CAST
COUNCIL FOR AGRICULTURAL SCIENCE AND TECHNOLOGY

INTERPRETIVE SUMMARY

TASK FORCE REPORT 142 OCTOBER 2011

CARBON SEQUESTRATION AND GREENHOUSE GAS FLUXES IN AGRICULTURE: CHALLENGES AND OPPORTUNITIES

This publication is a timely update of the landmark 2004 CAST Task Force Report, *Climate Change and Greenhouse Gas Mitigation: Challenges and Opportunities for Agriculture*. Modern-day environmental issues include the need to decrease concentrations of carbon dioxide (CO_2) and other greenhouse gases (GHGs) in Earth's atmosphere. Agriculture is in the middle of this, and the challenges include adapting management and land use to cope with the changing climate and adopting mitigation strategies to decrease agriculture's net contributions to GHG production. While agriculture deals with its key production roles, it also must consider conservation and the protection of natural resources. This report examines the current science to inform the public and policymakers about this crucial topic.

AGRICULTURAL INVOLVEMENT

Globally, agriculture accounts for 13.5% of GHG emissions. In the United States, agriculture is a small but significant component of the country's and world's GHG emissions. We are moving into an uncertain and changing climate pattern that could affect agriculture production, sea levels, and human health. This report's primary focus is on agriculture's role in the land-atmosphere exchanges of GHGs as well as agriculture's ability to decrease GHG emissions or sequester additional carbon in agricultural soils while continuing to supply the necessary food, feed, and fiber required for the world's growing population.

MITIGATION OPTIONS

Emissions of CO_2, CH_4 (methane), and N_2O (nitrous oxide) from agriculture are the result of both human-induced and natural processes in the ecosystem carbon (C) and nitrogen (N) cycles. Although these causes of GHG emissions cannot be completely eliminated, they can be lowered through modified land use and management.

In general, agricultural activities can mitigate emissions by

1. Decreasing emissions of GHGs due to agricultural causes;
2. Increasing sequestration of C in soil organic matter and plant biomass, resulting in a net removal of CO_2 from the atmosphere; and
3. Using sustainable agricultural biofuels with their capacity to offset CO_2 emissions from fossil fuels.

This report outlines a number of practices for which increased C sequestration and decreased emissions of GHGs have been established or, in some instances, are presently under investigation. The practices are evaluated and presented in separate sections that cover annual cropland, pasture and range, horticultural crops, agroforestry systems, wetlands and organic soils, confined livestock, and biofuel feedstock production.

There are two principal opportunities for C sequestration in agricultural ecosystems:

1. Improved management of permanent agricultural land through practices that enhance C storage
2. Conversion and/or restoration of marginal and degraded agricultural lands to alternative, C-sequestering uses

Emissions from N_2O can be decreased mainly through more efficient use of N additions to soils, and the main opportunities for CH_4 reductions in U.S. agriculture are through improved livestock and manure management practices.

IMPACTS ON SOCIETY, INCLUDING ON AGRICULTURE

Economics govern the adoption of GHG emission-decreasing or sequestration-enhancing practices. The many possible ways to design adoption incentives or implement policy tools include the following:

1. Emission taxes—Emitters of GHGs would face a tax on their emissions whereby emitters would be encouraged to implement emissions reduction technologies and thereby decrease their GHG emissions.
2. Market-based cap and trade—An overall limit (cap) on GHG emissions is set by a regulator and regulatory credits are issued equal in number to the level of the cap.

These systems have various options and issues that the authors examine in this report. They also point out several other important factors:

- Biophysical estimates of emissions reduction potentials are generally overestimates as they do not account for adoption costs or the possibility of higher economic returns from competing practices, and, in fact, different practices will likely dominate at different market prices.
- In addition to providing more reliable emission estimates under current land use, detailed multi-GHG models are needed to reliably assess mitigation potentials at regional and national scales within the United States.
- Agricultural management practices that sequester C or lower GHG emissions may have other environmental benefits (cobenefits) such as decreased soil erosion, decreased N and phosphorus surface runoff, and improved wildlife habitat.

Land owners may engage in GHG mitigation efforts for a variety of reasons, such as a desire to practice good environmental stewardship or a reaction to incentives for participating in private-sector offset markets or government-sponsored mitigation programs.

The rapid development of user-friendly tools that also can incorporate state-of-the-art models and fine-scale information on soil, climate, and management variables can help support science-based mitigation activities for U.S. agriculture. Comprehensive GHG legislation would also impact agricultural income in three ways:

1. Restrictions in GHG emissions would induce an increase in energy prices, which would raise agricultural production costs for energy.
2. Through economy-wide adjustments to increased energy prices, stronger incentives to produce alternative energy sources such as biofuels would likely increase.
3. Legislation that creates a market for GHG mitigation credits with offsets may generate new streams of income.

Carbon Sequestration and Greenhouse Gas Fluxes in Agriculture: Challenges and Opportunities was written by a task force of 22 scientists, cochaired by Dr. Ron Follett, USDA–ARS–NPA; Dr. Sian Mooney, Boise State University; Dr. Jack Morgan, USDA–ARS–NPA; and Dr. Keith Paustian, Colorado State University. The publication, Report 142, is available from CAST for $50 plus shipping. Individual, retired, and student members of CAST may request a free copy for a shipping charge only—contact Melissa Sly, Membership and Marketing Director, at msly@cast-science.org. Visit the CAST website at http://www.cast-science.org.

CAST
COUNCIL FOR AGRICULTURAL SCIENCE AND TECHNOLOGY
4420 West Lincoln Way
Ames, Iowa 50014-3447, USA
(515) 292-2125, Fax: (515) 292-4512
e-mail: cast@cast-science.org

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