Agriculture and the Environment

A combination of policies, institutional innovations, and investments can help reduce agriculture's large environmental footprint and harness its potential to deliver environmental services. Managing the connections between agriculture, natural resource conservation, and the environment must become an integral part of using agriculture for development in order to achieve more sustainable agricultural production systems.

The agriculture and environment agendas are inseparable.

Agriculture is a major provider of environmental services, which are generally unrecognized and unremunerated. In addition to its essential role in meeting the growing demand for food and other agricultural products, agriculture plays an important role in sequestering (storing) carbon, managing watersheds, and preserving biodiversity. But agriculture is also the major user of natural resources, contributing to underground water depletion, agrochemical pollution, soil exhaustion, and global climate change. Degradation of natural resources undermines the basis for future agricultural production and increases vulnerability to risk, thereby imposing high economic losses. But these costs can be often be minimized through a combination of policy reforms and institutional and technological innovations. An integrated policy approach is required when addressing the agriculture and environment agendas, as well as climate change and biofuels, which are discussed in separate policy briefs.

Intensive agriculture has helped limit conversion of natural ecosystems, but often with environmental or health costs of its own.

Agriculture's intensification in irrigated and high-potential rainfed farming areas in much of the developing world was caused by a remarkable shift to high-input farming, which has helped meet the rising food demand and has reduced the rate of turning natural ecosystems into agricultural land. The green revolution alone is estimated to have saved over 80 million hectares of land from being converted to agricultural uses from 1960 to 2000. But agricultural intensification has also generated environmental problems ranging from reduced on-farm biodiversity to mismanaged irrigation water to groundwater depletion and agrochemical pollution (table 1). The health costs associated with those problems are high. Every year 355,000 people die from pesticide poisoning. Globally, some 15 to 35 percent of total water extraction for irrigated agriculture is estimated to be unsustainable because the use of water exceeds the renewable supply—that is, water replenishment rates in aquifers are below what is needed to sustain viable ecosystems. The livestock revolution has its own costs, especially in densely populated and periurban areas, through disposal of animal waste and the spread of animal diseases such as avian influenza.

In areas not affected by the green and livestock revolutions, there has been little if any agricultural intensification; instead, agriculture has grown through *extensification*—bringing more land under cultivation. This trend led to environmental problems of a different kind—mainly the degradation and loss of forests, wetlands, soils, and pastures. Every year about 13 million hectares of tropical forest are degraded or disappear, mainly because of agricultural encroachment. Some 10 to 20 percent of drylands may suffer from land degradation or desertification. Some lands—especially in forest

Table 1. Agriculture's environmental problems onsite and offsite

	Onsite effects	Offsite effects (externalities)	Global effects (externalities)
Intensive agriculture (high-potential areas)	Soil degradation (salinization, loss of organic matter)	• Groundwater depletion • Agrochemical pollution • Loss of local biodiversity (natural and agricultural)	• Greenhouse gas emissions • Animal diseases • Loss of in situ crop and animal genetic diversity
Extensive agriculture (less-favored areas)	Nutrient depletion Soil erosion onsite effects	• Soil erosion downstream effects (reservoir siltation) • Hydrological change (e.g., loss of water retention in upstream areas) • Pasture degradation in common property areas	• Reduced carbon sequestration (storage) from deforestation and carbon dioxide emissions from forest fires • Loss of biodiversity

and upland areas—also protect watersheds, regulate water flows in major river basin systems, sequester large amounts of carbon above and below ground, and are host to a rich array of biodiversity. Unfortunately, few of these environmental benefits are valued in the market place.

A combination of policies can make agriculture more environmentally sustainable.

The large environmental footprint of agriculture on natural resources remains pervasive, but there are many opportunities for reducing it. Different types of problems require their own policy response as well as collective action at an appropriate level, depending on whether the environmental costs are largely onsite or externalities.

Removing policy distortions and other obstacles to socially optimal farming practices. Widespread adoption of more sustainable approaches is often hindered by inappropriate pricing and subsidy policies or such factors as insecure land tenure, poor availability of inputs, difficulties in marketing outputs, and lack of credit. For example, subsidies for canal irrigation and electrical power in northwest India, abetted by state procurement of output at guaranteed prices, led farmers to overproduce rice (a water-intensive crop) and make excessive withdrawals of groundwater. As a result, 60 percent of groundwater aquifers are overexploited in Punjab, the leading green revolution state. But removing subsidies has proven politically difficult. Better quality of irrigation services, better control of water and electricity supply, complemented by participatory institutional arrangements, can improve the political acceptability of reducing subsidies. Farmer participation in the management of irrigation systems through water user associations, community cost-sharing approaches and other innovative institutional arrangements and technologies (such as remote sensing for water measurement) has helped attain at least partial cost recovery and improve the quality of irrigation services.

With onsite environmental problems such as nutrient depletion or soil degradation on farmers' own fields, removing policy distortions may create sufficient incentives for farmers to choose appropriate technology and water management practices and to move toward sustainable resource management (for example, adoption of water-saving crops and technologies). Resolving many offsite problems (externalities) requires additional interventions through regulation- or market-based transfers, because the effects of farmers' practices—both positive and negative—extend beyond those farmers' fields and pastures.

Choosing market-based approaches or regulation. Regulation may be an obvious answer to resolving such offsite environmental effects as the runoff from pesticides and animal waste and the clearing of forests for farming. But enforcing environmental regulations is difficult in developing countries with generally weak public institutions and monitoring capacity. When aided by innovative technology and institutional approaches, some systems of environmental regulation have a better chance of success. For example, by using satellite technology, Mato Grosso state in Brazil has effectively combined the licensing process for conversion of forest to agricultural land use with monitoring.

Market-based instruments, including payment for environmental services, environmental certification, and tax and subsidy incentives to investments, can often be more effective ways of managing offsite environmental effects. Thus, tax rebates have successfully provided incentives to poultry farmers in Thailand to relocate from periurban areas, where population is particularly vulnerable to an increased risk of spreading diseases. Environmental certification of products (such as fair trade certified or shade-grown coffee) is another market-based instrument which allows consumers to pay a premium for products produced according to sustainable management standards.

Watershed and forest protection create environmental services (clean drinking water, stable water flows to irrigation systems, carbon sequestration, and protection of biodiversity) for which providers can be compensated through payments. In this approach, providers of environmental services (e.g., hydroelectric power producers, irrigators and other water users) may make payments to farmers and local community organizations for clean water or other environmental services generated through forest conservation, watershed protection and adoption of sustainable farming practices. Pilot projects of such payments in Colombia, Costa Rica, and Nicaragua have induced substantial changes in land use, with degraded pastures transformed into silvopastoral systems (where trees and livestock are produced together). If payment schemes are to be used more widely, they will have to ensure that the funding base is sustainable for the long term. This will require direct links between service users and providers.

Investing in technologies. Many promising technological innovations can make agriculture more sustainable, with minimal tradeoffs between growth and poverty reduction. Examples include conservation tillage, improved fallows, green manure cover crops, soil conservation, and pest control that relies on biodiversity and biological control more than pesticides. The widespread adoption of conservation (or zero) tillage is one of agriculture's major success stories in the past two decades. Because these technologies are often location-specific, their development and adoption requires more decentralized and participatory approaches, often involving collective action by farmers and communities.

New technologies can also help to better manage and monitor the use of natural resources. Remote-sensing technology, as has been used in Thailand, has helped to manage the environmental and health problems of intensive poultry and livestock systems. Such technology can also facilitate the regulation of surface and groundwater withdrawals in water-scarce areas, such as the Republic of Yemen.

Building institutional capacity and taking collective action. Adoption of sustainable technologies hinges on adequate institutions, such as clearly assigned and secure property rights and—especially for offsite effects—some level of collective action. In Niger, secure tenure over trees helped reverse desertification in parts of the Sahel through agroforestry. Community-based approaches to natural resource management (e.g., a successful watershed management program in Eastern Anatolia in Turkey) have helped to combat severe soil erosion. But community approaches are not a panacea, and much remains to be learned about the necessary conditions for such programs to succeed and be scaled up.

This policy brief has been extracted from the World Bank's 2008 World Development Report, *Agriculture for Development*. Further information and detailed sources are available in the Report. The Report uses a simple typology of countries based on the contribution of agriculture to overall growth, 1990-2005 and the share of rural poor in the total number of poor (2002 $2-a-day level). In agriculture-based countries (mostly Africa), agriculture contributes a significant (>20%) share of overall growth. In transforming countries (mostly in Asia), nonagricultural sectors dominate growth but a great majority of the poor are in rural areas. In urbanized countries (mostly in Latin America and Europe and Central Asia), urban poverty dominates.