Ecoagriculture Policy Focus

Mitigating Climate Change Through Food and Land Use

Over the past century, ingenious systems were developed to supply food, with remarkable reliability, to most of the world's 6.7 billion people. But these systems need a fundamental restructuring in the coming decades to establish sustainable food systems that help reduce and reverse climate change and that are also more resilient to it. Private-sector action will determine the response, but public policy and civil society will play a crucial role in providing the incentives and framework for markets to respond effectively.

Food production and other land uses are currently among the highest greenhouse gas emitters on the planet—but that can be reversed. Although recent food price riots have discouraged actions that could raise costs, if action is not taken costs will rise anyway as local food systems are disrupted and as higher energy costs ripple through a system that has not been prepared with alternatives.

More than 30 percent of all greenhouse gas emissions arise from the land use sector (see Box 1). Thus, no strategy for mitigating global climate change can be complete or successful without reducing emissions from agriculture, forestry, and other land uses. Moreover, only land-based or "terrestrial" carbon sequestration offers the possibility today of large-scale removal of greenhouse gases from the atmosphere, through plant photosynthesis (see Box 2).

Box 1. Greenhouse Gas Emissions from Agriculture and Land Use

Carbon dioxide (77 percent), nitrous oxide (8 percent), and methane (14 percent) are the three main greenhouse gases that trap infrared radiation and contribute to climate change. Land use changes release all three of them. Of the total annual human-induced greenhouse gas emissions in 2004 (49 billion tons of carbon dioxide equivalent), roughly 31 percent—15 billion tons—was from land use. By comparison, fossil fuel burning accounts for 27.7 billion tons of CO2-equivalent emissions annually. Naturally occurring forest and grassland fires also contribute significantly to greenhouse gas emissions. In the El Niño year of 1997–98, fires accounted for 2.1 billion tons of carbon emissions. Due to the unpredictability of these events, annual emissions from this source vary from year to year.

Land Use	Annual Emissions (million tons CO_2 eq.)	Greenhouse Gas Emitted*
Agriculture	**6,500**	
Soil fertilization (fertilizers, applied manure)	2,100	Nitrous oxide
Gases from food digestion in ruminant livestock	1,800	Methane
Biomass burning**	700	Methane, nitrous oxide
Paddy (flooded) rice production	600	Methane
Livestock manure	400	Methane, nitrous oxide
Other (e.g., delivery of irrigation water)	900	Carbon dioxide, nitrous oxide
Deforestation (including peat)	**8,500**	
For agriculture and livestock	5,900	Carbon dioxide
Total	**15,000**	

** The warming impact of 1 ton of nitrous oxide is equal to 298 tons of carbon dioxide over a 100 year period; 1 ton of methane is equivalent to 25 tons of carbon dioxide over a 100 year period.*

*** Data does not include carbon dioxide emissions.*

Source: IPCC 2007, Steinfeld et al. 2006, Santilli et al. 2005; see Scherr and Sthapit 2009 for full references.

Land use strategies

Five major strategies for reducing and sequestering terrestrial greenhouse gas emissions are:

Enriching soil carbon. Soil is the third largest carbon pool on Earth's surface. Agricultural soils can be managed to reduce emissions by minimizing tillage, reducing use of nitrogen fertilizers, and preventing erosion. Soils can store the carbon captured by plants from the atmosphere by building up soil organic matter, which also has benefits for crop production. Adding biochar (biomass burned in a low-oxygen environment) can further enhance carbon storage in soil.

Farming with perennials. Perennial crops, grasses, palms, and trees constantly maintain and develop their root and woody biomass and associated carbon, while providing vegetative cover for soils. There is large potential to substitute annual tilled crops with perennials, particularly for animal feed and vegetable oils, as well as to incorporate woody perennials into annual cropping systems in agroforestry systems.

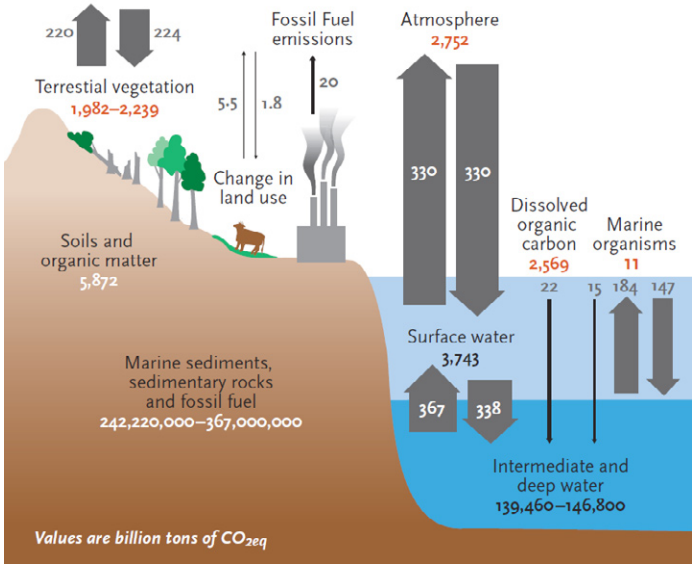
Climate-friendly livestock production. Rapid growth in demand for livestock products has triggered a huge rise in the number of animals, the concentration of wastes in feedlots and dairies, and the clearing of natural grasslands and forests for grazing. Livestock- related emissions of carbon and methane now account for 14.5 percent of total greenhouse gas emissions—more than the transport sector. A reduction in livestock numbers may be needed but produc-

Box 2. The Carbon Cycle

The carbon cycle is the movement of the element carbon, sometimes in altered chemical forms, through different reservoirs or carbon sinks on the planet. Over a relatively short timescale of less than thousands of years, carbon moves among the vegetation, soil, and animals on land; the atmosphere; and the organisms and water in the oceans (see figure). Over a longer time span of millions of years, carbon also moves to and from the deeper parts of Earth's surface via geological processes.

Carbon dioxide (CO2) and methane are two greenhouse gases in the atmosphere that contain carbon; a third major greenhouse gas, nitrous oxide, does not. Green plants use the energy of sunlight to facilitate a chemical reaction (photosynthesis) between CO2 and water to produce complex sugars that are the ultimate food source for almost all life on the planet. In the process, plants remove carbon from the atmosphere and add it into soils, vegetation, and the bodies of animals that feed on that vegetation. Meanwhile, plants, animals, and organic matter continue to release carbon dioxide and methane into the atmosphere through respiration and decay.

Increasing the amount of carbon in a sink or reservoir other than the atmosphere is called "carbon sequestration. "Carbon storage" refers to the net carbon that stays in living biomass and in soils.



tion innovations can help, including rotational grazing systems, manure management, methane capture for biogas production, and improved feeds and feed additives.

Protecting natural habitat. The planet's 4 billion hectares of forests and 5 billion hectares of natural grasslands are a massive reservoir of carbon—both in vegetation above ground and in root systems below ground. As forests and grasslands grow, they remove carbon from the atmosphere. Deforestation, land clearing, and forest and grassland fires are major sources of greenhouse gas emissions. Incentives are needed to encourage farmers and land users to maintain natural vegetation through product certification, payments for climate services, securing tenure rights, and community fire control. The conservation of natural habitat will benefit biodiversity in the face of climate change.

Restoring degraded watersheds and rangelands. Extensive areas of the world have been denuded of vegetation through land clearing for crops or grazing and from overuse and poor management. Degradation has not only generated a huge amount of greenhouse gas emissions, but local people have lost a valuable livelihood asset as well as essential watershed functions. Restoring vegetative cover on degraded lands can be a win-win-win strategy for addressing climate change, rural poverty, and water scarcity.

Many technologies and management practices to implement these five strategies are already available. They could lighten the climate footprint of agriculture and other land uses and protect the existing carbon sinks in natural vegetation (See Box 3). Many more could become operational fairly quickly with proper policy support or adaptive research and with a more systematic effort to analyze the costs and benefits of different strategies in different land use systems. Additional innovative ideas will emerge if leading scientists and entrepreneurs can be inspired to tackle this challenge.

Potential co-benefits are extensive and diverse (see Box 4). Land use-based climate solutions can help meet United Nations' Millennium Development Goals in developing countries. These goals include eradicating extreme poverty and hunger (Goal 1), promoting gender equality and empowering women (Goal 3), and ensuring environmental sustainability, including access to safe drinking water and conservation of biodiversity (Goal 7). Indeed, a key pillar for achieving the hunger eradication goal is to restore and protect natural resources, including soils and vegetative cover, upon which poor people rely for food production and gathering. Globally, land-based climate solutions can help transform agricultural and forestry production systems and ecosystem services to a sustainable and climate-friendly trajectory.

Policy action

Although climate leaders are sensitive to these ideals, they are not yet convinced that climate policy should promote development and conservation activities. Rather, these are seen as a potential distraction of attention and resources from the immediate need for emission reduction in the energy sector.

This concern is misplaced. The core rationale for aggressive and comprehensive climate action on farming and land use is, of course, that these sectors account for nearly a third of all global emissions and are on a trajectory of emissions increase. Moreover, there is a moral imperative for action to mitigate the impacts of climate change on the world's poorest and most vulnerable people. Rather than being a distraction, linking sustain-

able land management with climate action will attract a broad group of actors with a stake to become political allies in promoting overall stricter climate regulation and greater investment in mitigation.

There are already so many initiatives to address climate change in the food and land use sectors, providing a rich foundation of practical, implementable models. But the scale of action so far is limited. With the exception of the REDD (reducing emissions from deforestation and degradation) initiatives to save standing forests through intergovernmental action, which are still in an early stage, no major international initiatives address the interlinked challenge of climate, agriculture, and land use.

As we move toward international climate negotiations in Copenhagen in December 2009, and the years after that when international and national climate action rules and guidelines are crystallized, we recommend the following six principles for tapping the full potential of land use based mitigation:

1. Include the full range of terrestrial emission reduction, storage, and sequestration options in climate policy and investment. The most important action is to ensure that the full range of terrestrial emission reduction, storage, and sequestration options are included in international framework agreements, national legislation, and investment programs to address climate change. This approach will not only ensure that terrestrial emissions receive the critical attention they need, and that terrestrial sequestration opportunities are fully realized, but it will also broaden the set of citizens, businesses, and other parties with a stake in effective climate protection.

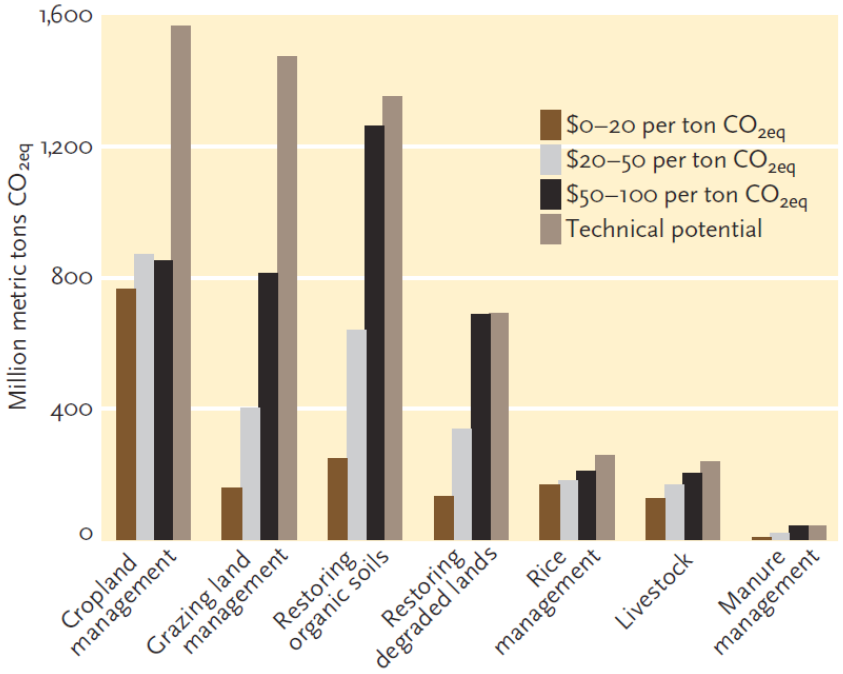
2. Incorporate farming and land use investments in cap-and-trade systems. We will need maximum effort from all sectors to meet the 450 parts per million goal set by the IPCC in 2007, much less the 350 ppm goal now considered by many scientists to be necessary to prevent risk of catastrophic impacts. Emphasis should be on limiting overall greenhouse gas emissions with a schedule of gradually lowered caps that will meet the goal. Caps should be extended to the land use sectors and eventually the full value chain of food, fiber, and biofuel industries. Within those caps, we should seek the lowest-cost options to achieve both emission reduction and sequestration.

Cap-and-trade systems will generate far greater resources for shifting to a low-carbon economy than can be done with government tax revenues alone. It may take a few years to sort out implementation and measurement issues, but there should be a clear timeline and roadmap for doing so. The way to handle risks and uncertainties is through various insurance mechanisms and through strict monitoring protocols.

3. Link terrestrial climate mitigation with adaptation, rural development, and conservation strategies. Greenhouse gases that are sequestered and stored anywhere on the planet have the same beneficial impact in slowing climate change. Thus, decisions on how, where, and with whom to invest in terrestrial emission reduction and sequestration can and should be made to maximize anticipated co-benefits for sustainable rural development, poverty reduction, and ecosystem conservation. Climate action plans should help shift economies to a low-carbon/low greenhouse gas trajectory.

Hence, climate funding should help to accelerate the transformation of agricultural systems to long-term profitable alternatives, helping to overcome early transition costs and barriers to adoption, and to invest in improved technologies. This means refining the definition of "additionality" to ensure that climate investments result in production and land use approaches that are both profitable and sustainable over the long term. Wherever possible, mitigation efforts

Box 3. Greenhouse Gas Reduction and Sequestration Potentials from Farming and Land Use, by Level of Mitigation Spending



Note: Figure illustrates how different strategies can achieve varying degrees of emission reduction by the year 2030 for different price per ton of carbon. In the case of cropland management, nearly half of the technical potential can be achieved at a carbon price lower than $20 per ton, but paying more (up to $100 per ton) gives little further benefit. On the other hand, a higher price per ton on grazing land management, restoring organic soils, and restoring degraded lands can achieve progressively higher emission reduction.

Source: IPCC 2007; see Scherr and Sthapit 2009 for full references.

should be linked to adaptation goals and planned and implemented jointly. Agriculture, rural development, and conservation strategies should incorporate mitigation and adaptation centrally in their plans.

4. Encourage large, area-based programs. The synergies arising from such coordinated and integrated approaches are likely to be greatest in large, area-based programs. Using landscape, watershed, or territorial frameworks for planning can maximize links to development, agricultural, ecosystem management, and energy strategies. Landscape-wide monitoring of emissions and sequestration can be done at lower cost, and setting caps or targets at this scale enables maximum flexibility for land use and management to reflect a dynamic economy. Large reserves within the landscape can be maintained as self-insurance, and leakage will be minimized. Carbon payments, whether made by governments or markets, can be used to pay for coordinated, program-scale investments.

5. Encourage voluntary markets for greenhouse gas emission offsets from agriculture and land use. It is likely to take some time for fully inclusive cap-and-trade systems to be in place. Meanwhile, policymakers, businesses, nongovernmental organizations, and farmer organizations should make extensive use of emerging voluntary carbon markets. Climate action advocates should raise awareness and social pressure to engage in such markets on the part of emitters not yet required to act by regulation. This sector can be used intentionally and creatively to test diverse types of institutional rules and arrangements, monitoring methods, and farmer engagement processes, for later incorporation into regulated markets.

6. Mobilize a worldwide, networked movement for climate-friendly food, forest, and other land-based production. It is time to forge unusual political coalitions that link consumers, producers, industry, investors, environmentalists, and communicators to mobilize action to slow climate change. Food is something that the public understands. By focusing on food systems, climate action will become more real to people.

No climate change mitigation strategy can be complete or successful without addressing greenhouse gas emissions and sequestration in agriculture, forestry, and conservation land uses. Engaging rural land users in mitigation, as well as adaptation, and linking them effectively with urban consumers and industrial emitters, will broaden societal understanding of the issues and deepen commitment to an ambitious climate response. Such action will also stimulate higher standards of planning, management, and implementation in rural production and conservation sectors, and contribute to sustainable rural economic development. Indeed, the status of farmers and land managers in societies will be enhanced as their responsibility as stewards for a stable climate is recognized and rewarded. And society will reconnect in a new way with its ancient roots in the cultivation of land for food.

Box 4. Sustainable Development Benefits Motivating Climate Action

Climate action in and around farms and grazing lands tends to create platforms for improved biodiversity and provision of ecosystem services that improve farming livelihoods. Access to wild plants, game, and sources of micro-nutrients improves nutrition, while also providing "safety nets" during lean seasons. Access to medicinal plants, fuel, and construction materials provides options for additional income, while fodder, fertilizer trees, pollination services, improved soil health, nutrient cycling, and improved water quality and supply make farming more sustainable and productive.

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Left: Windbreaks and other planted trees create habitat and corridors for biodiversity of neighboring forest and protect the soil and crops from erosion. Kijabe, Kenya.

Right: Intercropping citrus trees with vegetable crops such as cabbage increases the carbon sequestered on the farm and diversifies food production. Diversified production is crucial for resilience necessary to adapt to climate change. Bali, Indonesia.

For further reading:

Scherr, S.J. and S. Sthapit. 2009. Mitigating climate change through food and land use. *Worldwatch Report* 179. Washington, DC: Ecoagriculture Partners and Worldwatch Institute.

Ecoagriculture Policy Focus Series

The Policy Focus series, produced by Ecoagriculture Partners in collaboration with other organizations, highlights issues relevant to policy experts and decision makers in the fields of agriculture, conservation and rural development to promote integrative solutions

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