of all natural processes. They are essential agents for nitrogen, carbon, energy and water cycles, inter alia, and therefore the species composition and their relationship may affect functioning and yields of agroecosystems. Soil and its constituents associated with solar energy are the main natural resources for agroecosystem production. Soil organisms and microorganisms respond to the maintenance of organic matter decomposition, nutrient cycling, soil structure, water balance, and fertility of soils. More recently, identification of biodegrading microorganisms has fostered their use to recover soils contaminated with pesticides in order to diminish the undesirable effects of these chemicals on beneficial organisms.

Pollination

A large proportion of crops depend on pollination for good yield. It has been estimated that honeybee kills due to pesticide use in the US result in losses of up to US$ 200 million/year (2). Pondering that honeybees are one single, and probably not the most important pollinator, one may have a dimension of the service rendered by pollinators at large. Collectively, wild and domestic bees provide pollination services four to five times more valuable than the market price of all honey produced in the United States (3). Also according to these authors, one in every three mouthfuls of food we eat depends on pollination by bees and other animals to reach our kitchen tables.

Symbiotic associations

The selection and inoculation of nitrogen fixing bacteria for leguminous crops has considerably reduced the application of N-fertilizers. The case of soybean in Brazil is remarkable, with no N-fertilization being needed any longer in most cases, leading to savings of US$ 1.6 billion/year (4). The selection of species and varieties adapted to other crops, in special the grass family, would bring savings estimated into hundreds of million dollars a year (5), and without the deleterious environmental effects of nitrates in waters. Nutrition of many plants depends on successful associations with fungi and other microorganisms to improve nutrient absorption efficiency. Many associations are very specific and unknown, meaning that the existence of a diverse microflora is essential for the maintenance of plant communities. Additionally, less fertilizers are needed when symbiotic associations improve nutrient absorption, lowering the risk of water pollution.

Genetic resistance

Wild species of plants and animals are a source of genetic variability for the recovery of resistance traits lost during the process of domestication and breeding for agricultural improvement. Genetic diversity provides stability and productivity to farm systems in response to disturbance of the environment, such as insect pests, animal and plant diseases, unfavorable climate, among others. Over 30% of all remaining genetic resources of domestic animals are at risk of extinction (6). It was estimated that 50% of indigenous goats, 30% of indigenous sheep and 20% of indigenous cattle breeds in India are threatened. The protection of natural refuges of the ancestors and close relatives of current crop plants and animals are the only assurance of new improvements for the domesticated varieties.

New species of economic importance

New species are continuously being added to our list of economically cultivated crops. These species may be a direct source of wealth, especially for traditional communities (7). In addition, many opportunities for economic use are still unknown in regard to food and industrial products as well as the recovery of degraded lands and waters. Some examples are species of mushrooms, inland fishes, soil and water living organisms, and microorganisms with specific functions in agroecosystems. Also, numerous species of the grasses and legumes occur naturally in Brazil and have shown evidence of suitability for economic use in cultivated pastures.

Conservation of biodiversity has, therefore, the potential for improving quality of environment and life of present and future populations. One additional advantage of biodiversity conservation initiatives is the widespread effect of conservation areas over neighboring lands, functioning as source of biodiversity.

Impacts of agriculture on biodiversity

Loss and succession of species are inherent features of an ecosystem in re-

sponse to internal and external disturbances. However, the practice of economic activities may exert additional environmental pressure, increasing the rate of species loss and preventing the ecosystem from maintaining its resilience.

Agricultural production utilizes natural resources of diverse ecosystems worldwide and is the most representative economic activity as far as extension of land is concerned - nearly one third of the world's land area is used for food production. As a consequence, many adverse effects may occur on biodiversity at on- and off-farm levels. Most of the world biodiversity on land is harbored by areas under exploitation by humans, so conserving biodiversity implies improving the ways agroecosystems are managed (8).

High input farming, with its reliance on monoculture, mechanization, and intensive use of agrochemicals diminishes the diversity of fauna, flora and microorganisms, including beneficial organisms. Those practices normally lead to a simplification in the components of the environment and to unstable production systems. In the same way, expansion of agriculture to frontier areas, including forests, savannas, wetlands, mountains and dry-lands, combined with overgrazing, spread of monocropping, and inadequate crop management and pest control strategies contribute to depreciation of biodiversity, as well as to the loss of cultural diversity of traditional communities.

Besides affecting biodiversity within the production areas, intensive agriculture often interferes with biodiversity of aquatic habitats. Soil erosion associated with the influx of agrochemicals to water bodies alter the original characteristics of these ecosystems. The composition of the biological community is changed, transforming the functioning of the system, and causing for instance, acceleration of eutrophication.

Use of agrochemicals also provokes unbalance in the complex communities of organisms in cultivated soils. Alteration in species composition of microorganisms and arthropods may affect natural processes such as organic matter decomposition, carbon and nitrogen cycles, natural control of plant pathogens by antagonists, and so forth.

The growing interest in using the knowledge and practices of traditional farmers, as well as the current interest in alternative agriculture, such as organic farming and use of environmentally sound technologies, indicate an increasing concern with the conservation and sustainable use of biodiversity and with the negative impacts of highly technified agriculture on one hand, and the emergence of new market opportunities and a demand for safer products on the other.

General Recommendations

In summary, there is an urgent need to reduce the impacts of agricultural practices on landscape homogenization, on biodiversity loss, and on the functioning of natural processes and cycles of nature. The field of agriculture, however, offers a unique opportunity for the Convention on Biological Diversity to link concerns with biodiversity conservation and sharing of benefits resulting from the use of genetic resources, with the mainstream economy. The Convention should consider sustainable agriculture as one of its key focal areas given its social and economic relevance and its prospects to reduce negative impacts on biodiversity. Also, conservation of biodiversity in agricultural areas may help to enhance the value of biodiversity, to link conservation efforts with social and economic benefits, and offers the opportunity to leverage further financial resources orders of magnitude higher than those currently available to implement the commitments of the Convention. Furthermore, considerable and rapid progress could result from the synergism of stakeholders in the fields of biodiversity conservation, sustainable agriculture and community participation.

A program on sustainable agriculture and biodiversity conservation would offer definite opportunities for parties to cooperate in in situ and ex situ conservation, access to genetic resources, technology transfer, biosafety, sustainable use of biodiversity components, sharing of benefits from use of genetic resources and economic valuation of biodiversity components and services. Such a work program should start with a few selective initiatives to promote the desired partnerships and establish the correct mood.

Specific recommendations

1. The third Conference of the Parties should establish a five-year **Global Program of Action on Agricultural Biodiversity** coordinated by the SBSTTA with support from the CBD Secretariat and the GEF, in close cooperation with leading international agencies, such as the CSD, FAO, CGIAR, IUCN, IICA, World Bank, regional banks and ODAs, with the following elements:

a) Establish an "**International Pollinator Conservation Initiative**", to measure and monitor the loss of pollinators worldwide, to identify the specific causes of pollinator decline, to estimate the economic cost associated with reduced pollination of crops, to identify and promote best practices and technologies for more sustainable agriculture and to identify and encourage the adoption of conservation practices to maintain pollinators or to promote their re-establishment.

b) Establish an "**International Initiative on Symbiotic Soil Microorganisms**" to measure and monitor the worldwide loss of Symbiotic Soil Microorganisms (SSM), in particular nitrogen-fixing bacteria and mycorrhizal fungi, to identify and promote the transfer of technologies for the detection of SSM and their use to enhance nitrogen fixation and phosphorus absorption, to estimate the potential and actual economic gain associated with reduced use of chemical N and P fertilization of crops with enhanced use and conservation of SSM, to identify and promote best practices for more sustainable agriculture and to identify and promote conservation measures to conserve SSM or to promote their re-establishment.

c) Establish an "**International Initiative on the Conservation of Biological Control Organisms**" to measure and monitor the worldwide loss of Biological Control Organisms (BCO), to identify and promote the transfer of tech-

nologies for the detection of BCO and their use through Integrated Pest Management (IPM), Habitat Management, BCO release and other approaches, to estimate the potential and actual economic gain associated with reduced use of pesticides in crops with enhanced use and conservation of BCO, to identify and promote best practices for more sustainable agriculture and to identify and promote conservation measures to conserve BCO or to promote their reestablishment.

2. The GEF should be instructed to finance and leverage projects on agrobiodiversity, particularly those under the above initiatives and those under the following guidelines.

3. Parties and international organizations, development banks, bilateral and multilateral funding agencies and other development agencies should be urged to adopt measures for the conservation and sustainable use of agricultural biological diversity and the equitable sharing of the benefits resulting from the use of genetic resources according to the following guidelines, and should be requested to report to the Conference of the Parties at its future meetings on progress made.

a) Emphasize a long-term and sustainable approach to agricultural production, with an integrated and systemic view that contemplates conservation and sustainable use of biodiversity, equitable sharing of benefits and the needs of future generations. Regard must be given to the irreversibility of biodiversity losses when managing natural resources. Consider that biodiversity conservation must contribute and be linked to rural development strategies, with emphasis on welfare of people on a long-term and sustainable basis.

b) Foster development of new and revision of current agriculture policies, adopting regulatory measures and incentives to promote conservation and sustainable use of biodiversity in agroecosystems and in areas under their influence and the equitable sharing of benefits from the use of genetic resources.

c) Consider the representation of biodiversity and ecosystem services of agricultural interest in the creation of conservation units. Also promote on-farm conservation of biodiversity and improve ex situ conservation of useful and endangered genetic resources.

d) Stimulate the development, transfer and adoption of alternative practices and technologies, such as organic farming, integrated pest management, biological control, no-till agriculture, multicropping, intercropping, crop rotation, agroforestry, among others, aiming at conserving biodiversity in agroecosystems and their surroundings, as well as at recovering disrupted areas. Efforts should also be driven to validate and disseminate practices and knowledge used or retained by indigenous and traditional communities.

e) Require ex ante and ex post evaluation of impacts to biodiversity of agricultural development projects, to assure the use of best practices to promote the conservation and sustainable use of biodiversity and a fair sharing of benefits. So far, little attention has been paid to biodiversity in agricultural development projects. For example, less than 2% of 377 agricultural projects financed since 1988 by the World Bank dealt explicitly with biodiversity (9).

f) Support development and adoption of methods to assess and predict impacts on biodiversity of agricultural technologies, practices and production systems, with emphasis on high input farming, as well as support the development of indicators for agrobiodiversity to allow the evaluation of biodiversity in agricultural production systems and of conservation and remediation measures.

g) Develop new and apply existing methods of economic valuation of biodiversity, in order to better assess the impacts of research and development projects and initiatives on sustainable agriculture and agrobiodiversity conservation.

h) Identify key components of biodiversity in agricultural production systems responsible for maintaining natural processes and cycles, evaluating the effects of different agricultural practices and technologies on those components and stimulating the adoption of repairing practices to attain appropriate levels of biodiversity.

i) Support the establishment/enhancement of quarantine facilities to ensure the safe exchange of organisms for practical uses and research, minimizing risks of adverse effects on native organisms and on the stable functioning of food chains. The use of biosafety guidelines should also be promoted. ■

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