3. Principles for Conserving Biodiverse Agricultural Landscapes

We have considered the conservation of genetic resources on-farm, and the conservation of ecosystem services, provided by biodiversity existing on-farm and near farms. In this last section, we will move to a broader perspective, at the landscape level. The landscape level means areas that combine several land-use types, over tracts of land that might be an administrative area, a community territory, a watershed or an arbitrarily determined area several square kilometres in extent. Here, whole ecosystems are involved. The biophysical landscape here includes soils, water and microclimate, all of which can vary within one field, but vary substantially more at landscape level. The ambit includes not only the fields, pastures and agroforests, but also all areas of managed or unmanaged fallow and wild land within, among and around agroecosystems.

It is largely at the landscape level where agriculture interacts with wild biodiversity. Loss of wild habitat to agricultural use is usually given as the largest threat to the planet's wild biodiversity. It is critically important for biodiversity planners and agricultural policy makers to pay attention to those borders and balances between agriculture and protected areas. While agriculture is often seen as incompatible with wild biodiversity, several strategies are available to make more space for wildlife in agricultural landscapes. Under some conditions, increasing agricultural productivity on existing farmlands will reduce the expansion of farming onto new lands, or even encourage the contraction of production areas. Meanwhile, in and around existing farmlands it is often possible to identify spaces that can be maintained as protected areas, either as larger reserves, or as habitat networks in production areas. Many new approaches suggest that landscapes can be managed for both the production of food and the conservation of wild biodiversity (McNeely and Scherr, in press).

No agricultural system can be understood independently from the manner in which management is organized and the forces that interact to shape this organization. Management involves farmers and their families, community leaders and others, and in modern times also officials of government and agriculture departments. The layout of farms, the rotation of their land-use stages and field types, are all determined by those who manage the farms and the biological landscape within which farms operate. Thus, as we look at conservation of biodiversity in agricultural landscapes, we also include a consideration of the knowledge systems and differential abilities which determine management practices.
Key prinicples for the conservation of landscape level diversity, wild biodiversity in agricultural landscapes, and knowledge systems for agrobiodiversity are:

3.1 Protected areas are desirable near farming areas, ranch land and fisheries

3.2 Farm resource management practices can be modified to enhance habitat quality in and around farmlands

3.3 Conservation and management of biodiversity will be optimized by varying degrees of agricultural intensification on a landscape. Thus, NBSAPs should promote policies that will maintain the diversity of land use across the landscape.

3.4 NBSAP planners need to recognize and utilize traditional practices as a component of the knowledge system that support conservation and management of agrobiodiversity.

3.5 NBSAP planning needs to take account of the fact that different ecologic and socio-economic differences between farmers make it easier for some to manage biodiversity than others and that these difference are widening, thus new instruments for conservation may be needed.

Principle 3.1 Protected areas are desirable near farming areas and grazing land.

Historically, most protected areas were established in and around lower-intensity rainfed agricultural systems, where land values and productive potential were relatively low. Even in these areas, however, their value for local people may still be significant, and without local people's "buy-in" to the site boundaries, it has been difficult to ensure those boundaries.

Biodiversity conservation initiatives are increasingly being targeted at lands with much higher value for agriculture. In such cases, a much clearer analysis of tradeoffs is needed, and evidence of potential benefits of conservation for the surrounding farmers must be rigorously produced. Where it isjustifiable to take or keep land out of agricultural production in order to establish protected areas, it is critical to obtain the support of local agricultural populations. This is likely to be in conditions where:

1. the site clearly helps to make farming more productive or sustainable (e.g., by protecting valued pollinators);
2. the reserve helps to protect locally-valued environmental services (e.g., good water quality);
3. the site offers attractive alternative livelihood options (e.g., by enhancing fishing income or attracting tourists);
4. farmers are adequately compensated for the loss of land or helped to make the transition to an equally attractive livelihood option (e.g., with payments for biodiversity services); or
5. local communities themselves value the aesthetic, cultural, or recreational aspects of the habitat or of particular species (e.g., to protect sacred groves from development by outsiders).

One of the clearest benefits to farmers from protected areas is watershed protection. The same good natural vegetative cover needed to maintain healthy watersheds to produce a steady and reliable source of water, may also provide good biodiversity protection. For example, La Tigra National Park in Honduras with 7600 hectares of cloud forest provides a critical water supply to the capital city of Tegucigalpa (40 percent of its drinking water at a cost of about 5 percent of its second largest source) and farming communities downstream. Guatopo National Park in Venezuela provides 20,000 liters per second of high-quality water to Caracas, but also to agricultural users. In northern Thailand, quite large upper-catchment areas are conserved from agriculture for watershed protection.

Gradually, the role of protected areas in providing other ecosystem services such as pest control and waste recycling, is gaining recognition (see Box, Cosat Rica). Yet communities and traditional societies have long set aside protected areas for multiple functions. The village of Missidè Héïré for example, in the Fouta Djallon of Guinea, reserves 3.1 ha of

In **Costa Rica**, a large company produces oranges next to the Guanacaste Conservation Area as well as in many other places throughout the country. They realized that their plantations next to the protected area had few pests, and year-round secure water supply. They also wished to use the natural woodlands to let their orange residues decay, instead of otherwise having to dispose of them. As they needed to use far less pesticides next to the forest, they were concerned to see that the protected area is well maintained, and consented to pay an equivalent of almost half a million dollaors over 20 years to the reserve.
from Jeff's full draft

forest and 15.6 ha of woody savanna immediately adjacent to its 27.2 ha of intensively-cultivated infields for the gathering of fuelwood, medicinal and other useful plants, for religious reasons and also for protection from seasonal fire arising in the surrounding outfields and fallow areas (Boiro et al. 2002, forthcoming). It is important to recognize that such conservation arrangements do occur at local level, without external imposition. Planning for new protected areas in agricultural land should build on local residents' understanding of land conservation benefits.

An interesting new development is occurring, with reserves being set up to protect agricultural genetic resources, or their close wild relatives. In recognition of the fact that ***in situ*** conservation allows species to continue to co-evolve in relation to their natural environment, associated pests, and human selection pressure, conservation efforts for wild relatives of domesticated crops have sometimes also been linked to establishment of protected areas that include working farms (Amaral, Persley and Platais 2001). Reserves currently exist for maize in Mexico, wheat in Israel, and a country-wide program funded by the Global Environment Fund (GEF) in Turkey (Hodgkin and Arora 2001). India has established a "gene sanctuary" in the Garo Hills for wild relatives of citrus and further sanctuaries are planned for banana, sugarcane, rice and mango (Hoyt 1992). The Chatkal Mountain Biosphere Reserve in Kirgizstan conserves important wild relatives of walnuts, apples, pears, and prunes. These programs seek to preserve farming areas and nearby wildlands, usually with some restrictions on management and harvest to protect wild biodiversity.

BEST PRACTICES

- Establish protected areas near farming areas, ranch land, and fisheries where both rural populations and wild biodiversity can mutually benefit.
- Involve local farmers and organizations in the planning of protected areas.
- Involve the ministry of agriculture in the planning of protected area systems
- Provide incentives for farmers to cooperate.

Protected area planning information
World Commission on Protected Areas?
Conservation handbook?

Priniciple 3.2 Modify farm resource management practices to enhance habitat quality in and around farmlands.

The following discussion borrows heavily from the text of the expert review on wild biodiversity in agricultural landscapes, commissioned from J. McNeely and S. Scherr.

BEST PRACTICES

- Promote increases in agricultural productivity that expressly lead to a contraction in agricultural lands and reversion to wild vegetation
- Modify resource management with a concern for wildlife.
- Use non-agricultural land in farm landscapes in biodiversity-friendly ways
- Recognise sources of conflict between agriculture and wildlife, and plan for it, or compensate for it.

One means of modifying farming practices to accomodate the needs of wildlife is to promote increases in agricultural productivity that expressly lead to a contraction in agricultural lands and reversion to wild vegetation. The trends, of course, are presently in the opposite direction: pressure for agricultural expansion often results from incentives to expand profitable production systems. But in many cases, the pressure results from stagnant agricultural productivity in the face of rising market and population pressures, lack of agricultural employment that induces the landless to seek unexploited lands, and degradation from unsustainable intensification in lower quality lands that leads to land abandonment. Increases in agricultural productivity and sustainability may help to slow or reverse these latter processes

McNeely and Scherr in our wild biodiversity expert review have compiled a series of documented cases where increases in agricultural productivity have led to a contraction in agricultural lands, and reversion to wild vegetation. All of these took place in farming systems in marginal lands that relied on short fallows. Intensification of production on the best (irrigated, or more fertile) lands permitted farmers to withdraw from (or slow expansion into) more extensively managed fallow areas. Their example of regenerating native pine forest habitat in Honduras through improved crop technology is given in the box below.

Another important means of accomodating wildlife in agricultural landscapes is through modifications in the way resources are used. Habitat quality of farmlands can often be improved by changing water, soil and plant resource management in ways that have neutral or even positive effects on agricultural production. There is great scope for increasing use

Honduras: The central region of Honduras covers about 8,900 square kilometers, of which over 90 percent is rugged hillsides. All was originally forested; about half of the area today is covered by native pine forest, with scattered deciduous forest stands. Significant deforestation occurred prior to the mid-1970s, due to over-logging and frontier agricultural settlement. Since then, commercial logging has been sharply controlled. However, conversion of forest to farmland has continued as a result of a 2.3 percent annual rural population growth, agricultural demand from the even faster-growing capital city nearby, and widespread erosion and nutrient depletion in steep fields used for low-value staple food crops. As a result of loss of forest habitat, wild populations of deer, agouti, raccoon, various squirrels (which have traditionally provided an important source of animal protein for local diets), as well as other native fauna and flora have declined sharply.

But a different pattern of land use change has emerged in some of the region’s communities, as a result of research and extension by National Coffee Program of Honduras and by the local Pan-American Agricultural School of Zamorano. In the 1980s the Zamorano School identified a wide range of fruit and vegetable varieties suitable for local steepland conditions, and developed integrated nutrient and pest management strategies and sprinkler irrigation and conservation practices. The Coffee Program encouraged coffee-growing communities to intensify production of basic grains, to free up farmland to expand shade coffee area, and plant higher-yielding coffee to replace traditional varieties. In the late 1980s and early 1990s, communities occupying a third of the area of the Central Region adopted and adapted these new technologies. Higher cash incomes from vegetables and coffee enabled farmers to purchase fertilizers to replenish soil nutrients both in their commercial fields and in subsistence staple food crops, thus nearly doubling maize yields on permanent fields. This allowed them to abandon marginal fallowed fields, which reverted to forest. Aerial photograph analysis shows that the net area under forest cover remained stable during this period in the coffee-growing communities and declined only slightly in the horticultural communities. This contrasts with at least 13 percent, and in some cases as high as 20 percent, forest cover decline in the basic grains communities. Unlike the extensive farming communities, these did not report a decline in wild game over the period; indeed, their reliance on hunting for game declined (Pender, Scherr and Durón 1999; Scherr 2000).

efficiency of both rainwater and irrigation water in agriculture, thus making more water available for wetlands and wildlife. Better management of drainage water in irrigation systems can prevent salinization of soils and water, and resulting radical changes in habitat quality. Water conservation measures can help to slow the velocity of water moving across the surface, encouraging better percolation through the soils and availability of water for non-crop plants.

Natural vegetation in farmlands can be better managed for both habitat quality and production. It used to be common wisdom that fallows would have no role in the permanent agriculture of the future. Over the past decade, however, researchers working together with farmers have developed short-duration, improved woody fallows for many tropical agroecosystems. Because they reduce farmers' cash costs for purchase of fertilizers and produce a range of valuable products for household use or sale, the practice has spread rapidly, even on small farms. Short fallows, using trees, shrubs or herbaceous plants, can enhance wild biodiversity by reducing agro-chemical pollution and providing suitable habitat. Fallow systems provide mosaics of spatially interacting fallow and cropped plots (van Noordwijk 1999); these can be an important part of broader land use mosaics to enhance wild biodiversity.

Simple changes in the treatment of crop residues at the end of harvest may benefit wildlife. A study of the northeast region of the U.S. has shown that numbers of wild turkeys, Canadian geese, deer, raccoons, skunks and possums have increased where farmers leave more crop residues in autumn and winter (Mac ***et al***. 1998).

Resource systems may be modified by focusing more on production of wild species for consumptive use. The establishment of large wildlife reserves in traditional grazing areas, with sharp restrictions on local rights to graze and to destroy wildlife threatening their cattle, has caused conflict and exacerbated poverty. In response, new paradigms have been developed for co-managing domestic livestock and wildlife (Bourn and Blench 1999; IFAD 2001; Kiss 1990). Research has shown that livestock and wildlife exploit different (but overlapping) ecological niches in time and space, and have evolved different physiological and behavioral strategies to reduce competition. Some experts now advocate mixed livestock raising and harvesting of wild herbivores as the most economic use of low-rainfall rangelands, thus maintaining the full natural biodiversity (Western and Pearl 1989). While maintaining income and use values from livestock, the new strategies also benefit pastoralists economically by integrating wildlife into their livelihood strategies, earning income from ecotourism, safari hunting, park revenue sharing, cash compensation for the risks of wildlife damage, sale of rangeland products to tourists. For example, the CAMPFIRE community-based wildlife management program in Zimbabwe has increased incomes in communal areas by an estimated 15-25 percent (Butler 1995), though household level income increases may be less. Research in Ghana, Kenya, Zimbabwe, and Namibia showed significantly higher economic rates of return on wildlife ranching than from cattle, though the income from tourism, trophy hunting, and wild meat is subject to market saturation (Bojos 1996).

In most agricultural landscapes, even those with intensive farming systems, considerable land area is devoted to non-agricultural uses. These include obvious features, like farm wetlands, wood lots, or windbreaks, but also often-ignored sites like schoolyards, temple grounds or graveyards (see box, Non-cultivated areas). There is often more wild biodiversity present than most people realize, and considerable scope to protect or enhance those resources. Thus, a third major strategy to promote biodiversity in agricultural regions is to modify the use of those "in-between" spaces, to provide better ecological conditions for wild biodiversity to thrive.

No matter how carefully they are protected, small reserves will progressively lose their most distinctive species if they are surrounded by a hostile landscape. But if the surrounding matrix is managed with biodiversity in mind, agricultural areas can make a positive contribution to biodiversity. The greatest potential for meeting biodiversity conservation goals is by establishing habitat according to an integrated pattern within and across farms that reflects landscape-scale ecosystem planning. Different types of niches in agricultural landscapes, depending upon their size, shape and location, may support different types of biodiversity. Non-farmed areas can be utilized to provide "patches" of certain types of habitat, or to form "corridors" linking protected areas and enabling species to maintain genetic contact between populations that otherwise would be isolated. This may involve protecting remnant native vegetation or re-establishing wild species, often "keystone" species that provide micro-habitats for associated species. Remnants may

Non-Cultivated Areas in Agricultural Lands: Potential Habitat for Wild Biodiversity

Around water resources:

- Riparian forests and ecosystems
- Natural waterways
- Irrigation canals
- Watershed areas to promote water harvesting
- Farm, road and other drainage ways
- Drainage water used for fish habitat or production
- Stream filter strips (using native and a variety of usable components), to catch sediment and chemical run-off

In and around farm fields:

- Conservation reserve areas taken out of farming
- Uncultivated strips within crop fields as habitat for weeding relatives of crop plants, especially in areas known to be centers of origin or diversity for crop plants
- Windbreaks
- Border plantings or live fences between plots or paddocks, or between farms
- Irrigation bunds
- Vegetative barriers to soil and water movement within crop fields
- Areas taken out of production to control salinity, or abandoned as a result of salinity
- Little used or low-productivity croplands
- Little used or low-productivity grasslands

In and around forest areas:

- Farm or community woodlots
- Farm, community, government or private natural woodlands or forest
- Private industrial plantations

Other sites:

- Homesteads
- Along roadsides
- "Sacred groves" in communal lands, churchyards or graveyards
- Schoolyards
- Agroindustrial or hospital sites
- Agro-ecotourism sites
- Public or private recreational parks
- Special sites conserved for cultural value to indigenous people

include both biological communities that depend on a continuation of traditional land use practices, and survivors of pre-agricultural vegetation. Through various kinds of linkages with the surrounding landscape, protected areas can avoid becoming fragmented and degraded and become more effective in conserving biodiversity.

While we still have much to learn about ecological relationships between wild species and agricultural habitats, some general principles are developing. We know that since many vertebrate and insect species use and require two or three habitats diurnally, seasonally, or in their life cycle, the proximity and access to such habitats is critical (Forman 1995). Networks of natural vegetation are particularly effective for maintaining populations of "edge species," and for connecting breeding stocks in dispersed protected areas. Such networks could potentially meet a significant part of the habitat needs for many types of species, even

USA: Managing flooded rice fields for wildlife habitat

Flooded fields apparently provide foraging habitat equivalent to semi-natural wetlands and, because of reduced predation threat, may be a safer habitat for waterbirds. Thus if managed appropriately one of the world's dominant forms of agriculture can provide valuable waterbird habitat. For example, flooded rice fields in California are used by numerous aquatic birds during winter. This habitat functions like more natural wetlands, so increased flooding may help replace the extensive wetlands that occurred in the region prior to agricultural development (Elphick 2000). Researchers compared the habitat value of flooded rice fields and semi-natural wetlands for several species of aquatic bird. The availability of invertebrate species used by birds for food did not differ among habitats. Semi-natural wetlands had less rice grain but more seeds from other plants than the two rice habitats. Predators passed over a feeding area less often in flooded fields than in unflooded fields or semi-natural wetlands, but birds fed more often in flooded fields.

Such results are relevant in many parts of the world. In the Sacramento and San Joaquin Valleys of California, farmers working together in the Valley Care program have instituted minor management changes in flooded rice production that have greatly increased their value for tropical migrant shorebirds and waterfowls. These methods were pioneered by Ducks Unlimited, a conservation and hunters' organization. After rice is harvested, rice stubble and straw are rolled and crushed, and then flooded over the winter as an alternative to burning it. The system accomplishes the grower's objective of decomposing waste straw and controlling weeds and diseases, while providing winter habitat and food for waterbirds. Rolling rice straw is economical in comparison with alternative agronomic methods that do not have the same wildlife benefits, and also eliminates air pollution due to burning, which is now tightly regulated. Some restored natural wetlands are being managed jointly with agricultural lands to provide year-round wildlife habitat. Species benefiting are not only waterfowl (like ducks) but also wading birds, shorebirds and cranes. Shorebirds include dunlins (*Calidris alpina*), dowitchers (*Limnodromus scolopaceus*), killdeers (*Charadrius vociferus*), and other sandpipers. Ducks included northern pintails (*Anas acuta*), American widgeons (*A. americana*) and even mallards (*A. platyrhynchos*) and northern shovelers (*A. clypeata*). Snow geese and Ross' geese were also common (Paine, Bias and Kempka 1996). The rice cropping system in the upper coast of Texas creates a heterogeneous mosaic of flood rice wetlands, grazed fallow lands, and ploughed fields, that has dramatically increased use by migratory birds like the lesser snow geese, the greater white-fronted geese and Canada geese. Over 20 million waterfowl and geese winter on the upper Texas coast, with the bulk of these using freshwater wetlands associated with rice agriculture (Lacher *et al*. 1999).

without large protected areas nearby. In western Australia researchers found that even modest increases in native vegetation from 7 to 10 percent, strategically located, significantly improved habitat value (C.Binning, pers. comm. 3/01).

Even small fragments of native habitat can help migratory animals at sites that provide food and shelter for specific periods of the year. Many migratory species of birds, for example, will find these relatively small areas of habitat sufficient to meet their transitory needs. Recent studies of insect-eating birds in isolated fragments in Brazil have indicated that the rapid establishment of tall secondary forests around small fragments linking them back to more extensive primary forest areas and greatly accelerates the recovery of the avian insectivore community to something close to the pre-isolation situation. Thus small fragments can provide a safety net for a significant number of species and their genetic diversity, and a breathing space for conservationists to plan strategies for preventing the loss of the species concerned. Intervention management can then be focussed on species that are particularly sensitive to fragmentation, such as large carnivores, large trees, and epiphytic orchids. For example, Cowlishaw (1999) concludes that 30 percent of forest primate fauna will be lost even if deforestation is controlled, unless corridors to connect protected areas are established.

Many farmers are interested in wildlife conservation, where it can be done without signifi-

Costa Rica: Farmland corridors

In 1989, the Conservation League of Monteverde, in a wet, mountainous region of northeast Costa Rica of high natural biodiversity value, initiated tree-planting activities with farmers. The project worked in 19 communities, and helped farmers to establish over 150 ha of windbreaks. The windbreaks, a mix of indigenous and exotic tree species, were designed to protect coffee trees and dairy cows from the negative impacts of high winds. The economic returns from windbreaks to the farmers are very high, even without considering timber products, as wind protection results in higher coffee and milk yields, reduced calf mortality and morbidity, and larger herd-carrying capacity of pastures. Nearby farmers also established windbreaks that allowed the production of high-value horticultural crops in the protected fields. Damage to coffee from wild parakeets has been reduced, because the parakeets prefer the fruit of a native tree known as colpachi, one of the species used in the windbreaks. Furthermore, farmers who received benefits from the windbreaks have been more receptive to efforts to protect the remaining natural forest on their farms (Current 1995).

Research has shown that the planted windbreaks serve as effective biological corridors connecting remnant forest patches in the Monteverde area. These corridors are especially useful for the migratory species of songbirds that are an essential part of agroecosystems in North America during their summer breeding season. The windbreaks also dramatically increased the deposition of tree and shrub seeds within the agricultural landscape. A careful study of annual “seed rain” patterns in the windbreaks and adjacent patterns found that seeds deposited in the windbreaks represented 174 species and at least 53 plant families. Trees accounted for a third of all species. Epiphytes and trees were primarily bird-dispersed, whereas herbs were primarily dispersed by wind, gravity or explosive mechanisms, and shrubs by a combination of mechanisms. These windbreaks were only 3-7 meters in width, yet they increased seed deposition by birds over 95-fold relative to the pastures. They were effective despite consisting of primarily exotic, nonfruit-bearing species that offered no food resources for birds. If native, fruit-producing trees were incorporated into the windbreaks, it is likely they would enhance the incoming seed rain and species richness further (Harvey 2000) cant financial loss or livelihood risk. For example, farmers have worked to recover native or endemic species now rare in the landscape, by converting low-value unfarmed areas to native vegetation, or preserving biodiversity-rich wetlands. In ranching systems, landowners and community groups have allocated marginal grazing lands to help conserve wild species. For example, a large-scale row- and field-crop farm in central California incorporated over 50 locally adapted species of native perennial grasses, forbs, sedges, rushes, shrubs and trees into various parts of the farm — on poor quality lands, roadsides, irrigation canals, natural sloughs, tailwater ponds and hedgerows. The 200 hectare farm has 3 ha of 5-10 meter wide multi-species hedgerows that serve as year-round "habitat highways" for deer, fox, bear, coyotes and many other animals, whose populations have dramatically increased. They act as a web connecting the other native habitat patches, as well as supporting beneficial insects that control pests in adjacent row crops. While the farmer faces additional costs for seed and plant materials, special equipment, and increased transportation due to limited local markets for the native grass seeds, cost savings are achieved from reduced pesticide use, labor and tillage. Field studies demonstrated no meaningful difference in crop yields, and implementing practices in unfarmed areas has caused little or no reduction in the land available for crops (Anderson ***et al.*** 1996). In Ontario, Canada, a farm survey found that in 1999 77 percent of farmers felt wildlife was "very or somewhat important as a necessary part of the balance of nature", and farmers had invested a total of almost $8 million in enhancing wildlife habitat (Ontario Soil and Crop Improvement Association 2001).

Philippines: Soil erosion barriers with native plants

Contour hedgerows are rows of perennial shrubs established along the contour that have been promoted on steeplands to reduce erosion and produce organic matter for soil improvement. Most contour hedgerows have used exotic grass or shrub species, requiring special nursery development to provide planting materials and considerable labor for establishment. In the early 1990s, researchers at ICRAF in the Philippines, frustrated at farmers' low adoption of hedgerow technology, began a series of studies to identify the most cost-effective approach to contour planting of perennials. They discovered that natural vegetative strips (NVS) — contour rows left uncultivated during plowing, so that natural vegetation could grow there — were not only the least expensive (zero cost for planting materials and establishment), but erosion control was nearly as effective as in planted shrub hedgerow technologies. Studies found rows as far apart as 2 to 4 meters elevation distance served nearly as well for erosion control as more closely-spaced rows, while removing much less area from production (Mercado *et al.* 1997). Further research developed a very low-cost method for laying out initial contour lines, and for enriching the natural vegetative strips with high value fruit trees from which farmers could earn cash income.

First introduced to NVS in 1996, thousands of farmers have now adopted this low-cost technology in the densely populated steep farmlands of northern Mindanao, the Philippines. The natural vegetative strips are not only valuable for maintaining soil fertility on farms and protecting local watersheds, but they also provide important habitat for wild biodiversity. A study of floral composition and community characteristics of fields with NVS confirmed the high diversity of native plant species, while the presence of untilled areas provided habitat for native fauna (Ramiaramanana 1993). Economically profitable timber and fruit tree species in the NVS further expand their habitat value for wildlife.

It is often desirable to include in plant mixtures species that produce products that are economically valuable, for cash sale or for household consumption. These can help to meet the livelihood needs of farmers, as well as important environmental functions. While they may modify habitats somewhat, their advantage is in providing financial incentives for farmers to maintain them over the long term. By enriching the natural vegetation growing in between farm fields with nutritious food species, the nutritional status of local people can be improved. Native vegetation established in non-farming areas, such as roadsides or schoolyards, can include food or fuel plants to be harvested by the poor. Even if not all vegetation in these "in-between" sites is native, increasing below and above-ground biodiversity will often be ecologically valuable. Inclusion of exotic species that provide products of value to farmers can encourage participation in biodiversity conservation, and may be considered wherever their establishment represents a net improvement in overall habitat quality and does not threaten to become invasive.

Two cases (see boxes) illustrate how wildlife habitat can be created "in-between" agricultural production areas, to the mutual benefit of farmers and wild species.

While identifying ways to support populations of wildlife in the midst of agricultural regions, it is important, however, to note that peaceful co-existence is not always the result. Important conflicts may arise. Increased wild bird populations (e.g., parrots) may consume standing crops or infect poultry with disease. Some wild animals may behave as predators on domestic livestock (e.g., wolves or lions). Some herbivores may raid crops, such as elephants, wild pigs, or rhinos; and some aggressive native or non-native plants may infest farm fields (e.g., weeds such as ***Imperata*** or ***Lantana***). Some species feed on stored crops (eg. rats, mice). Other wildlife may represent a potential threat to human life and health (e.g., poisonous snakes, tigers). Indeed, concerns about such threats led to many of the original decisions by farmers or whole communities to clear native vegetation and remove potential wildlife habitat. Farmer resistance to increasing wildlife populations can be considerable, even among individuals with a strong philosophical commitment to environmental values. Even so, "ecoagriculture" implies active co-management of both agricultural production and wildlife.

Ecological research over the past few decades has shown that strategic interventions can often significantly reduce the number of actual conflicts with resident or visiting wildlife. Some wild predators actually serve to control agricultural pests, and are thus beneficial to farmers. Measures that have been implemented successfully in various parts of the world include: modifications in livestock husbandry (everthing from lambing and kidding in sheds to putting bells on their sheep); fencing (species-specific requirements); guarding animals (such as donkeys in sheep and goat flocks); repellents and frightening devices; or maintaining wild populations of snakes or owls to control rats (USDA 1994). Near large wildlife reserves, digging trenches has proven effective in discouraging elephants and rhinos. Some types of weeds can be controlled with modified grazing regimes, and bird and insect pests has been successfully controlled by establishing plants that provide alternative feed and water sources. Some pests can be controlled by managing pest-predator populations. Selective destruction or removal of problem animals can be done. Considerable research is required to devise and document the efficacy of wildlife control methods for specific species and ecoagrosystems.

Recognition of potential problems is an important part of ecosystem planning, and monitoring of farm-wildlife interactions to enable corrective measures to be taken is an essential parts of the ecosystem management process. Especially promising ways to enhance agriculture-wildlife coexistence are strategies whereby local farming populations benefit directly from the presence of wildlife in their landscapes, through sharing of ecotourism revenues, direct harvesting of wild products, public assistance with wildlife control measures, or payments for biodiversity services provided (Kiss 1990). Where conflicts are unavoidable, mechanisms must be put in place to compensate farmers fairly for their losses (Tisdell 1999).

TOOLS

- A review of measures to mitigate human/wildlife conflict is catalogued at this website. For example, near wildlife reserves, digging trenches has proven effective in controlling the movement patterns of elephants and rhinos. Internet Center for Wildlife Damage Management.

  www. ianr.unl.edu/wildlife/solutions/handbook.

- This small booklet provides some guidance on managing agricultural landscapes for pollinators:

  Matheson, A., ed. 1994. Forage for bees in an agricultural landscape. International Bee Research Association. Cardiff, UK.

Principle 3.3 Conservation and management of biodiversity will be optimized by varying degrees of agricultural intensification on a landscape. Thus, NBSAPs should promote policies that will maintain the diversity of land use across the landscape.

Once we enter into a discussion of landscape-level management, questions of land tenure, property rights, and management authority need to be addressed, as these clearly have the strongest impacts of any policy interventions on landscape level diversity.

From the standpoint of agricultural biodiversity conservation, land tenure systems which permit security of tenure and landholder investment in conservation activities is needed. Moreover, a long history of research on land management systems has shown that the most innovative land stewardship systems come from flexible tenure arrangements (Brookfield 2001). But is too often the case that land tenure conditions are imposed from above, without adequate knowledge of indigenous systems, in particular social systems under which people can use their personal networks to access additional land, obtain assistance where it is needed, and help one another. Sometimes indigenous systems of tenure are quite deliberately disregarded, and new conditions are imposed that reflect the views held at state level concerning what proper land arrangements should be. A more sensitive approach to indigenous land rights is only slowly taking shape, and being applied in the management of relations between the state and its rural citizens.

An important distinction can, however, be drawn between countries and regions in which the state claims title to land, and allocates it to individuals on a legal basis, and those in which private arrangements continue to hold sway. One important aspect of colonial rule was the assumption by the state of title to all land not in current use, and sometimes to land in use as well. This has continued beyond the end of colonialism in many areas, among which the shifting-cultivation areas of Indonesia are a striking example (Brookfield, Potter and Byron 1995). Re-allocations took place, forcing people to occupy new areas, and to surrender large tracts of land to settlers, or companies.

NBSAP planning, like national agricultural policies and national environmental policies, are also top-down arrangements, and it cannot be said that any of those so far prepared take adequate account of the variety of land tenure arrangements that exist. Nor do they take account of the consequences in terms of inequality that make imposition of any set of uniform strategies an impossible goal. It is therefore important that in the development of such policies, there be consultation at local level on the implementation of strategies, and that this consultation be fully participatory among the farming populations who will be expected to conserve agrobiodiversity.

It is also important that other policies, in addition to land tenure policies, which promote diversified forms of managment, be promoted, and that political space be created for community and voluntary initiatives to promote diverse and appropriate land management schemes.

BEST PRACTICES

Review polices for relevant sectors and be proactive about a dialogue on plans (strategic EIA).
Review tenure policy over land, and biodiversity.
Support and encourage community initiatives to promote diverse and appropriate land management schemes.

Policies that work for sustainable agriculture (and landscape-level biodiversity conservation)

Policy 1: Declare a national policy for sustainable agriculture.

Encouraging resource-conserving technologies and practices
Policy 2: Establish a national strategy for IPM
Policy 3: Prioritise research into sustainable agriculture
Policy 4: Grant farmers appropriate property rights
Policy 5: Promote farmer-to-farmer exchanges
Policy 6: Offer direct transitionary support to farmers
Policy 7: Direct subsidies and grants toward sustainable technologies
Policy 8: Link support payments to resource conserving practices
Policy 9: Set appropriate prices (penalise polluters) with taxes and levies
Policy 10: Provide better information for consumers and the public
Policy 11: Adopt natural resource accounting

Supporting local groups for community action
Policy 13: Encourage the formation of local groups
Policy 14: Foster rural partnerships
Policy 15: Support for farmers' training and farmer field schools
Policy 16: Provide incentives for on-farm employment
Policy 17: Assign local responsibility for landscape conservation
Policy 18: Permit groups to have access to credit

Reforming external institutions and professional approaches
Policy 19: Encourage the formal adoption of participatory methods and processes
Policy 20: Support informaiton systems to link research, extension and farmers
Policy 21: Rethink the project culture
Policy 22: Strengthen the capacity of NGOs to scale up
Policy 23: Foster strong NGO-government partnerships
Policy 24: Reform teaching and training establishments
Policy 25: Develop capacity in planning for conflict resolution and mediation

from Pretty 1995

Policy reform in agriculture is under way in many countries, with some new initiatives supportive of more environmentally sustainable modes of production. Most of these focus on input reduction strategies. Only a few as yet represent coherent plans or processes for integrated management of agriculture and biodiversity. Nonetheless, in cumulative total, the policies listed in the accompanying box can lead to substantive changes in the way agricultural land is managed with respect to conservation of biodiversity. They could have even more impact is they could be integrated into a strategic environmental impact assessment on the environment and agriculture.

The literature on land tenure and environment is voluminous, and does not need to be invoked here. But experiences in tenure policies for rural populations over the wildlife which occurs on their land is a special case of land tenure issues that deserves mention. The experience of CAMPFIRE, in Zimbabwe, is informative (see box next page)

Informally there are many documented instances of local community initiatives that take "landscape approaches" to the conservation of key sites within a landscape; some instances are mentioned in section 3.1 A formal version of these initiatives is the Landcare Movement in Australia, and South Africa, which is premised on a perception by farmers that they themselves benefit from having "protected" land adjacent to their farms. The movement consists of groups of farmers who support one another and work together on a landscape scale to improve the agroecosystem. There are some 4,500 such groups now working in Australia. To take one example of 14 families in New South Wales, together they have addressed soil erosion, feral animals and introduced weeds. With community and government support, they have fenced a "local protected area", and removed all weeds and feral animals, and reintroduced their native wallabies. The "local protected area" is not only good for biodiversity conservation, but is a cornerstone of their campaign to fight gully erosion and land degradation. Protection, in this case, need not be by a government body, so long as community sanctions are in place.

Principle 3.4 NBSAP planners need to recognize and utilize a diversity of knowledge systems, including traditional practices, that support conservation and management of agrobiodiversity.

The following discussion borrows heavily from the text of the expert review on knowledge systems, commissioned from P. Mulvany.

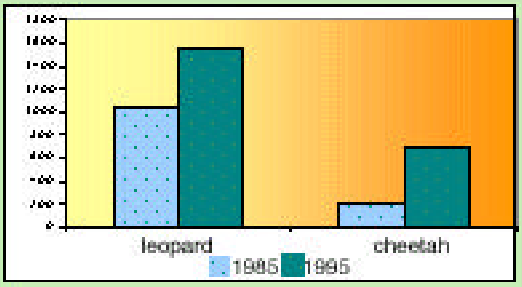
Agricultural biodiversity is the product of human ingenuity: it embodies the knowledge of generations from since some 10,000 years BC. That knowledge is bound into the genetic, species and agroecosystem diversity through countless managed adaptations of interactions between species (and subspecies, varieties, breeds, etc.) that have been the result of human initiatives. Thus, all agricultural biodiversity activities are based on knowledge systems that stretch from the birth of agriculture to the present day.

BEST PRACTICES

- Be aware of the diverse proposals on the international level to manage knowledge systems.
- Address national options for managing knowledge systems and respecting ownership and rights over traditional knowledge.
- Develop means of respecting community rights.

Zimbabwe: Since 1975, Zimbabwe has allowed private property holders to claim ownership of wildlife on their land and to benefit from its use. Zimbabwe has pioneered consumptive uses of wildlife with its Communal Area Management Programme for Indigenous Resources. CAMPFIRE, emerged in the mid-1980's with the recognition that as long as wildlife remained the property of the state no one would invest in it as a resource. CAMPFIRE is a programme than has sought to give rural communities an alternative to destructive uses of the land by making wildlife a valuable resource, on the thesis that wildlife is the most economically and ecologically sound land use in much of Zimbabwe. Through CAMPFIRE, Zimbabwe seeks to involve rural communities in conservation and development by returning to them the stewardship of their natural resources, harmonising the needs of rural people with those of ecosystems. Under CAMPFIRE, people living on Zimbabwe's impoverished communal lands, which represent 42% of the country, claim the same right of proprietorship. Conceptually, CAMPFIRE includes all natural resources, but its focus has been wildlife management in communal areas, particularly those adjacent to national parks, where people and animals compete for scarce resources. Since its official inception in 1989, CAMPFIRE has engaged more than a quarter of a million people in the practice of managing wildlife and reaping the benefits of using wild lands.

CAMPFIRE begins when a rural community, through its elected representative body, the Rural District Council, asks the government's wildlife department to grant them the legal authority to manage its wildlife resources, and demonstrates its capacity to do so. By granting people control over their resources, CAMPFIRE makes wildlife valuable to local communities because it is an economically and ecologically sound land use. The projects these communities devise to take advantage of this new-found value vary from district to district. Most communities sell photographic or hunting concessions to tour operators - under rules and hunting quotas established in consultation with the wildlife department. Others choose to hunt or crop animal populations themselves, and many are looking at other resources, such as forest products. The revenues from these efforts generally go directly to households, which decide how to use the money, often opting for communal efforts such as grinding mills or other development projects. The councils, however, have the right to levy these revenues.



The Parks and Wildlife Act gives privileges to owners or occupiers of private land and rural district councils in the case of communal areas to utilise and exploit plants and animals on their land. Conservancies are mostly located in areas of low agricultural potential where wildlife is the only viable and sustainable form of land use. Its success, next to the traditional competition between agriculture and wildlife, is seen in the following results: domestic stock predators such as lion, cheetah and leopard which were being eradicated to safeguard domestic stock before the legislation and policy changes were put into place, have now started to increase in umbers. For example, surveys on 206 game and game/cattle ranches (for leopard) and 37 ranches (for cheetah) showed the following changes between 1985 and 1996:

On average CAMPFIRE projects in Zimbabwe generate over Z$20 million annually. In addition to income directly accruing to participating households from the CAMPFIRE programme, local authorities have put up schools, grinding mills, electric fences and sales depots using revenue from the programme. Communities which include both the large scale commercial farmers running conservancies/game ranches and smallholder farmers involved in the CAMPFIRE programme are key players in sustainable wildlife management.

Global initiatives:

The International Environmental Governance structure has dealt with knowledge systems in a number of ways, which need to be considered in relation to agricultural biodiversity.

Under the Convention on Biological Diversity Article 8j, indigenous knowledge is recognised as connecting the knowledge systems directly to a social group:
Subject to its national legislation, respect, preserve and maintain knowledge, innovations and practices of indigenous and local communities embodying traditional lifestyles relevant for the conservation and sustainable use of biological diversity and promote their wider application with the approval and involvement of the holders of such knowledge, innovations and practices and encourage the equitable sharing of the benefits arising from the utilisation of such knowledge, innovations and practices.

The United Nations Food and Agriculture Organisation has been discussing the concept of "Farmers' Rights" for some time. "Farmers' Rights" values the knowledge system of local farming communities and recognises the value of the genetic enhancements they have developed within seeds, in particular (e.g. FAO 5/89). Farmers' Rights mean rights arising from the past, present and future contributions of farmers in conserving, improving, and making available plant genetic resources, particularly those in the centres of origin/diversity.

A definition of Farmer's Rights is now embodied in the International Undertaking on Plant Genetic Resources, currently under negotiation, now explicitly includes:
1. protection of traditional knowledge relevant to plant genetic resources for food and agriculture;
2. the right to equitably participate in sharing benefits arising from the utilization of plant genetic resources for food and agriculture;
3. the right to participate in making decisions, at the national level, on matters related to the conservation and sustainable use of plant genetic resources for food and agriculture.

Globally, there are two distinct knowledge systems within the formal sector of both private and public institutions, and within the informal sector of communities and individuals. The formal sector knowledge systems are codified, are recorded in writing and are defended through national and international law; the knowledge systems of the informal sector are often oral, are built on trust and are defended through the norms and practices of traditional institutions. The intellectual property (IP) of the former is recognised in law in industrialised countries and in the industrial sectors of developing countries. The latter has weak jurisprudence in its defence: there are no mechanisms to implement legislation and, in most cases, no legislation has yet been enacted, despite ratification of a number of international agreements, such as the Convention on Biological Diversity (CBD). It is left to individual governments to develop legislation that will ensure the protection of informal knowledge and the equitable sharing of benefits from its use.

National approaches:

The potential conflict between the two knowledge systems does need to be recognised and social, technical and legal systems of protection for biological resources in the public domain and those used by, and for the benefit of, the majority need to be developed accordingly.

Intellectual property rights (IPRs) are the rights given to persons over the creations of their minds – their intellectual property (IP). They are granted by a state authority for certain products of intellectual effort and ingenuity. They usually give the creator an exclusive right over the use of his/her creation for a certain period of time. There has been much debate over the suitability of patents and other forms of intellectual property rights (IPRs) for the protection of plant genetic resources for food and agriculture. For example. the Crucible Group in their first report ***"People, Plants and Patents"***, included reflections on the inappropriateness of IP systems that risk the well-being of their peoples or that jeopardise the biological diversity within their borders. They also noted that there were likely to be conflict between IP proposals and other initiatives for plant genetic resources conservation and exchange:

Whatever the arguments may have been, there is now an overwhelming pressure on all WTO Members, through TRIPs Article 27.3(b) to consider applying IPRs to living material, and an obligation to apply them to plant varieties. In responding to this, countries have to weigh the balance of rights between industrial innovators, often not from the country concerned, and the rights of local communities, farmers, indigenous peoples and consumers within the country.

Community Rights

As Darrell Posey points out in ***"Beyond Intellectual Property",*** IPR laws are generally inappropriate and inadequate for defending the rights and resources of local communities and indigenous peoples. Traditional community knowledge is usually shared and the holders of restricted knowledge in communities probably do not have the right to commercialise it for personal gain. There are thus a number of models that are emerging to help people develop the basis of future legal systems to protect their knowledge and resources. These rights embody both biological and cultural rights and thus may go beyond other ***sui generis*** models (i.e. rights or legally recognised systems that are adapted to the particular needs of a country or community), which concentrate only on the biological resource (Posey and Dutfield, 1996).

Community rights may incorporate rights to manage some aspects of self-governance, natural resource management and economic livelihoods, including control over biodiversity, local knowledge, innovations and practices as required by the CBD.

The movement to set up community registers of biodiversity to thwart misappropriation and initiatives to implement a moratorium on bioprospecting are evidence of concern at community level, in the absence of adequate protection (see box, page x).. Farmers' Rights should also be considered within this bundle of rights and, importantly, need to be seen as complementary to, rather than in conflict with, other forms of community or indigenous peoples' rights.

Some of these rights are embodied in the CBD, especially Article 8(j), as well as in the FAO Farmers' Rights resolution 5/89, but these have yet to be enacted in national laws in most countries though there are a number of models under consideration (see Posey and Dutfield, 1996). The African Union (AU) has developed draft community rights legislation and some countries, including India and Malaysia as well as Andean Pact countries, have developed legislation that protects certain aspects of community rights.

The development of such codes of ***sui generis*** rights, recognised by trading partners, are seen by some countries as being a preferable alternative to the TRIPs Agreement with respect to biological resources, indigenous, local and community knowledge and locally controllable productive resources.

TOOLS

- IPGRI. 1999. Key questions for decision-makers. Protection of plant varieties under the WTO Agreement of Trade-related aspects of intellectual property rights. Decision Tools, October 1999, International Plant Genetic Resources Institute, Rome, Italy.

Principle 5: NBSAP planning needs to take account of the fact that different ecologic and socio-economic differences between farmers make it easier for some to manage biodiversity than others and that these difference are widening. In addition, diversity produced by farmers may not be maintained as their socio-economic circumstances change and thus new instruments for conservation may be used.

The following discussion borrows heavily from the text of the expert review on landscape level diversity , commissioned from H. Brookfield.

BEST PRACTICES

Assess the differences and explain them.
Develop specific policies for specific groups; including payment for ecological services
Link poverty alleviation plans with biodiversity plans

The layout of farms, the rotation of their land-use stages and field types, are all determined by those who manage the farms and the biological landscape within which farms operate. This is dynamic. Farmers are quick to respond to signals which demand variation in their strategies of resource mobilization. One aspect is of particular importance: the differential ability of farmers to manage their resources effectively. Farmers differ both in the amount of land and resources that they can use, and in their skills of management. The result is a patchwork of different outcomes for biodiversity.

Farmers managing good soils, and disposing of adequate resources of labour and other inputs, have an easier time in developing effective management of their soils than do poor farmers working only poorer soils. Increasing population density and evolving commercialization of production have the effects that resources become concentrated in the hands of a minority of more affluent farmers. In some areas, for example a high-density area of western Kenya, there is now a marked differentiation between a minority of affluent farmers who are able to invest in the good management of their soils and biodiversity and a majority now reduced to working very small farms. The latter cannot produce much of their own food, and depend so heavily on external employment that they are scarcely able to farm at all (Crowley and Carter 2000). No single strategy applicable to all farmers can be effective in the face of such differentiation.

The market has increasingly become the dominant force in farmers' decision-making. Farmers such as the Kofyar in northern Nigeria have not only given up most aspects of an intensive subsistence-based system developed over centuries on the Jos plateau but, in moving onto the plains, they have also shifted to market production as their principal enterprise. Yam cultivation for the urban markets absorbed more than a third of their total labour inputs in the 1980s (Stone 1997). In the West Africa case study written for this project, Gyasi and Enu-Kwesi describe in some detail the shift in production patterns made by the enterprising and adaptable people of southeastern Ghana. Having been major innovators for the export market in the late 19th and early 20th centuries, they responded to disease problems and market instability by shifting their activities to production for the national urban market in the second half of the 20th century. They continue to respond to the signals from that market.

The dynamism of farmers' practices has a large literature, the modern beginning of which was Richards (1985). Recently, Brookfield (2001) has described and discussed over 20 modern case studies, from the literature and field work, in which a high degree of adaptability is demonstrated.

Farmer adaptability has also been documented by the United Nations University Project on People, Land Management and Environmental Change (PLEC). Working since 1997 in almost 30 'demonstration sites', the PLEC project shows how agrodiversity not only supports global objectives toward conserving biodiversity, but also supports human needs and development. From some of its areas has come the important finding that sound management of biodiversity, both agrobiodiversity and managed forest biodiversity, can be profitable to farmers. PLEC works with the most skilled, or 'expert' farmers, in devising ways of using natural resources that combine superior production with enhancement of biological diversity. Successful farmers in turn train other farmers. Work is at different levels of farm intensification. As one example among many, PLEC scientists in northern Ghana are working with local farmers to conserve ***Oryza glaberrima***, the indigenous African rice. Farmers have traditionally relied on a diversity of varieties of this rice for food and livelihood security in face of difficult water availability and ecological change. The local group of PLEC scientists, and their farmer collaborators, are experimenting with ten varieties.

An important PLEC innovation has been the formation of a new kind of farmers' associations, both to manage demonstration activities and to form bridges between farmers, scientists and the authorities. These associations have been formed in most PLEC areas, and are working effectively in coordinating conservation with development at the local level. The project supports them in a number of ways, principally with material assistance rather than money. Several of the associations have organized income-earning activities among their members, especially in creating value from biodiversity. With these sources of income, they are able to plan and conduct new activities. By degrees, they are also becoming associated with other projects and with NGOs, thus facilitating the mobilization of support. The backing of the scientists has been very important in their formation, but increasingly the more successful of these associations are taking charge of their own affairs.

Farming systems, even those described as 'traditional', do not remain constant. Indeed, they can change very quickly, adapting to new circumstances, disasters and, in particular, opportunities. Although some farmers now regret the loss of formerly-widespread landraces, a great many eagerly adopted the products of modern plant breeding during the 'green revolution' years, and many continue to do so.

TOOLS

- Farmers' associations: It is not easy to specify tools for agrobiodiversity maintenance at landscape level, as the main requirement is the formation of groups of farmers able and willing to cooperate in agroecosystem management in whole communities and over areas of sub-regional extent. Moreover, the necessary scientific support has to be provided where it is not already present. The Australian landcare model could be used in participation with NGOs or Universities, and the PLEC farmers' association model can be employed if the necessary external support is forthcoming from agricultural and other research centres. The farmers' association model (a variant of the Community-based organization, or CBO) is as close as it is possible to get in many developing countries to the landcare model, and it can be an important tool for conservation in harmony with the improvement of livelihood security.

- The United Nations University Project on People, Land Management and Environmental Change (PLEC), since 1998 supported by the Global Environmental Facility, is another networking organization that brings together the efforts of more than 200 scientists and almost 3,000 farmers in twelve developing countrie: Brazil, China, Ghana, Guinea, Jamaica, Kenya, Mexico, Papua New Guinea, Peru, Tanzania, Thailand and Uganda.PLEC is specifically devoted to developing sustainable and participatory approaches to conservation, especially of biodiversity, within small farmers' agricultural systems.

PLEC produces a twice-yearly periodical, including numerous articles by its members, called *PLEC News and Views*; 18 issues have now appeared since 1993. One of the project's main objectives is to influence agricultural and conservationist policy in appreciating the value of indigenous land-use systems which have withstood all the tests of population growth, economic and environmental change.

http://www.unu.edu/env/plec/index.htm