10. Agriculture, biodiversity conservation and protected areas

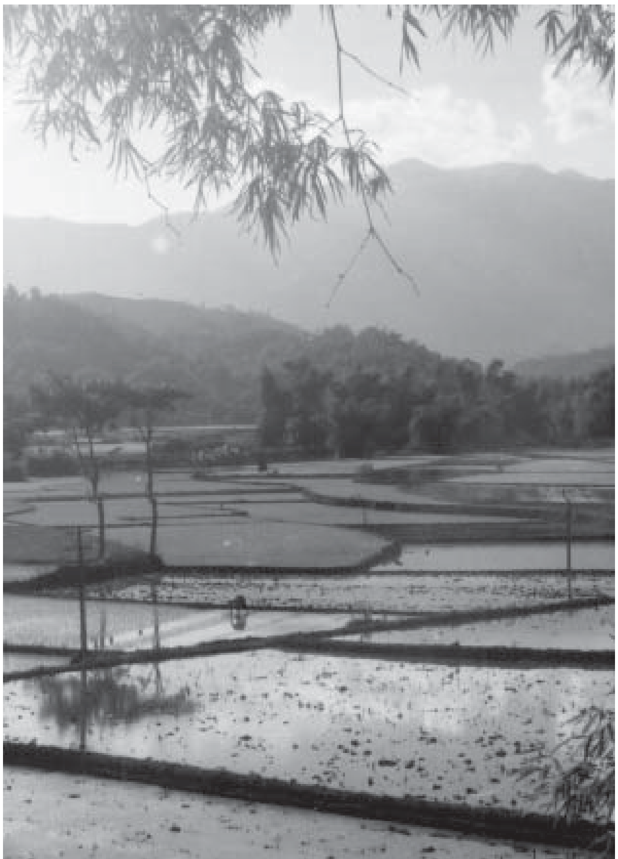
Introduction

Agricultural productivity, both in terms of sustainable yields and genetic resilience, is being lost and the ecological services on which agriculture depends are being degraded. Productivity loss arises from simplification of crops and adjacent habitat, species and genetic depletion, and disruption to soil and water regimes: all components of biodiversity.

Regimes of protection for biodiversity throughout the agricultural landscape are needed to support the agriculture sector in general and farmers in particular. There are many opportunities to establish protective regimes that will contribute to the agriculture sector through "protect-and-connect" policies and practices. These can also contribute to the biodiversity value of natural protected areas in the vicinity of farming areas. Special attention should be paid to agrobiodiversity and to traditional agricultural systems and their practitioners, from whom much can be learned.

The fact that some significant biodiversity has been conserved in agricultural landscapes is considered an achievement, but it is one that needs to be consolidated and built upon. A global-scale achievement is the growing practical application of the Convention on Biodiversity (CBD) to agricultural biodiversity.

Changes in attitude and policy are needed to give practical effect to biodiversity conservation in agricultural landscapes and new methodologies, drawing on understanding arising from the study of landscape ecology.



Section 1

The evolving relationship between agriculture, biodiversity and protection measures

Simplification of agricultural and natural systems

Agriculture evolved as a system of manipulation of plant and animal biodiversity and its environment to satisfy people's needs for food and other products. This was done in the context of a landscape that included large areas of unmodified native biodiversity. As societies became more complex the concept of surplus production for trade led to commercialisation. The agricultural landscape was simplified for physical and economic efficiency. Single-species crops replaced mixed-species crops, and cropping on the same land was repeated at short intervals. Soil fertility was depleted and populations of pest and disease species built up, being more readily transferred through contiguous plantings of the same cultivar.

Organic fertilisers have long been used to address declining fertility. Pests and disease were initially controlled through crop rotation. During the 19th century it was learned that chemical interventions could boost soil fertility. As chemical knowledge increased and the technology to deliver chemicals to crops and soils improved, a different approach to agriculture became entrenched.

Ironically, from a system of clever manipulation of the natural environment, well integrated with biodiversity conservation, agricultural practice has changed to the extent that it has become a major factor in the destruction of natural ecosystems and the elimination of species. Even though modern agriculture has come later to tropical countries the trend has been the same. Not only has local biodiversity — much of which is fundamental to local lifestyles and livelihoods — been degraded, but the chemicals used to attack unwanted biodiversity (pests, diseases and weeds) have accumulated. These have been transferred to ecosystems and species far removed from the crops and soils to which they were applied. In the 20th century agricultural efficiency was equated with simplification. To be a "good" farmer meant clearing the wild.[1] Clearing of more natural vegetation and the establishment of uniform fields were encouraged by mechanisation and the management cost savings of monocultures.

The old agricultural systems are much more diverse in structure and species composition. This gives them greater ecological stability and contributes to food security: even if some crops fail, others will produce. Modern agriculture, based on a quest for short-term efficiency, has produced economic gains, but it has sacrificed stability. Misused pesticides and fertilisers poison water and soil. Agricultural expansion fragments the landscape, breaking wild species populations into smaller units more vulnerable to depletion and disrupting riverine corridors of biodiversity.

Elimination of wild species and habitat

Modern farmers have sought to eliminate wild species from their lands in the belief that doing so would reduce pest and predator threats. Yet a host of invasive introduced plant and animal species has entered agricultural landscapes, mixed with crop seed supplies, adhered to farm machinery and wedged in the hooves of livestock brought in from other areas. Proliferating in an agricultural landscape, they have added to agricultural production costs and made damaging incursions into natural ecosystems, including those of neighbouring protected areas.[2]

Soils have been compacted by modern agricultural machinery. This restricts water penetration and increases the amount of surface water, causing runoff to carry away greater volumes of soil from where it is needed into the aquatic ecosystems where it is so disruptive. Tree removal to open up semi-arid land for grazing and cropping has resulted in subsurface salt rising to the surface. Very large areas of Australian soils have been severely degraded by salinisation, and similar problems trouble the agricultural landscapes of India and Pakistan. On conversion to agriculture some high-sulphur soils become the source of acid that not only renders the soil infertile but also drains to and degrades associated aquatic systems. This affects both land and marine protected areas. All these physical and chemical changes are associated with disruptions of soil microorganisms, a vital, but neglected, element of biodiversity.

Water supply and regulation

Most of the world's agriculture is watered directly from natural sources. For this to be sustained, it is necessary to protect the source of water. Various forms of protected forest area have been established for this purpose. All serve to conserve natural biodiversity even where that is not specified as a management objective. Elegant and ecologically sustainable forms of water control have been developed by societies with close relationships with their surrounding environment. Being ecologically based, and constrained by ecological limits, they have proved sustainable over many centuries. The drift of agriculture away from the ecological context in which it originated, however, has led to modern irrigation systems that are based on simplistic engineering principles formulated on the basis of overcoming what are seen as environmental "barriers" to efficiency.

Protected areas also serve the agriculture sector by preventing excess surface runoff and so protecting cultivated land from erosion. Yet the agriculture sector has yet to recognise and support these functions of PAs.

Habitat for crop pollinators and for crop pest predators

Bats, wild bees, and other insects are the principal pollinators of fruit trees and major staple crops including potato, cassava, yam, sweet potato, taro, beans, coffee and coconut.[3] As Gemmill (2001) phrases it: "Pollination is an essential ecosystem service ... In many cases it is the result of intricate relationships between plant and animal, and the reduction and loss of either will affect the survival of both parties." While many staple foods are wind pollinated, at least one-third of the world's agricultural crops require insect or animal pollination. Pollination is an environmental service, one provided by protected areas and by relict areas of natural vegetation.

In order to secure sustained pollinator services associated with agricultural ecosystems, a far better understanding is needed of the multiple goods and services provided by pollinator diversity and the factors that influence it. It is necessary to develop management practices that minimise negative impacts by humans on pollinators, promote the conservation and diversity of native pollinators, and conserve and restore natural areas necessary to optimise pollinator services in agricultural and other terrestrial ecosystems.

Agricultural production and agro-ecosystem diversity are threatened by declining populations of pollinators. The major contributors to this decline in pollinator populations are fragmentation of the habitat of these species, agricultural and industrial chemicals that reduce their fertility and numbers, parasites and diseases, and the introduction of invasive alien species.

Enhancing agriculture through protection of biodiversity

New approaches to protection of species, habitats and genes are essential if agricultural productivity is to be sustained and rural communities are to survive and prosper.

Agriculture has been seriously compromised by unsustainable practices. These have squandered its critical natural elements, leading to falling production-for-unit effort. Conventional approaches that treat and manage protected areas as “islands” of natural vegetation in agricultural landscapes only partially meet the agriculture sector’s needs for biodiversity support. Agricultural productivity and protection of the biodiversity that underpins it can be achieved only by extending protected area concepts throughout the whole agricultural landscape:

- adopting a landscape perspective as a basis for agriculture planning and management through which regimes and areas of biodiversity protection are directly linked to the maintenance of agricultural productivity;
- focusing on understanding and working with native biodiversity (both wild species and those that constitute local agricultural biodiversity) and the ecological processes important for sustainable agricultural production; and
- developing and adopting measures to encourage native biodiversity throughout the agricultural landscape, wherever possible linking this through “corridors” with formal protected areas.

Section 2

Agricultural biodiversity

Crop and soil biodiversity

Vietnamese people use many hundreds of different plants. A Lao rice farmer has 20–30 varieties of rice on his farm from which to choose the appropriate mix to match the diversity of the soils of the fields and the diverse weather conditions. The Ifugao people of the Philippines sustain ancient wood lots, not just for wood but for the many associated plant species they use.[4] On the South Pacific island of Guadalcanal women can choose from over 50 different varieties of yam.[5] Yet a Canadian wheat farmer has little choice. He or she plants one or two varieties bred specifically to maximise yield; if the weather is not suited to the chosen crop, or chemical fertilisers are inadequate, the harvest is poor.

Agricultural biodiversity (agrobiodiversity) has two elements:

- biodiversity used for agriculture and horticulture as managed crops, both planted and wild, and as livestock; and
- species that support crop and livestock production, such as nitrogen-fixing soil micro-organisms and pest predators.

The biodiversity of agricultural systems is expressed in crops and animals, in the soil, and even in pest predators. Farmers in developing countries who still use traditional practices frequently grow mixtures of different crop species and varieties, selected for their suitability for different localities. This practice reduces the risk of economic loss caused by variations in weather conditions or from pest attack. These farmers focus on maximising food security rather than on maximising yield. Maintenance and use of crop genetic diversity is part of farmers’ coping strategies to deal with weather unpredictability and to shorten periods of food shortage by spreading food availability over time. Among dryland farmers, whether those of Rajasthan (India), the sorghum farmers of Tharaka (Kenya), the sorghum and millet farmers of Zimbabwe, or the potato farmers in Peru, the strategy is the same.

Food security for developing countries requires the an adequate range of agrobiodiversity. Yet the aggressive promotion of high-yield plant cultivars by private sector enterprises and development assistance agencies has suppressed the use of agrobiodiversity and associated traditional knowledge and diminished the stock of genes from which new forms of crops and livestock evolve to suit changed circumstances. Although the immediate impact is local, ultimately the whole world depends on these changes. There is now some recognition that the push for fertiliser and herbicide-dependent high-yield varieties has been unwise, but there is still insufficient attention to measures to stem the loss of agrobiodiversity.

Soil is a fundamental component of an agricultural system, but it is rarely considered in terms of biodiversity. Soils in poor condition cannot sustain productive agriculture. The key to soil fertility is soil biodiversity. Many agricultural systems are under threat because soils have been damaged during agricultural intensification. Microorganisms are an major part of key ecological processes that sustain the functioning of ecosystems, including a range of associations between plants and microorganisms that efficiently fix atmospheric nitrogen through legume-Rhizobium associations, and extract phosphorus, various micronutrients, and water under very low moisture conditions, and through mycorrhizal associations. Also, some free-living organisms are critical in converting insoluble forms of chemical compounds into forms that can be assimilated by plants. Blue-green algae, for example, have an essential role in wetland rice agriculture.

Under natural conditions, as agricultural insect pests evolve into more troublesome forms, so do their predators evolve to become more effective. The application of chemicals to control pests also harms their predators (birds, lizards, other insects). Maintenance of conditions that favour the co-evolution of pests and predators is an essential element of agrobiodiversity conservation. In this respect agrobiodiversity serves as a source of biological control species.

Much of the value of agrobiodiversity is in local knowledge of the use and management of agricultural species. Some of this knowledge is gender-associated. In Ethiopia it is women who select seeds of maize, bean and sorghum to be stored for later planting. In the Pacific islands it is women, not men, who can name long lists of yam cultivars and discuss the details of soil requirements.

Agricultural biodiversity is embraced by the CBD but is overlooked in most protected area planning and management. Inadvertently, some agrobiodiversity is included in existing protected areas; non-timber forest product (NTFP) species are a good example of this. Where protected areas do include agrobiodiversity, however, their management objectives do not include maintaining that biodiversity.

Genetic biodiversity of crops

Agricultural biodiversity is of fundamental importance to human survival and to the social and economic development of many countries. It supports human nutritional needs and a wide range of other products. Pressure to increase crop and livestock yields leads to the development of new plant varieties and new animal strains (additions to diversity) through conventional breeding techniques and biotechnology. The consequent focus on improved forms means that the traditional ones, by default, are lost. This loss of genetic diversity has both local and global significance.

In traditional agriculture crop genetic resources are passed from generation to generation of farmers and are subject to a range of natural and human selection pressures. Environmental, biological, cultural and socio-economic factors all influence a farmer's decision to select or maintain a particular crop cultivar at any given time. Farmers, in turn, make decisions about planting, managing, harvesting and processing their crops that affect genetic diversity. By consciously selecting for plants with preferred characteristics, over time a farmer may cause the genetic structure of a crop to be changed. He or she may influence the survival of certain genetic types by choosing a particular farm management practice or by planting a crop in a site with a particular micro-environment. Farmers make decisions on how much of each crop variety to plant each year, the percentage of seed or germplasm to save from their own stock and the percentage to buy or exchange from other sources. Each of these decisions affecting the genetic diversity of crop cultivars is linked to a complex set of environmental and socio-economic influences.

There are growing pressures on small farmers, who maintain this crop genetic diversity in the form of local cultivars. Increased population, poverty, land degradation, environmental change and the introduction of modern crop varieties have contributed to a substantial loss of crop genetic resources. In recent decades agricultural scientists have responded to this threat by developing a worldwide network of gene banks and botanical gardens for conserving genetic resources. This is valid, but it is only a partial solution. It cannot accommodate the full range of diversity in economically useful plant species, and it arrests the complex interaction of genetically diverse traditional forms with their soil and atmospheric environments and their associated pests, predators and pathogens. Without continued pest-predator co-evolution the net result is likely to be crops unable to resist pests and diseases, except through further inputs of chemicals that disrupt biodiversity. This form of genetic conservation also fails to retain traditional farming knowledge associated with agrobiodiversity. In addition, farmers cannot be ensured of continued access to these resources.

Section 3

Maintaining and enhancing agricultural biodiversity

Regimes of protection in agricultural landscapes

Hedgerows were once a common feature of the English farming landscape, where they served as fences, marked boundaries and drainage ditches, and functioned as windbreaks. These hedges also provided habitat suited to some native biodiversity. Most hedgerows were removed to facilitate intensive modern farming. In a landscape long deforested, this loss of biodiversity supporting habitat has been significant. Across the Atlantic, the productivity value of zones of vegetation in agricultural landscapes is gaining some recognition. Local tree species are being planted in Central American pastures, where they provide wood products, shade for livestock and food for birds as they migrate from the Monteverde Protected Area to the lowlands. In so doing they contribute to a corridor effect.

In most agricultural landscapes, even those with intensive farming systems, a considerable area is not farmed. There are many unused or lightly manipulated areas that may harbour native biodiversity at a local scale[6] and even help to sustain it at a landscape scale.[7] These include the following:

- streamsides, natural waterways, irrigation canals, untilled and ungrazed water catchment areas, and farm drainage ways;
- wood lots, vegetation filter strips (used to trap sediment and to facilitate breakdown of agrochemical residues), and uncultivated strips between crop fields;
- windbreaks, border plantings and living fences[8] along field boundaries;
- irrigation bunds, vegetation barriers planted to reduce surface soil erosion and promote water infiltration, and areas taken out of production to control salinity, or abandoned as a result of salinitisation;
- areas along roadsides and railways, sacred groves, churchyards, burial grounds and recreational areas; and
- areas of cultural or historical significance.

These small areas often contain native terrestrial and aquatic species. Surrounded by an actively farmed landscape, they will progressively lose their more distinctive species. Adaptive management of the surrounding land — with a view to achieving a measure of biodiversity conservation in the context of agricultural production — can increase the biodiversity value of these relict areas and the landscape as a whole.

The biodiversity conservation goals for an agricultural landscape can be met by protecting and establishing local biodiversity in an integrated pattern within and across farms. Non-farmed areas can be utilised to provide patches of certain types of habitat, or to form corridors that link protected areas and enable species to maintain genetic interaction between populations that otherwise would be isolated. This involves protecting remnant native vegetation and/or reestablishing wild species.

The aquatic ecosystems of Chesapeake Bay, in the northeastern USA, have been badly disrupted as a result of drainage from land-based development. Some farmers along the shore have contributed to the Bay's recovery by establishing buffer strips. This is land left aside to grow wild; it filters runoff and reduces the excess nutrients from fertilisers and animal wastes. The buffer strips also provide habitat for birds and native plants. Between 1985 and 1995, the amount of nitrogen entering the bay through these buffer strips dropped by 35 per cent; the level of phosphorus dropped by 56 per cent.[9]

In most parts of the world the opportunity to set aside substantial lowland tracts for biodiversity has been lost. The bulk of the effort to conserve terrestrial biodiversity through protected areas has been applied to relatively large tracts that have not been altered by agricultural activity. One important consequence has been that only a very small proportion of the native biodiversity of lowland areas has been managed for biodiversity protection. Yet much can be achieved through identifying remnant areas of native biodiversity and managing adjacent areas in ways that support the continued survival of this biodiversity. Agricultural landscapes need to be recognised as sources of remnant biodiversity. With the understanding and support of farmers, biodiversity conservation measures — which will also be seen as contributing to agricultural productivity — must be strengthened.

Hundreds of Australian Landcare groups of farmers and members of the non-farming public initially targeted soil erosion. Their work at a local scale, supported by government agencies, has extended to include protection of remnant patches of native vegetation and the enrichment of the local environment through planting of native species. Similarly, in the Sacramento and San Joaquin valleys of California, farmers work together in a "Valley Care Program". There, through minor changes to the management of water flows to and from rice crops, it has been possible to improve conditions for tropical migratory shorebirds and waterfowl.

Section 4

Achievements and challenges

Though peasant farmers for millennia have conserved agricultural biodiversity, little of this has been conserved in protected areas. This aspect of biodiversity has not been on the agenda of protected area planners. Attention and effort has been concentrated on "natural" biodiversity. While some protected areas established to conserve "natural" ecosystems have contributed to the agricultural sector, particularly through forest mediation of water flows, most achievements in agrobiodiversity conservation have been through the local and largely unrecognised efforts of farmers themselves.

Achievement: Traditional agricultural practices developed in a way that was consistent with environmental and social circumstances and based on the maintenance of biodiversity.

Over the past 30 years, borrowing from the wisdom of traditional farmers, increasing attention has been paid to forms of agriculture that embrace mixes of annual and perennial crops and reflect the structure and species composition of traditional agricultural systems. The development and promotion of the form of agriculture referred to as "agro-forestry" has drawn on the experience of many different agro-ecosystems. It has been widely promoted in tropical and subtropical areas, and has become an important element of protected area buffer zone management.

The shift towards agro-forestry has stimulated fresh thinking in other aspects of agriculture. Indonesian small-holder rubber plantations, with their associated undergrowth, would not be regarded by an agro-industrialist as being properly managed; the yield of rubber is reduced. These plantations provide habitat for local fauna, however, and support up to 300 other plant species, including some of economic value. This means that their overall value for the rural economy is greater than that from rubber alone.[10]

Conventional modern irrigation depletes wetlands when it extracts water. Traditional water resource management for agriculture has sustained wetlands even while making water available for crops. Zimbabwean farmers developed irrigated gardens in shallow, seasonally inundated depressions called “dambos”. Fenced plots in individual depressions linked through channels produce yields as much as twice as high as in a conventional irrigated system, and at much lower economic and ecological cost.[11] Dambo fields often retain some native vegetation, conserving valuable patches of biodiversity. Similar wetland agriculture associations are found in other countries.

Although the farmers adjacent to the U Minh Tong Nature Reserve of Vietnam’s Mekong Delta have adopted new crop cultivars and modern practices, they also understand the advantages of establishing shelters to attract bats from the reserve. The animals feed on crop pests in nightly sweeps across the farmers’ fields, and the resulting harvest of guano provides an economic bonus, in that it saves the cost of fertiliser.

The application and extension of agricultural practices such as these that assist biodiversity conservation gives hope for a more considered and balanced form of agriculture that better accommodates biodiversity values.[12]

Few protected areas have been established for the purpose of conserving the biodiversity of agricultural landscapes. Some exist in European countries, where an appreciation of historical landscapes has developed. A key element of Finland’s Linnansaari National Park, for instance, is an area of ancient agricultural fields where a subsistence peasant farm has been recreated, with land use as practised in the late 19th century. It includes a living museum of the traditional way of life of that time, with associated skills, tools and structures, along with old genotypes of cattle, sheep and crop plants. The idea of recreating a peasant farm, with all its associations of hardship, might not appeal to those countries that are only now emerging from peasant agriculture and striving to place their economies on a modern footing. The Finns, however, are maintaining a gene pool of domestic animals and cultivated plants that is not only of historical interest but could contribute to the future as well.

Faced with the drastic alteration of most of its natural once-forested landscape, Britons have established protected landscapes which have been extensively modified. Institutions such as the Countryside Agency foster the protection of landscape, including agricultural biodiversity.

Challenge: Since biodiversity is so important to agriculture it should be given greater prominence in agricultural sector planning and development.

Since agriculture — in all its forms, including annual crops, tree plantations and grazing lands — is such a dominant use of land it follows that it should be given much more attention in biodiversity planning. Many farmers, especially those who adopt intensive farming systems, face a difficult trade-off between agricultural production and biodiversity. The challenge is to increase food production through farming technologies and natural resource management practices that are more consistent with ecological realities. Some advances are being made in this respect, such as low-till farming, which substantially reduces soil compaction.

Much of the biodiversity loss in developing countries results from lack of advanced technologies, which in turn leads to expansion of farm areas to compensate for low yields. Improvements in cropping systems on slopes (as in shifting cultivation) could reduce the crop rotation period. It must be noted, though, that in many developing countries improvements in technology will not be effective unless they are accompanied by realistic and culturally appropriate measures to establish security of land tenure.

Achievement: Some important biodiversity has been conserved in agricultural landscapes and serves to maintain productivity and enhance the stability of agricultural systems.

Rural communities that use traditional resource management practices and knowledge have achieved a great deal for the global community by developing and caring for a broad base of agrobiodiversity. This biodiversity is now threatened, and the custodians need support to continue this conservation effort.

“On-farm conservation” is a term used by innovative agricultural managers to refer to the maintenance of populations of local crop cultivars (or landraces) in the natural habitats where they occur, whether as uncultivated plant communities or in farmers’ fields as part of existing agro-ecosystems, and with the active participation of farmers. It is a theme being promoted by, among others, the International Plant Genetic Resources Institute and the United Nations Environment Program.[13]

The Landcare model of community-based, participatory landscape management has been a success in Australia and has relevance for other countries (Box 1).

Box 1. New South Wales Native Vegetation and Conservation Strategy

A New South Wales Native Vegetation and Conservation Strategy has objectives that include enhancing productivity, reducing land degradation, conserving native plants and animals, enhancing water quality and sustainable agro-management practices, maintaining Aboriginal links with native vegetation, and sustaining community values and ties to native vegetation.

Implementation at a local level is through water catchment committees. To achieve functioning ecosystems over a fragmented landscape (all agricultural landscapes are fragmented) the committees seek in each catchment to match targets derived from local land use and ecological research.[14] This would see 30 per cent of land managed for intensive use; 40 per cent managed through production systems designed to deliver balanced economic and conservation outcomes; 20 per cent managed for multiple uses to provide habitat value and connectivity (especially along creeks and rivers); and 10 per cent managed for conservation outcomes.[15]

Farmers are key partners in this model for landscape management that serves to protect biodiversity and ecological services so as to sustain agriculture. This “Landcare” model is an effective demonstration of how farming systems and practices are being adapted so as to reduce impacts on the biodiversity on which the sector is so dependent.

Challenge: The agricultural landscape must be managed in ways that protect and enhance local biodiversity.

Protected areas are becoming islands of dying biodiversity in an agricultural landscape. Fires escaping from stubble burns that erode protected area margins, and invasive alien species of plants and birds that aggressively compete with native species, bring about changes in the composition and structure of those protected areas. This damages their capacity to sustain the environmental services needed by local agriculture.

Many practical measures can be taken in an agricultural landscape to support protected areas that benefit farmers. Riverine vegetation has particular conservation value. Rivers are not only corridors for animals, but stream bank vegetation filters sediment washed from the land and provides organic matter and nutrients for aquatic life. It also provides shade that helps maintain conditions favourable to native aquatic life. Investment in the enhancement or rehabilitation of degraded watercourses and their fringes can greatly boost the biodiversity values of agricultural landscapes.

To address this challenge it is necessary to coordinate management practice between managers of agricultural landscapes (the most important of whom are farmers) and biodiversity planners.

Challenge: protected area management needs to be reoriented so that it better serves the agriculture sector.

The surrounding landscape should not be seen as a source of threats to protected area integrity, but as the context in which the protected area is set. Accordingly, PAs should be managed to maintain their contributions to surrounding landscapes and to reinforce conservation and protection objectives.

Some initiatives have been taken to explore "biodiversity-friendly" agriculture.[16,17] These require the establishment of biodiversity protection regimes in areas of crop and livestock production, built on local residents' understanding of conservation benefits. As pointed out by Gemmell (2001) this is likely to succeed in the following circumstances:

- the protected area clearly helps to make farming more productive or sustainable (for instance, by protecting valued pollinators);
- it helps to protect locally-valued environmental services (such as good water quality);
- the protected area offers attractive alternative income generating options (by enhancing fishing income, perhaps, or attracting tourists);
- farmers are adequately compensated for loss of land or helped to make the transition to an equally attractive livelihood option (payments for biodiversity services, for instance); or
- local communities themselves value the aesthetic, cultural, or recreational aspects of the habitat or of particular species (as in the case of sacred groves).

McNeely and Scherr (2001) have identified key "eco-agriculture" strategies that they believe can help farmers grow the food they need while maintaining the habitats of the wild species that live on or near their land:

- reduce habitat destruction by increasing agricultural productivity and sustainability on lands already being farmed;
- enhance wildlife habitat on farms and establish farmland corridors that link uncultivated spaces;
- establish protected areas near farming areas, ranch lands, and fisheries;
- mimic natural habitats by integrating productive perennial plants;
- use farming methods that reduce pollution; and
- modify resource management practices to enhance habitat quality in and around farmlands.

Challenge: Changes in agricultural policy and extension practice are needed to provide a supportive context for agrobiodiversity conservation.

The technology-focused nature of agricultural science education and training has excluded consideration of traditional agricultural practices and knowledge. Even as the more enlightened practitioners of agricultural extension recognise the importance of local agrobiodiversity and its conservation needs they find it difficult to overcome policy obstacles.

Challenge: To establish and successfully manage new forms of protected areas that incorporate the maintenance of, and provide for, the continued evolution of agrobiodiversity.

The need is to adequately provide for agrobiodiversity conservation in a protected area context so that farming and horticulture can continue, under circumstances conducive to the continued evolution of agrobiodiversity. A primary management objective would be the maintenance of a wide range of plant cultivars and/or livestock types in the farming conditions under which they evolved. This will inevitably mean that artificial agricultural chemicals cannot be used; in some cases participating farmers will require financial and other forms of support.

Examples of such protected areas exist in Finland (Linnansaari National Park, described earlier), Mexico (maize), Israel (wheat), and Vietnam (rice, taro, litchi-longan, rice bean, citrus and tea). India has established a “gene sanctuary” in the Garo Hills for wild relatives of citrus; additional sanctuaries are planned for banana, sugarcane, rice and mango. The Chatkal Mountain Biosphere Reserve in Kyrgizstan conserves important wild relatives of walnuts, apples, pears, and prunes.

Achievement: Growing international recognition of the value of biodiversity in agricultural landscapes is supported by the CBD and is being addressed by international organisations.

Recent initiatives emerging from application of the CBD are encouraging:[18]

- wider understanding of the functions of biodiversity in agro-ecosystems and the interactions between its various components, at different spatial scales; and
- the promotion of methods of sustainable agriculture that employ management practices, technologies and policies that support the positive effects of agriculture on biodiversity and prevent or mitigate any negative impacts. These focus on the needs of farmers and indigenous and local communities to participate effectively in meeting these particular goals.

The Food and Agriculture Organization of the United Nations (FAO) has prepared a first Report on the State of World’s Animal Genetic Resources. An “International Initiative for the Conservation and Sustainable Use of Soil Biodiversity” has been proposed as a cross-cutting initiative within the FAO program of work on agricultural biodiversity.

Challenge: To influence development assistance policy and project design, to ensure that agrobiodiversity is not negatively affected and that opportunities are sought to protect and promote it, including measures to enrich agrobiodiversity in project areas.

In developing countries agrobiodiversity is integral to food security and poverty alleviation, two themes fundamental to development assistance. Agrobiodiversity is part of the overall social and economic development process and the development of a more environmentally benign form of agriculture was defined in Agenda 21 as a key environmental issue.

Section 5

Conclusion

The weakening of the agriculture-biodiversity-environment connection has been exacerbated by the training and attitude of professionals engaged in food production and biodiversity conservation. One consequence has been the difficulty each “side” has had in recognising the importance of biodiversity for agriculture and the role of protected areas in supporting agricultural production.

Yet new thinking is emerging, with new initiatives to recognise and accommodate biodiversity in fragmented landscapes. Multi-stakeholder approaches of landcare groups are examples of good governance and are proving effective in bringing farming and conservation interests together in pursuit of shared biodiversity and resource sustainability objectives. The complexities of this approach are not to be underestimated. Landscape-level management opens up issues of land tenure, resource access rights, and management authority that are sensitive issues in some developing countries.

Further progress depends on major attitudinal shifts among biodiversity planners and managers and agriculture professionals. Many farmers, particularly indigenous farmers, have an appreciation of their local biodiversity, so for them the adjustment will be less difficult.

Much has to be done to develop assessment methodology and appropriate designations for the many biodiversity niches in agricultural landscapes that would support agricultural production while meeting biodiversity conservation objectives. Methodology for the assessment of the impact on biodiversity of different land uses is being developed.[19] This will include indicators for use by managers and planners in the assessment and monitoring of a series of land-use gradients.[18]

The growing practical application of the CBD is encouraging, as is the fact that the Food and Agriculture Organisation is taking steps to act to stem the loss of valuable agrobiodiversity through development of methodology for agrobiodiversity assessment and monitoring.

Endnotes

1. McNeely and Scherr 2001.
2. Australia has been host to some notorious examples, including the prickly pear *(Opuntia inermis)* and the still advancing cane toad (*Bufo marinus*).
3. Prescott-Allen and Prescott-Allen 1990.
4. Rondolo 2000 has shown that of 264 plant species identified, the Ifugao regard 234 as useful.
5. Baines 1989.
6. “Kernen’s Prairie”, a relict 130-ha tract of prairie grassland ecosystem near Saskatoon, now a small island in a “sea” of cereal crops, has attained great significance as the last sizeable example of the prairie biodiversity that once characterised the plains of western Canada.
7. As where the fruit of native trees planted in Costa Rican farmland help to sustain populations of a local parakeet species.
8. “Living fences” are basically fence posts that grow, from thick, freshly-cut stems of tree species that, fixed vertically in the ground, regenerate as cuttings.
9. Lichtenberg 1996.
10. Leakey 1999.
11. Meinzen-Dick and Makombe 1999.
12. A well documented rationale for what the authors term “ecoagriculture” is in McNeely and Scherr 2001.
13. See, for instance, UNEP-BPSP Thematic Studies of Integration of Biodiversity into National Agricultural Sectors: National Experiences with Integrating Biodiversity into the Agricultural Sector: Six Regional Case Studies.
14. By the Commonwealth Scientific and Industrial Research Organisation (CSIRO).
15. For a practical application of this approach, see the South East Catchment Management Board web site at www.cmb.org.au/southeast.
16. McNeely and Scherr 2001.
17. Gemmell (2001).
18. The 6th meeting of the Conference of Parties of the CBD, May, 2002.
19. With initial funding through the Global Environment Facility.
20. These are in the Western Amazon basin, Cameroon, Thailand and Indonesia (Sumatra), where plant and animal biodiversity in early fallows and in late secondary forests and agroforests is being assessed over time.

Section 6

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