

# Mainstreaming Biodiversity in Agricultural Development

STEFANO PAGIOLA, JOHN KELLENBERG, LARS VIDAEUS, AND JITENDRA SRIVASTAVA

---

***The expansion and intensification of agriculture have been major contributors to the loss of biodiversity worldwide. As agricultural production continues to rise to meet the growing demands of the world's population, it is critical to find ways to minimize conflicts and enhance complementarities between agriculture and biodiversity.***

---

## What is biodiversity?

*Biological diversity* generally shortened to *biodiversity*, encompasses all species of plants, animals, and microorganisms; the genetic variability within these species; and the ecosystems and ecological processes that form and sustain them. Biodiversity is more than just the number of species; it also includes their variety and uniqueness. Biodiversity can be measured at three different levels:

- Ecosystem diversity, or the variation in groupings of species and their habitats across the earth's surface;
- Species diversity, or the variety of different species; and
- Genetic diversity, or genetic variability within a species.

Although biodiversity is often measured simply by counting species, their variety is also important. Introducing new, exotic species might increase the local species count, but it does not increase overall biodiversity. On the contrary, introducing exotic species, disturbing a habitat, or allowing natural weed species to invade may occur at the expense of native species that may be rare, threatened, or localized in their distribution (endemic). This will result in a net loss in overall biodiversity.

**A**GRICULTURAL expansion is a major contributor to the loss of biodiversity. Conversion of natural habitat to agricultural use substantially reduces its biodiversity. Naturally occurring plant species are replaced by a small number of introduced species (usually non-native and identical to crops produced elsewhere); wildlife is displaced; and insects and microorganisms are decimated by pesticides. There is also a change in functions, especially in energy and nutrient cycling and storage, as well as in water infiltration and storage. For example, the chart illustrates the substantially lower number of species found in agricultural landscapes compared with forest ecosystems in Borneo. Moreover, agricultural areas include more

common species, while forest ecosystems tend to have more endemic and indigenous species. All types of conversion are not equally harmful, however. For example, some traditional agroforestry systems in Sumatra contain as much as half the species diversity found in neighboring primary forest, a level substantially higher than those of other agricultural land use systems in the area.

Agriculture can also affect biodiversity outside the areas on which it is practiced. Common opportunistic species tend to move into areas where natural and agricultural land uses meet and displace local or endemic plants and animals. Agricultural areas frequently break up the remaining natural areas, which affects

---

**Stefano Pagiola,**  
*an Italian national, is an Economist in the Global Environment Division of the World Bank's Environment Department.*

**John Kellenberg,**  
*a U.S. national, is a Consultant to the World Bank's Latin America and the Caribbean Regional Office*

**Lars Vidaeus,**  
*a Swedish national, is Chief of the Global Environment Division of the World Bank's Environment Department.*

**Jitendra Srivastava,**  
*an Indian national, is Principal Agriculturalist in the World Bank's Europe and Central Asia Regional Office.*

the number and types of species they can support. Management of water for agricultural purposes can substantially affect the timing, volume, and speed of water flow, and the replenishment of groundwater, altering natural aquatic and riparian habitats. Pollution by agrochemicals exacerbates these problems. In addition, agriculture's supporting infrastructure (including roads, irrigation systems, and farm housing) can also significantly affect biodiversity.

Although extensive agricultural growth is the main threat, intensified cultivation of existing agricultural land can also damage the remaining biodiversity. On-site biodiversity can be reduced because of increased specialization and reliance on a few improved crop species, while off-site damage can increase through increased use of chemical fertilizers and pesticides.

Such damage threatens the many important benefits provided by diverse ecosystems. Although the specific benefits provided by any given ecosystem vary substantially, they often contain a variety of economically useful products that can be harvested or that can serve as inputs for production processes. Diverse ecosystems also provide economically valuable services, such as improving water availability for irrigated agriculture, industry, or human consumption; reducing sedimentation in reservoirs and waterways; minimizing floods, landslides, coastal erosion, and droughts; improving water quality; providing recreational opportunities; filtering excess nutrients; and providing essential habitats for economically important species. Diverse ecosystems can contain genetic material that can help develop useful products such as pharmaceuticals and improved crops. Moreover, many people value species and ecosystems for esthetic, moral, or spiritual reasons, even if they do not use them.

Many of the benefits of biodiversity accrue to agriculture itself, and the term *agrobiodiversity* has been coined to describe this important subset of biodiversity. Although human management has often greatly modified natural ecosystems, agricultural activities still depend on many biological activities. The provision of genes for the development of improved crop varieties and livestock breeds is an important element, but far from the only one. Others include crop pollination, soil fertility services provided by microorganisms, and

pest control services provided by insects and wildlife. Damage to biodiversity, therefore, often has important implications for agriculture itself. At the same time, there is substantial potential to exploit biodiversity to enhance agriculture.

### **Agriculture versus biodiversity**

Although biodiversity provides a wide range of benefits to agriculture and other sectors, agricultural activities often reduce biodiversity. To understand why certain types of land use may cause such damage, it is necessary to understand the incentives and constraints faced by farmers and other land users.

Any decision to change land use should weigh the benefits to be obtained from a change (usually increased agricultural production) against its costs. These costs are not limited to the cost of clearing the land. They also include the forgone benefits from continued use of the land in its present form and the costs of any external effects of the change. In principle, if the services provided by biodiversity were valued accurately and completely, and if prices accurately reflected the opportunity costs of all goods and services to society, decisions to change land use would be optimal in the sense that expected benefits from the change would equal or exceed expected costs. For several reasons, this seldom happens.

Markets for many of the benefits of biodiversity often function poorly or not at all. The benefits of biodiversity often do not accrue to those deciding whether to conserve it. Such benefits as water filtration, for example, are enjoyed primarily by water users downstream from a wetland. Since farmers do not receive any payments from downstream beneficiaries, they will not consider the loss of these benefits in their decision making. In other cases, the benefits of biodiversity accrue to a group. Even when farmers belong to the group of potential beneficiaries, their individual incentives to conserve biodiversity is low. As individuals, they would enjoy the full benefits of conversion (in terms of increased agricultural income), but bear only part of the consequences of reduced biodiversity. Conversely, farmers often bear a disproportionate share of the cost of conservation (in terms of forgone agricultural income) but enjoy only a fraction of the benefits. Because of these

poorly functioning or nonexistent markets, land users tend to systematically undervalue the services provided by biodiversity. Consequently, decisions that reduce biodiversity are common.

In many countries, government policies, including those aimed specifically at the agriculture sector and broader economic policies, have exacerbated agricultural pressure on biodiversity. The vast majority of developing countries have, until recently, had policies that discriminated heavily against agriculture in a variety of ways. These include overvalued exchange rates, protection of competing sectors, price controls, and high direct taxation. A sample of 18 developing countries found that effective taxation of agriculture averaged 46 percent of agricultural GDP during 1960–84. These policies tended to discourage investments

***“Diverse ecosystems can contain genetic material that can help develop useful products such as pharmaceuticals and improved crops.”***

in improving productivity, leaving area expansion as the only way to increase agricultural production.

In many countries, agricultural policies have explicitly promoted conversion of natural areas to agricultural use, often in spite of high costs, with no consideration for the value of biodiversity. Many governments have subsidized the use of various inputs, including many that can be harmful to biodiversity, such as pesticides. In the mid-1980s, Indonesia spent about \$150 million annually for subsidies on pesticides, which led to their considerable overuse. Far from increasing production, this overuse proved harmful, because targeted insects rapidly developed resistance and natural controls on their populations were reduced.

The institutional structure and social rules and norms of the communities in which farmers live and work also have an important influence on their decisions. Insecure tenure reduces farmer incentives to consider long-term productivity effects on their land, including the long-term

## The challenge for the World Bank

World Bank support to its developing country partners for mainstreaming biodiversity in agricultural development is essential for several reasons. First, conservation of biodiversity is linked to sustainable agricultural development, and for many developing countries, agricultural production is the main engine of economic growth. Second, the Bank is committed to helping client governments meet their obligations under the Convention for Biological Diversity, which call for conservation and sustainable use of biodiversity to be integrated into the plans, programs, and policies for sectors such as agriculture, fisheries, and forestry, and for cross-sectoral planning. Finally, as an implementing agency for the Global Environment Facility, the Bank has a direct responsibility to help client governments place biodiversity in the mainstream of development.

The challenges for the Bank in mainstreaming biodiversity are fourfold:

- Deepen the implementation of "do no harm" strategies in the design of agricultural projects by effective use of environmental assessments and by systematically applying the Bank's policy encouraging compensatory actions for natural habitats threatened by proposed project activities;
- Promote identification of synergies between biodiversity conservation and agricultural development, and build them into project design;
- Broaden the use of environmental assessments as a tool to mainstream biodiversity in agriculture (which includes using sectoral and regional environmental assessments to screen both public investment programs and upstream project design options to ensure they are consistent with the objectives of biodiversity conservation); and

- Use agricultural investment and sector adjustment operations appropriately as instruments to support policy reform, institutional capacity, and awareness of the importance of mainstreaming biodiversity in agricultural development.

To help achieve these aims, the World Bank has launched the Global Overlays Program in partnership with bilateral donors and nongovernmental organizations. This program seeks to internalize global externalities into national environmental planning and the Bank's sector work, operations, and dialogue with governments and partners. It is an iterative process, combining conceptual studies and reviews of techniques for measuring and mitigating global externalities, and testing these concepts and tools through country studies to identify good practices for country planners and Bank task managers. The results will help guide national actions to reduce greenhouse gas emissions, conserve biodiversity, and protect international waters.

Biodiversity overlays add a new dimension to traditional sectoral economic planning by analyzing environmental impacts and taking account of global externalities. Such analysis poses the question: How and at what cost would policies, institutions, and investment priorities change if global environmental objectives were added to conventional sectoral objectives? More specifically, biodiversity overlays address the following questions: How do agricultural development activities in the sector or subsector affect biodiversity? How can the sustainable use of biodiversity enhance agricultural development? How can government policies and programs be adjusted to reduce biodiversity loss? What are the costs of such adjustments? And how can the relevant trade-offs be evaluated?

effects of reducing biodiversity, and to minimize such damage. It also reduces incentives to intensify agricultural production. Management problems in communal areas, such as community forests and pastures, can also affect biodiversity. Such areas are often modified less than areas used more intensively for agriculture, and so tend to have greater biodiversity.

### Responses to the problems

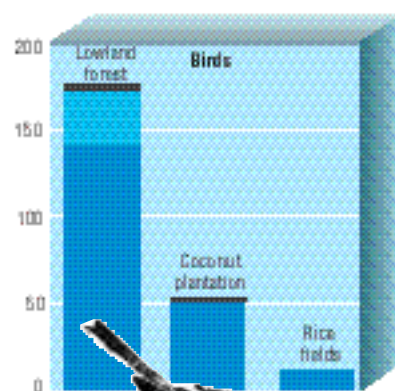
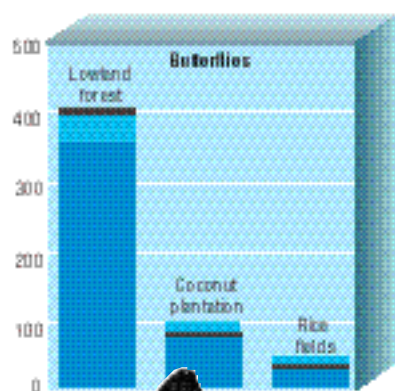
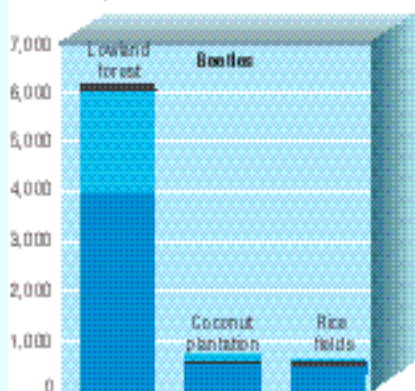
Because habitat conversion tends to be much more damaging to biodiversity than land-use changes within agricultural landscapes, increased intensification could help preserve biodiversity by slowing agriculture's encroachment on natural areas. Some forms of intensification, however, can be quite harmful to biodiversity

and in many cases undermine their own long-term sustainability. The challenge is to encourage sustainable forms of intensification.

An important first step in conserving biodiversity is to ensure that policies that reduce biodiversity by providing direct or indirect subsidies to convert natural habitats are eliminated or reformed. Since

### Comparison of biodiversity in forest and agricultural ecosystems in Borneo

Number of species



such policies are often also economically inefficient, this is generally a “win-win” reform. Policy reforms that remove impediments to intensification can also help increase agricultural production while easing pressure on remaining habitats. In fact, many developing countries have already made great strides toward liberalizing their economies and removing the worst of the distortions that once afflicted the agriculture sector.

Although meeting the needs for increased agricultural production through intensification rather than expanding cultivated acreage will help reduce damage to biodiversity, care must be taken to avoid intensification policies that are likely to cause damage. Here, too, there is potential for “win-win” policies, because practices that are particularly likely to damage biodiversity, such as pesticide use, have often been artificially encouraged by government policies.

The basic outlines of biodiversity-friendly macroeconomic and agricultural policies are clear, but the details are often difficult to work out. It is often difficult to predict the consequences of specific policy measures, and each situation needs to be examined individually. This problem will become increasingly important as liberalization progresses and the most obvious sources of inefficiencies (such as pesticide subsidies) are removed.

Policy reforms are only part of the solution, however. Since many of the problems result from weak or nonexistent markets for the services provided by biodiversity, efforts are also needed to improve these markets. This would lead farmers to take

account of the benefits of biodiversity in their management decisions.

In principle, assigning property rights to biodiversity or its services would ensure that they are used appropriately. The practical difficulties of doing so are clearly huge, however. A more realistic alternative is to ensure that property rights or the legal rights to make use of biologically diverse sites are secure. This would often substantially change the way these sites are exploited by improving the chances that land users are able to appropriate at least some of the benefits of biodiversity. In cases where insecure tenure prevents investments in intensification, increasing the security of tenure to agricultural land could also reduce damage to biodiversity by reducing pressures to convert additional natural habitats. Where most of the costs of not conserving biodiversity are borne by local communities, giving them authority to regulate the use of habitats in their areas can significantly improve conservation. Community involvement in forestry management in Nepal, for example, appears to have substantially improved the conditions of forested areas. Such authority, however, will not increase incentives to avoid damages that are not experienced at the local level.

Considerable efforts have been made in recent years to find mechanisms that increase the benefits farmers derive from biodiversity. These include developing new income opportunities dependent on biodiversity, such as ecotourism; returning to local communities royalties from genetic material collected in a specific area; and compensating local communities for protecting critical biodiversity. Environ-

mental (“green”) taxes could substitute for the missing markets for services made possible by biodiversity, thereby reducing damage and leading farmers to include these costs in their decisions.

In many countries, the pressure to expand agriculture is so great, at least in the short term, that adopting appropriate policies and addressing market failures might succeed only in slowing the rate of expansion. Complementary conservation measures are necessary to ensure that such expansion causes the least possible damage.

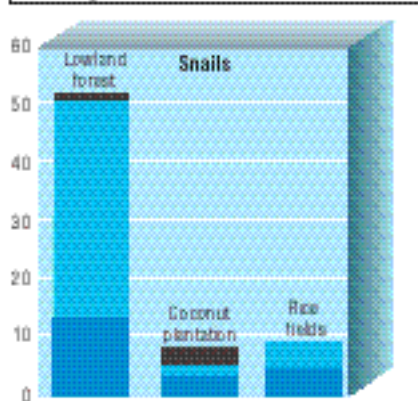
- The extent of damage to biodiversity can be contained by protecting key areas within the growing agricultural landscape.

- Targeted actions can also improve biodiversity within agricultural landscapes—for example by preserving corridors between remaining habitats to facilitate the movement of species; by protecting and expanding remnants of natural habitats; and by limiting land use in areas adjacent to natural habitats to uses, such as forestry or agroforestry, that minimize collateral effects and enhance the retention of ecological functionality.

- In degraded and unproductive agricultural areas, vegetation can be restored by replanting native flora or by allowing the areas to reseed themselves. Large areas suffering from alkalinity and salinity have been reclaimed as productive agricultural lands through the use of regenerative agricultural practices.

- Finally, where losses of natural habitat from agricultural expansion are inevitable, additional conservation measures can help preserve at least a portion of the site's biodiversity. [E&D]

Legend: Indigenous (dark blue), Endemic (light blue), Introduced (grey)



Source: The World Bank.

