Agriculture and Climate Change: An Agenda for Negotiation in Copenhagen

2020 VISION FOR FOOD, AGRICULTURE, AND THE ENVIRONMENT

Synergies Among Mitigation, Adaptation, and Sustainable Development

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There is very significant cost-effective greenhouse gas (GHG) mitigation potential in agriculture. The mitigation potential at a range of future carbon prices is similar to the potential in the industry, energy, transport, and forestry sectors. Using economic mitigation potentials from the Intergovernmental Panel on Climate Change's Fourth Assessment Report (IPCC AR4), the yearly mitigation potential in agriculture is estimated to be worth between US$32 billion and US$420 billion at carbon prices between US$20 and US$100 (t CO_2-eq.$^{-1}$).[1] From both a mitigation perspective and an economic perspective, we cannot afford to miss out on this opportunity. But many mitigation options also offer the promise of facilitating adaptation to climate change and contributing to sustainable development more generally.

In this brief, synergies between mitigation, adaptation, and sustainable development are described so that multiple policy goals can be identified when considering how to include agriculture in the climate change negotiations in Copenhagen.

Identifying the best options for GHG mitigation in agriculture

The IPCC AR4 considered approximately 60 GHG mitigation options in agriculture. These can be grouped into several broad categories including cropland management (such as agronomy, nutrient management, tillage and residue management, and better use of organic manures), grazing land management, agroforestry and set aside, the restoration of cultivated organic soils (such as peats), the restoration of degraded lands, livestock management, manure management, and rice management.

Some of these options work better than others in different regions, so a "one-size-fits-all" recommendation cannot be made. For this reason, the mitigation strategies need to be assessed on a region-by-region basis. The most favorable mitigation options also confer increased resilience and enhanced adaptation to future climate change and/or support sustainable development.

Relationship between mitigation and adaptation in agriculture

Climate change mitigation, impacts, and adaptation will happen simultaneously and interactions will occur. Mitigation-driven actions in agriculture could have either (a) positive adaptation consequences (such as carbon sequestration projects with positive drought preparedness aspects) or (b) negative adaptation consequences (for example, if heavy dependence on biomass energy increases the sensitivity of energy supply to climatic extremes).

Adaptation-driven actions also may have both (a) positive mitigation consequences (as when residue returned to fields to improve water-holding capacity also sequesters carbon) or (b) negative mitigation consequences (for example, an increased use of nitrogen fertilizer to overcome falling yield that leads to increased nitrous oxide emissions).

In many cases, actions will be taken for reasons that have nothing to do with either mitigation or adaptation—for example, actions taken toward enhancing soil fertility or food security. But these events may still have considerable consequences for mitigation, adaptation, or both, as seen when deforestation for agriculture or other purposes results in the loss of both carbon and ecosystems as well as the resilience of local populations. In terms of mitigation, the accumulation rates for sequestered carbon, the growth rates for bioenergy feedstocks, and the size of livestock herds are all variables affected by climate change. Depending upon the climatic impact, there are likely to be shifts in, among other things, plant and tree growth, microbial decomposition of soil carbon, and livestock growth. All of these factors will alter mitigation potential, some positively and some negatively. For example, lower livestock growth rates could increase herd size and, consequently, emissions from manure and enteric fermentation, while increased microbial decomposition under higher temperatures will lower soil carbon sequestration potential. Interactions also occur with adaptation. Crop mix and changes in both land usage and irrigation are all potential adaptation strategies to warmer climates. All would alter mitigation potential.

Mitigation measures that also enhance adaptation

Nearly 90 percent of the mitigation potential in agriculture lies in reducing soil carbon dioxide emissions (by restoring cultivated organic soils, for example) or in sequestering carbon dioxide in the soil organic matter of mineral soils. It has long been known that increasing soil organic matter content improves soil fertility, nutrient supply, soil structure, water-holding capacity, and a host of other vital soil functions. These functions increase the resilience of the soil under threat from future climate change. Soil carbon sequestration then is one of the clearest examples of a mitigation measure that also protects against changes in climate and enhances adaptation and the sustainability of crop production. Other examples include the application of animal manure to soils, which reduces fertilizer use and also improves soil structure and water-holding capacity; the reduction of tillage intensity with improved residue management, which can increase soil carbon while retaining soil moisture; and the restoration of degraded lands, which can sequester carbon and also enhance livelihoods and the resilience of the soils for sustaining agriculture under a changing climate.

Some management changes that are made mainly for the purposes of adaptation—to make agriculture more resilient to climate change—also increase carbon sequestration and so enhance mitigation. For example, conservation tillage increases soil water retention in the face of drought while also sequestering carbon below ground. Small-scale irrigation facilities not only conserve water to cope with greater variability, but also to increase crop productivity and soil carbon stocks. Agroforestry systems increase above- and below-ground carbon storage while also increasing water storage below ground, even in the face of extreme climate events. Properly managed rangelands can cope better with drought and sequester significant amounts of carbon. Project- and program-based funding schemes that support adaptation should also be able to draw on mitigation resources.

[1] The value (in $US) of one ton of carbon dioxide in future carbon markets.

Table 1

ACTIVITY CATEGORY	SUSTAINABLE DEVELOPMENT		
	Social	Economic	Environmental
Agroforestry	Uncertain	Uncertain	Positive
Tillage/residue management[1]	Uncertain	Uncertain	Positive
Nutrient management	Uncertain	Overall efficient use of nutrients will yield cost reduction and productivity improvement	Positive
Water management[2]	Positive	Positive (even if the farmers are supposed to pay for water!)	Positive
Livestock management: breeding improved systems	Uncertain to negative as these practices may not be acceptable due to prevailing cultural practices, especially in developing and underdeveloped society	n/d	n/d
Grazing land management[3]	Positive	Positive	Positive
Increase C storage in agricultural products	Positive	Positive	Positive

[1] Improves fertility of the land. [2] All efficiency improvements are positive for sustainability goals. [3] Positive.

Mitigation and sustainable development

There are various potential impacts of agricultural GHG mitigation on sustainable development. Table 1 evaluates the impact of selected mitigation activities in the agriculture sector on the pillars of sustainable development, namely the social, economic and environmental factors. Table 1 suggests the likely impact, but the exact magnitude will depend upon the scale and intensity of the mitigation measures and where they are undertaken.

Agriculture contributes more than half of the world's emissions of CH4 and N2O; and nutrient, water, and tillage management can help to mitigate these GHGs, especially in rice crops. By careful drainage and effective institutional support, methane emissions and irrigation costs for farmers can be reduced, thereby improving farmer incomes. An appropriate mix of rice cultivation with livestock—known as integrated annual crop-animal systems and traditionally found in West Africa, India, Indonesia, and Vietnam—can increase net income, improve cultivated agro-ecosystems, and enhance human well-being. Such combinations of livestock and cropping, especially for rice, can improve income generation, even in semi-arid and arid areas of the world.

In agriculture in general, groundwater quality may be enhanced and the loss of biodiversity slowed by careful use of farmyard manure and more targeted use of pesticides. The impact of this mitigation measure on social and economic aspects of agriculture, however, remains uncertain. Better nutrient management can improve environmental sustainability.

Pasture improvement by the control of overgrazing favorably impacts livestock productivity (creating greater income from the same number of livestock) and slows or halts soil loss and desertification, thereby providing other environmental benefits. It also provides social security to the poorest people during extreme events such as drought and other crises, especially in Sub-Saharan Africa.

Changes in land cover and tillage management could promote both mitigation and adaptation. A mix of horticulture crops with optimal crop rotations would promote carbon sequestration and could also improve agro-ecosystem function. Societal well-being would also be enhanced through provisioning of water and enhanced productivity. While the environmental benefits of tillage and residue management are clear, other impacts are less certain.

The impacts on sustainable development goals of other mitigation measures listed in Table 1 are context- and location-specific. Appropriate adoption of mitigation measures is likely to help achieve environmental goals, but farmers may incur additional costs, thereby reducing their returns and their income. This trade-off would be most visible in the short term, but, in the long term, synergy among the constituents of sustainable development would emerge through improved natural capital. Trade-offs between economic and environmental aspects of sustainable development might become less important if the environmental gains were better acknowledged, quantified, and incorporated in the decision-making framework.

Suggested negotiating outcomes:

Many mechanisms can be envisaged for rewarding synergies among mitigation, adaptation, and sustainable development, such as giving mitigation credits for projects that also have adaptation potential, giving preference to mitigation projects that also have significant adaptation benefits, or using an adaptation fund. Alternatively, markets could be used to reward synergies, for example by the use of "premium" carbon credits, either as part of future voluntary or compliance markets. Activities that have been shown to confer additional adaptive capacity or enhance sustainable development goals in addition to providing a GHG or carbon benefit would be assigned a higher value in such a credit system than activities that provide only a GHG benefit. ■

For Further Reading: P. Smith et al., "Agriculture," in B. Metz et al., eds., *Climate Change 2007: Mitigation, Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change* (Cambridge, U.K., and New York: Cambridge University Press, 2007); P. Smith et al., "Policy and Technological Constraints to Implementation of Greenhouse Gas Mitigation Options in Agriculture," *Agriculture, Ecosystems & Environment* 118: 6–28 (2007); P. Smith et al., "Greenhouse Gas Mitigation in Agriculture," *Philosophical Transactions of the Royal Society B* 363: 789–813 (2008).

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