Equator Initiative
iied
International Institute for Environment and Development
undp
OPINION
World Summit on Sustainable Development
2002

Reconciling Agriculture and Biodiversity: Policy and Research Challenges of 'Ecoagriculture'

Sara J. Scherr and Jeffrey A. McNeely

Conventional wisdom holds that modern farming is largely incompatible with wildlife conservation. Thus policies to protect wildlife typically rely on land use segregation, establishing protected areas from which agriculture is officially excluded. Farmers are seen as problems by those promoting this view of wildlife conservation. This paper argues, however, that enhancing the contribution of farming systems is an essential part of any biodiversity conservation strategy, and requires new technical research, support for local farmer innovation, and adoption of new agricultural and environmental policies at local, national and international levels.

Many studies have emphasised the importance and feasibility of establishing protected areas for wild biodiversity. (Pimm, *et al*., 2001) But recently published research demonstrates that strategies for wildlife conservation that ignore farmed areas are almost certain to fail. Population Action International recently overlaid global population data with maps delineating Conservation International's 'biodiversity hotspots' - areas holding 44 per cent of the world's vascular plant species and 35 per cent of its bird, mammals, reptiles and amphibians. Their analysis showed that 1.1 billion people live in the 25 biodiversity hot spots, most of which have higher population growth rates than the global average. (Cincotta, R.P. and R. Engelman, 2000) FAO and other data on rates of malnutrition indicate that at least a fifth of all malnourished people live in these biodiversity hotspots. (WFP, 2000) Farming is the principal livelihood of most of these people, and in low-income biodiversity-rich countries, it is a major engine of economic development. (Pinstrup-Andersen, Pandya-Lorch and Rosegrant, 1997) While protected areas are necessary in these biodiversity hotspots, and elsewhere, they are not sufficient. Additional approaches are needed.

Over a third of the global agricultural extent[1] is in high-intensity systems that generally use high levels of agrochemicals for continuous cropping, and often reshape land and waterways. (Wood, Sebastian and Scherr, 2000) The rest of the agricultural extent is under extensive farming systems that use far fewer inputs, but require relatively large expanses of land to produce relatively low crop and livestock yields. Agriculture is necessary to feed people, but both broad types of agriculture have had notable negative impacts on wild biodiversity:

- Nearly half of all temperate broadleaf forest and tropical and subtropical dry forest, and a third of temperate grass and shrubland, have been lost as wildlife habitat, through conversion to agricultural use; conversion rates are especially high in Asia and Europe. (Wood, Sebastian and Scherr, 2000)

KEY CHALLENGES:

- **Develop and fund a Global Programme for Ecoagriculture Research and Development, in selected biodiversity hotspots.**
- **Undertake international and national policy research and innovation to develop cost-effective market, legislative and institutional interventions to promote ecoagriculture on a large scale.**
- **Develop networks of farmer innovators with technical specialists in agriculture and environment, who work in similar habitat types, through websites, e-workshops, and field tours in biodiversity hotspots of mutual interest.**
- **Fund basic research in biodiversity hotspots on interactions between agricultural systems and wildlife habitat and species, particularly in landscape ecology, agricultural ecology, and wildlife behaviour.**
- **Develop programmes to educate farmers, agricultural researchers and policymakers in ecosystem management, and to educate wildlife biologists, ecologists and conservation policymakers in agricultural resource management.**

BrasilConnects Culture & Ecology
Canada
IDRC International Development Research Centre | CRDI Centre de recherches pour le développement international
IUCN The World Conservation Union
WF
UNITED NATIONS FOUNDATION

- Irrigation is practiced on over 250 million hectares, and uses over 70 per cent of all freshwater - 89 per cent in low-income countries, often diverting water resources needed by land-based and aquatic wildlife. (Wood, Sebastian and Scherr, 2000)
- Globally, over half of wetlands - among the planet's most valuable wildlife habitats—have been converted to agriculture. (Frazier, 1999)
- Farming has led to significant soil degradation on 16 per cent of all crop, pasture and forestland worldwide, and half of all land within the agricultural extent, thereby affecting the diversity of soil microorganisms. (Scherr, 1999)
- Excessive use and poor management of crop nutrients, pesticides, and penned livestock wastes are a major cause of habitat pollution that can kill wildlife directly or impair reproduction. (Wood, Sebastian and Scherr, 2000)

Can ways be found to reduce, or even reverse, the impacts of agriculture on wild biodiversity? With conventional agricultural technologies and policies, most farmers can increase biodiversity significantly only by reducing production and livelihood security. Initiatives to promote more ecologically sensitive farming systems (called 'sustainable', 'regenerative', or 'organic' agriculture) are expanding, often with positive impacts on wild biodiversity, but they focus mainly on preserving 'useful' wild species, such as pollinators or beneficial soil microfauna.

Such evidence suggests a need to redouble efforts to establish protected areas 'off limits' to agriculture. But this is not enough. Of over 17,000 major sites already devoted to conserving wild biodiversity, 45 per cent (accounting for 20 per cent of total protected land area) have at least 30 per cent of their land used for agriculture. Most of the rest are islands within a 'sea' of agriculture. (McNeely and Scherr, 2001) Some ecologists calculate that even if the existing protected areas do continue as wildlife habitat, 30-50 per cent of their species may still be lost because such isolated protected areas do not contain large enough populations, especially of large species with relatively low populations, to be viable. (McNeely and Scherr, 2001)

FAO statistics indicate that only 12 per cent of global land area is in agriculture, and previous analyses from remote sensing was consistent with this, as these defined land units as 'agricultural' only if crops or planted pasture covered 60 per cent of the land unit analysed. Re-analysis of the same data by IFPRI and WRI (Wood, Sebastian and Scherr, 2000), counting as 'agricultural' land units with at least 30 per cent of area under agricultural use (a level at which significant ecological changes to the entire unit may be expected from agricultural use in a part), presents a very different picture. It shows that about 10 per cent of the global land area is under intensive agricultural use; 17 per cent is planted more extensively. Another 40 per cent is in grasslands, of which much is used for grazing of domestic livestock. Thus the scale of agricultural impact is much greater than had previously been recognized. In many countries (such as the UK), as much as 70 per cent of land area is in agricultural use.

In Europe and North America, wealthy urban populations are able to transfer large financial payments to their small farming populations to take land out of (surplus) production to preserve as wildlife habitat or to provide financial incentives for conservation farming. But in poor countries with large rural populations, this approach is viable only in a few selected areas receiving generous foreign assistance, or where protected areas also provide highly valued environmental services (such as water and tourism) to urban populations. Elsewhere, environmental planners must rely upon local support for conservation efforts. While protected areas are still required, and need to be expanded, they ultimately will be successful only if surrounded by production systems of high environmental value that are also economically viable.

An essential strategy for conserving wild biodiversity, especially that found in highly populated, poor rural areas around the world, is to convert agriculture that is destructive of biodiversity into a new type of agriculture: 'ecoagriculture'. (McNeely and Scherr, 2002) Ecoagriculture, which builds on the concept of 'ecosystem management', refers to land-use systems that are managed both to produce food and to protect wildlife and other critical ecosystem services. For ecoagriculture, enhancing rural livelihoods through more productive and profitable farming systems becomes a core strategy for both agricultural development and conservation of biodiversity.

Ecoagriculture encompasses two sets of strategies for land and resource management. First, it increases wildlife habitat in non-farmed patches in agricultural landscapes, creating mosaics of wild and cultivated land uses, by:

1) Creating new protected areas that also directly benefit local farming communities (by increasing the flow of wild or cultivated products, enhancing locally valued environmental services, or increasing agricultural sustainability),

2) Establishing habitat networks and corridors in nonfarmed areas (such as hedgerows or windbreaks that are compatible with farming).

3) Raising the productivity of existing farmland to prevent or reverse conversion of wild lands (where that is possible, given tenure, labour and price conditions; and efforts to protect or restore the biodiversity value of uncultivated lands are also undertaken).

Second, ecoagriculture enhances the habitat quality of productive farmlands, by:

4) Reducing agricultural pollution through new methods of nutrient and pest management, and farm and waterway filters;

5) Modifying the management of soil, water and natural vegetation to enhance habitat quality; and

6) Modifying the mix and configuration of agricultural species to mimic the structure and function of natural vegetation.

A joint study by IUCN and Future Harvest identified at least 36 examples of ecoagriculture, from diverse regions of the world and types of farming systems, have been documented to have significant positive impacts on wildlife populations, farm yields and farmer income. (McNeely and Scherr, 2002) A quarter of these are already being practiced on millions of hectares (including wildlands re-established as a result of crop intensification on a smaller area; integrated pest management and organic production to reduce pesticide pollution; minimum tillage in mechanised cropping; trees grown in pastures; and species-rich agroforests). The rest are being used on a smaller or pilot scale.

To have a meaningful impact on biodiversity conservation at global or regional scales, ecoagriculture must be developed and promoted for many more systems, on far larger areas. Agricultural and environmental policies need to be modified to encourage these new approaches. In some cases, ecoagriculture systems can be developed by using available components and information from scientific and local knowledge, and by improving these through trial and error to design landscapes that address both local livelihood and conservation objectives. But in most cases major scientific initiatives will also be required, using sophisticated methods and tools from various disciplines. Indeed, ecoagriculture is feasible now in large part because of our greater capacity to find synergies through scientific management. Advances in conservation biology, agricultural ecology, plant breeding, ecosystem monitoring systems and modelling are revolutionising our ability to understand and manipulate wildlife-habitat-agriculture interactions. For example, recent research on cotton, maize and tobacco has demonstrated the potential for farmers to assist plants in manipulating predator-prey interactions through allelochemicals that activate plant defence genes that attract the predators of their insect pests. (De Moraes *et al*. 1998 and Arimura *et al*., 2000) Completely new, low-cost and environmentally benign pest control systems could be developed based on this basic research.

New technologies, supported by needed policy changes, are enabling the design of farming systems and landscapes supporting ecoagriculture. For example:

- Using new methods to monitor wildlife and analyse patterns of 'countryside biogeography', conservation biologists have been able to determine spatial and temporal movement patterns and territorial requirements for wildlife. These are enabling the design and placement of corridors and habitat patches in farmlands, and spatial configuration of wild and domesticated plant species within farms, for cost-effective wildlife conservation (see for example Daily et al., 2001). Local farmers can organise themselves effectively to play a lead role in designing landscape and farm interventions. Promising examples include LandCare groups in Australia, farmer federations in the Phlippines, and forest user groups in Nepal.
- The use of analytical spectrometry with remote sensing has enabled scientists to identify sources of nitrogen- and phosphorus-rich agricultural sediments in Lake Victoria, that feed water hyacinth (an invasive alien species) and cause turbidity and loss of native aquatic biodiversity. These data are being used by public agencies and farmer groups to target revegetation and conservation programmes. (ICRAF, 2000)
- Scientists working in West Africa developed a natural biocide, from a strain of an environmentally friendly fungus (*Metarhizium anisopliae*), that was successful in controlling grasshopper and desert locust pests that were devastating grain crops in West Africa, and greatly reduced the need for insecticides that had been threatening stork and songbird populations. Field-based research and monitoring programmes are essential elements for success of such efforts.
- Veterinary research to develop a livestock vaccine against rinderpest, a viral disease, has not only greatly protected domestic cattle in East Africa, but also protected millions of wild buffalo, eland, kudu, wildebeest, giraffe and warthog that share rangelands and reserves, and that are also susceptible to the disease. (Woodford, 2000) New park zoning and use regulations, as well as communications systems with local herders, are needed for successful co-management.
- Crop breeders in the U.S. are developing native perennial grains (such as bundleflower, leymus, eastern gamagrass, Maximilian sunflower) that can be grown more sustainably with much less environmental damage in dryland farming regions. The systems are not yet economically competitive, but yields have reached 70 per cent of annual wheat varieties, while production costs are lower; habitat value for wildlife is many times higher than in conventional wheat fields. (Pimm, 2000) Promoting these species will require changes in agricultural subsidy policies.

- In the humid tropics, research has demonstrated the benefits for both sustainability of production and biodiversity conservation of farming systems that 'mimic' the structure of the natural forest ecosystems. Millions of hectares of multi-strata 'agroforests' in Indonesia produce commercial rubber, fruits, spices and timber, often in a mosaic with rice fields and rice fallows. (Leakey, 1999) The number of wild plant and animal species in these agroforests are often nearly as high as in natural forests. Maintaining these systems involves policy reforms to strengthen farmers' tenure claims, and 'level the playing field' with subsidised rice production.
- In Central America, researchers are developing modified systems of shaded coffee with domesticated native shade tree species, that maintain coffee yields while also diversifying income sources and conserving wild biodiversity. (Beer, Ibrahim and Schlonvoigt, 2000 and Lacher, Slack, Coburn and Goldstein, 1999). Farmer adoption of these systems has been promoted through changes in public coffee policy to favour shade systems, technical assistance, and in some cases price premiums in international markets for certified 'biodiversity-friendly' coffee.

An ambitious policy and research agenda is needed to develop and promote the adoption of farming systems that increase production, wildlife and also farm incomes in areas of high biodiversity value. Such research will require a full partnership of ecological/ wildlife sciences and the agricultural sciences, working in association with operational-scale conservation and agricultural development programmes. Priority areas for such efforts include regions of high biodiversity value threatened by agricultural development; regions where agricultural productivity growth depends on restoring environmental services critical for agriculture; and in regions where biodiversity conservation will benefit the poor directly through ecosystem restoration and income opportunities.

How can resources for such an agenda be mobilised on a globally significant scale? First, private R&D by large-scale commercial food producers and agro-processors could play an important role in areas where they dominate land use and production. Private food processing companies that obtain a large share of their raw material from smallholder farmers located near protected areas may be motivated to encourage ecoagriculture (e.g., current trends to reduce agrochemical use in cocoa production). Private agricultural service companies might, for example, sell pest control services to farmers based on ecoagriculture principles rather than simply selling them products. Private tourism industry that benefits from wild biodiversity may be willing to help support ecoagriculture. Public and civic conservation groups can encourage this work, and monitor wildlife impacts of farming systems.

But public sector institutions and civic organisations will have to play a leading role in ecoagriculture development, simply because so much of the necessary research and investment is in support of providing 'public goods'. In many parts of the world, wildlife conservation organisations will need to take the lead in developing ecoagriculture strategies and contracting for targeted research to support those strategies, as is already being done in many U.S. organisations (for example, the support given by Ducks Unlimited to research on winter rice flooding in California; or The Nature Conservancy support to conservation ranching in the western U.S.). The Consultative Group on International Agricultural Research (CGIAR), Global Environment Facility, the United Nations Foundation and other international donors can lead in funding ecoagriculture research and development in and around globally important protected areas, such as World Heritage Sites and Biosphere Reserves; such an effort is already under development in Kenya.

However, this new challenge emerges just at a time when public resources for agriculture are declining. International aid for developing-country agriculture has declined almost 50 per cent in real terms between 1986 and 1996. In relation to their agricultural production, developing countries spend, on average, only a fifth as much as more developed countries on agricultural research and development. The Future Harvest Centres - a network of 16 international food and environment research institutions supported by the CGIAR - is well positioned to work on these issues, but faces stagnating resources even as their mandate has expanded to address agricultural sustainability and biodiversity conservation.

Developing the scientific basis and policy framework for ecoagriculture is an exciting challenge that should attract the best minds from numerous fields. It is essential to increase resources for both agricultural and environmental research and development, to improve the integration between them, and to integrate agriculture fully into ecosystem management, to ensure both sustainability and wildlife conservation.

To accelerate ecoagriculture development in 'hotspots' for both biodiversity and rural poverty, several important steps are needed:

1) Develop and fund (from sources not already being used for agricultural research or biodiversity conservation), a Global Programme for Ecoagriculture Research and Development, in selected biodiversity hotspots. These could focus on collabourative efforts by the Future Harvest Centres, public agricultural institutions, conservation organisations, and farmer organisations to develop operational systems, backed by socioeconomic analysis and supportive policy interventions (US$50 million per year over 5 years);

2) Undertake international and national policy research to determine cost-effective market, legislative and institutional interventions to promote ecoagriculture on a large scale ($10 million per year over 5 years);

3) Develop networks that link farmer organisations with technical specialists in agriculture and environment who work in particular habitat types, through websites, e-workshops, and field tours in biodiversity hotspots of mutual interest ($10 million per year over 5 years);

4) Establish a budget line item in national scientific institutions in industrialized countries and in 'megadiversity' countries such as Brazil and Indonesia that have strong agricultural research capacity, to fund basic research in biodiversity hotspots, on interactions between agricultural systems and wildlife habitat and species in landscape ecology, agricultural ecology, and wildlife behaviour etc ($20 million per year over 5 years);

5) Develop programmes to educate farmers, agriculturalists and policymakers in key elements of ecosystem management, and to educate wildlife biologists, ecologists and conservation policymakers in key elements of agricultural resource management ($10 million per year over 5 years).

In a recent essay (Janzen, 1998), the conservationist Daniel Janzen argued that we must re-conceptualise wildlife protection as 'gardenification'. In a world where human population may reach 9 billion by mid-century, it is not enough to 'leave wildlife alone'; 'wild lands' must be actively managed as we already do our agricultural lands. This point can be taken a step further: agriculture itself needs to be re-conceptualised as a producer of both food and key ecosystem services, such as biodiversity conservation. With such compelling evidence on the vulnerability of wildlife to agricultural expansion and intensification, and the dependence of much of the world's poor on agricultural development, ecoagriculture has become a pressing policy and research priority. ●

Sara J. Scherr is Senior Policy Analyst, Forest Trends, 1050 Potomac St., NW, Washington, D.C. 20007; and Adjunct Professor, Agricultural and Resource Economics Department, University of Maryland, College Park, sjscherr@aol.com. Jeffrey A. McNeely is Chief Scientist, World Conservation Union (IUCN), Gland, Switzerland, jam@hq.iucn.org.

References and Notes

Arimura *et al*. 2000. 'Herbivore-induced volatiles elicit defence genes in lima bean leaves.' *Nature* 406:512-515

Beer, J., M. Ibrahim and A. Schlonvoigt. 2000. 'Timber production in tropical agroforestry systems of Latin America'. In Krishnapillay, B. *et al., eds.* XXI IUFRO World Congress, 7-12 August, 2000, Kuala Lumpur, Malaysia, Sub-Plenary Sessions, Volume I. IUFRO, Kuala Lumpur.

Cincotta, R.P. and R. Engelman. 2000. *Nature's Place: Human Population and the Future of Biological Diversity*. Population Action International, Washington, D.C.

Daily, G.D., P.R. Ehrlich and G. Artura Sanchez-Azofeifa. 2001. 'Countryside biogeography: Use of human dominated habitats by the avifauna of southern Costa Rica' *Ecological Applications*

De Moraes *et al*. 1998. 'Herbivore-infested plants selectively attract parasitoids' *Nature* 393:570-573.

Frazier, S. 1999. 'Ramsar sites overview: a synopsis of the world's wetlands of international importance'. Wetlands International, Wageningen, The Netherlands.

Janzen, D. 1998. 'The gardenification of the wildland nature and the human footprint' *Science* 279:1312-1313'.

Lacher, T., R. Slack, L. Coburn and M. Goldstein. 'The role of agroecosystems in wild biodiversity', In Collins, W.W. and C.O. Qualset, *eds., Biodiversity in Agroecosystems*. CRC Press, New York.

Leakey, R.R.B. 1999. 'Agroforestry for biodiversity in farming systems'. In Collins and Qualset, eds. 1999, op cit.

McNeely, J.A. and S.J. Scherr. 2002, forthcoming. *Ecoagriculture: Strategies to Feed the World and Save Wild Biodiversity*. Island Press, Washington D.C.

McNeely, J. A. and S.J. Scherr. 2001. *Common Ground, Common Future: How Ecoagriculture can Help Feed the World and Save Wild Biodiversity*. IUCN, Future Harvest: Washington, D.C.

Pimm, S.L. *et al*. 2001. 'Can we defy nature's end?' *Science* 293, 2207.

Pimm, S.L. 2000. 'In search of perennial solutions'. *Nature* 389:126-127.

P. Pinstrup-Andersen, P., R. Pandya-Lorch and M. Rosegrant. 1997. 'The World Food Situation: Recent Developments, Emerging Issues and Long-Term Prospects'. *2020 Vision Food Policy Report*. International Food Policy Research Institute, Washington, D.C.

Scherr, S.J. 1999. 'Soil Degradation: A Threat to Developing Country Food Security by 2020?' IFPRI Food , Agriculture and the Environment Discussion Paper 27. International Food Policy Research Institute, Washington, D.C.

Wood, S., K. Sebastian and S.J. Scherr. 2000. *Pilot Analysis of Global Ecosystems: Agroecosystems*. International Food Policy Research Institute and World Resources Institute, Washington, D.C.

Woodford, M.H. 2000. 'Rinderpest or cattle plague'. Briefing Note to Future Harvest.

World Food Programme. 2000. *Map of World Hunger*. WFP, Rome.

About the Equator Initiative

***The Equator Initiative** was created by UNDP in partnership with BrasilConnects, the Government of Canada, the International Development Research Centre (IDRC), IUCN - The World Conservation Union, Television Trust for the Environment (TVE), and the United Nations Foundation to reduce poverty through the conservation and sustainable use of biodiversity in the Equatorial belt by identifying and strengthening innovative community partnerships. It was designed recognising that the world's greatest concentration of both human poverty and biological wealth is found in tropical developing countries where the loss of biodiversity is accelerating as poverty is increasing. However, there are many creative and effective ways through which indigenous and other local communities are rising to these challenges. Whether for food, medicine, shelter or income generation, these groups are using their biological resources in a sustainable way to improve their livelihoods - yet their innovations remain largely unknown.*

The *Equator Initiative* seeks to promote a worldwide movement to address these challenges through a three-part programme to:

(1) Recognise local achievements through the '*Innovative Partnership Awards for Sustainable Development in Tropical Ecosystems*'

(2) Foster South-South capacity building through community-to-community learning exchanges;

(3) Contribute to the generation and sharing of knowledge for policy impact through publications, radio, television and the Internet.

Current Equator Initiative partners:

- BrasilConnects (Brazil) - www.brasilconnects.org
- Government of Canada - www.canada.gc.ca
- IDRC (Canada) - www.idrc.ca
- IUCN - The World Conservation Union (Switzerland) - www.iucn.org
- Television Trust for the Environment (TVE, UK) - www.tve.org
- United Nations Foundation (UNF, USA) - www.unfoundation.org

Contact details:
Equator Initiative
United Nations Development Programme
One UN Plaza, New York, NY 10017, USA
Tel: 1.212.906-6206 Fax: 1.212.906-6973
E-mail: EquatorInitiative@undp.org
Website: www.EquatorInitiative.org

The **International Institute for Environment and Development** (IIED) is an independent, non-profit research institute working in the field of sustainable development. IIED aims to provide expertise and leadership in researching and achieving sustainable development at local, national, regional and global levels. In alliance with others we seek to help shape a future that ends global poverty and delivers and sustains efficient and equitable management of the world's natural resources.

Contact: Tom Bigg, WSSD Coordinator, IIED
3 Endsleigh Street, London WC1H 0DD
Tel: 44 20 7388 2117 Fax: 44 20 7388 2826
Website: www.iied.org
Email: wssd@iied.org or info@iied.org