WRI POLICY NOTE
CLIMATE:AGRICULTURE No. 2
WORLD RESOURCES INSTITUTE

AGRICULTURE AND CLIMATE CHANGE: GREENHOUSE GAS MITIGATION OPPORTUNITIES AND THE 2007 FARM BILL

EVAN BRANOSKY AND SUZIE GREENHALGH

How can managers of agricultural operations reduce their greenhouse gas emissions? What opportunities exist under the Conservation Title of the 2007 Farm Bill to enhance climate change mitigation opportunities from the U.S. agricultural sector?

RECOMMENDATIONS

1. Ensure that 2007 Farm Bill legislative language includes greenhouse gases specifically as a resource of concern under air quality.
2. Ensure that 2007 Farm Bill implementation language for conservation programs includes opportunities for reductions in all agricultural greenhouse gas emissions, including nitrous oxide and methane and enhanced carbon storage as national priorities.
3. Require that environmental tradeoffs are assessed when evaluating applications for cost-share or incentive payments in the 2007 Farm Bill. Include in the United States Department of Agriculture (USDA) implementation language the need to establish protocols to assess environmental tradeoffs within broader conservation program implementation language, e.g., between enhancing wildlife benefits and reducing greenhouse gas emissions.
4. Explicitly specify nitrous oxide and methane mitigation opportunities in any existing climate change language.

The agricultural sector emits large quantities of the more potent greenhouse gases (GHGs) responsible for global warming—approximately 70 percent of total U.S. emissions of nitrous oxide (N_2O) and 30 percent of total U.S. methane (CH_4) emissions, as well as small amounts of carbon dioxide (CO_2).[1] *Agriculture and Climate Change: The Policy Context*, our first agriculture and climate Policy Note, describes the impact of climate change on U.S. agriculture, provides information on the agricultural sector's contribution to climate change, and summarizes the possible roles for agriculture in proposed climate change legislation.[2] The aim of this policy note is to describe GHG mitigation opportunities for the agricultural sector in greater detail, highlight some of the potential trade-offs of mitigating GHGs instead of addressing other environmental issues, and outline options for addressing climate change within the Conservation Title of the 2007 Farm Bill.

This note does not go into any detail regarding biofuel production[3] or other renewable energy opportunities such as wind and solar, but these technologies also present significant opportunities for the agricultural sector to both benefit from climate mitigation action and reduce U.S. GHG emissions. Further, this note does not discuss the Forest or Rural Development Title of the Farm Bill, though many opportunities exist to mitigate GHG emissions through programs in these titles as well.[4]

Climate Change in the 2002 Farm Bill

Climate change and the mitigation of GHGs is addressed within the Farm Security and Rural Investment Act of 2002 (FSRIA or 2002 Farm Bill),[5] though the subject deserves far greater attention. Table 1 outlines where GHGs are specifically referred to in the 2002 Farm Bill, describes the purpose of the program as it relates to GHGs, explains any relevant USDA implementation language, and discusses the status of appropriations for three programs under Titles II, VIII, and IX.

Agricultural Mitigation Options—Nitrous Oxide

Under current practices the agricultural sector emits more nitrous oxide (N_2O)—one of the more potent GHGs[6]—than any other sector of the U.S. economy. This N_2O comes from two main sources—livestock manure and chemical fertilizers.

When bacteria interact with ammonia, N_2O is released. Therefore, to reduce N_2O emissions, farmers must decrease either direct emissions of N_2O or the amount of ammonia produced during normal agricultural processes. In dairy and cattle operations, large amounts of ammonia are produced when urea and livestock manure break down in water or slurry. Even greater emissions come from field operations, where applications of nitrogen fertilizer and related cropping practices constituted 68 percent of U.S. nitrous oxide emissions in 2004.[7]

Since fertilizer is responsible for large amounts of agricultural sector N_2O emissions, farmers can choose to implement soil

TABLE 1 Specific 2002 Farm Bill References to GHGs

Farm Bill Title	Relevant Section	GHG Relevant Language and Purpose
Title II-Conservation	Subtitle D-Environmental Quality Incentives: Sec. 1240H. Conservation Innovation Grants (CIG).	CIG encourages projects that undertake innovative conservation practices, including the storing of carbon in the soil. Relevant implementation language: The 2006 announcement of program funding[a] lists: • agricultural GHG emissions and carbon sequestration under the atmospheric resources section of the natural resource concerns component of the CIG. • development of GHG accounting tools as a sub-topic of the market-based approaches section of the technology component of the CIG. In the three-year existence of the CIG program, over $53 million has been awarded.[b]
Title VIII-Forestry	Sec. 8002: Sec 4. Forest Land Enhancement Program (FLEP).	One of the FLEP's objectives is to increase and enhance carbon sequestration opportunities on non-industrial private forest lands. Relevant implementation language: • The 2003-2004 interim directive does not list GHGs, carbon sequestration, or climate change as one of its national priorities. Similarly, the interim rule does not specify any natural resource concerns. Rather it lists eligible forest practices, some of which increase carbon sequestration.[c] Of the $100 million allocated to this program only $35 million was appropriated. This program was not renewed in 2005.
Title IX-Energy	Sec. 9009: Cooperative Research and Extension Projects.	Encourages collaboration among scientists to develop and evaluate GHG data. Also develops measurement and monitoring methods to assess carbon sequestration potential and the exchange of other GHGs by agricultural and forestry practices. Status: • This program has not been fully funded for the last several years.

Notes

a. For complete details and the 2006 program announcement, see http://www.nrcs.usda.gov/programs/cig/pdf_files/CIG06WebFinal.pdf.

b. This amount includes total 2004 National awards, 2005 Chesapeake Bay Watershed and National awards, and 2006 National awards. The total amount covers projects that involve both water quality and GHGs. For more information, see http://www.nrcs.usda.gov/programs/cig/index.html.

c. For the 2003 FLEP interim directive see http://www.fs.fed.us/spf/coop/library/FLEP%20Interim%20Directive.pdf and for the interim rule see http://www.fs.fed.us/spf/coop/library/FLEP%20Rule.pdf.

management practices that lead to appropriate fertilizer application rates. One of these practices is nitrogen field testing, which determines the nitrogen fertilizer needs of a crop.[8] Farmers who use these simple tests can decrease N_2O emissions by avoiding costly fertilizer over-application that results from following many of the recommended application rates which are based on ideal growing conditions.[9] In addition to nitrogen field sampling, further N_2O mitigation options include using cattle feed pads during winter months, using nitrification inhibitors with fertilizer, properly timing fertilizer applications, improving field drainage, and avoiding soil compaction which slows water drainage.

Agricultural Mitigation Options—Methane

The agricultural sector is the second largest contributor of CH_4 in the United States, with approximately 70 percent of agricultural CH_4 emissions coming from enteric fermentation, 25 percent from the decomposition of manure, and 5 percent from rice cultivation.[10]

Enteric fermentation is a natural process that occurs in the digestive systems of animals such as cattle, sheep, and goats. This process produces CH_4 when microorganisms break down complex carbohydrates into simple sugars that can be absorbed into the bloodstream of an animal. As much as 7 percent of an animal's feed can be lost as CH_4, so feedlot operators who increase animal digestive efficiency will save feed costs and decrease methane emissions. Options for increasing efficiency include increasing the daily percentage of highly digestible feed and correcting nutrient deficiencies in livestock diets.

Manure stored in central tanks or lagoons also releases CH_4 during anaerobic decomposition. However, new technologies now make it possible for this excess CH_4 to be captured and either used directly or sold as energy. Capturing the released CH_4 and using it for energy[11] effectively reduces GHG emissions, while also helping to meet on-farm energy needs and reduce electricity costs.

Finally, rice production is responsible for the remaining CH_4 emissions from agriculture. These emissions are generated through the cultivation of wet rice, which promotes the anaerobic decomposition of plant wastes that remain after harvest. In California, Mississippi, Missouri, and Oklahoma this occurs once a year; in Arkansas, Florida, Louisiana, and Texas where there are two crops per year, more CH_4 is released. Reductions in CH_4 emissions can be achieved by using different rice cultivars, improving water management practices, and using inorganic fertilizers.

Agricultural Mitigation Options—Carbon Dioxide

The agricultural sector contributes less than 1 percent of U.S. CO_2 emissions. A majority of these emissions are related to land-use change (i.e., deforestation), diesel fuel use, and energy used for irrigation and drying of grain. Increasing cultivation efficiency by moving to low- or zero-tillage crop management practices, using more energy-efficient machinery, or reducing energy demand will reduce these direct CO_2 emissions.

While agriculture emits only small amounts of CO_2, it has the capacity to store carbon in plant material and soils. For this reason, many Congressional bills seeking to establish cap-and-trade programs target the agricultural sector as a source of offsets for all sectors under the cap.[12] However, this ability to store carbon is limited. In 2003, U.S. agricultural land directly sequestered 52 million metric tons of CO_2 equivalent, while total CO_2 emissions for the United States and its territories were approximately 5,778 million metric tons.[13] Implementing certain best management practices can increase the potential for greater CO_2 storage, but sufficient farmer buy-in must be achieved to make them effective. These practices include conservation tillage, nutrient management, rotational grazing and improved forage management, use of cropping rotations and cover crops, and the establishment of riparian buffers.

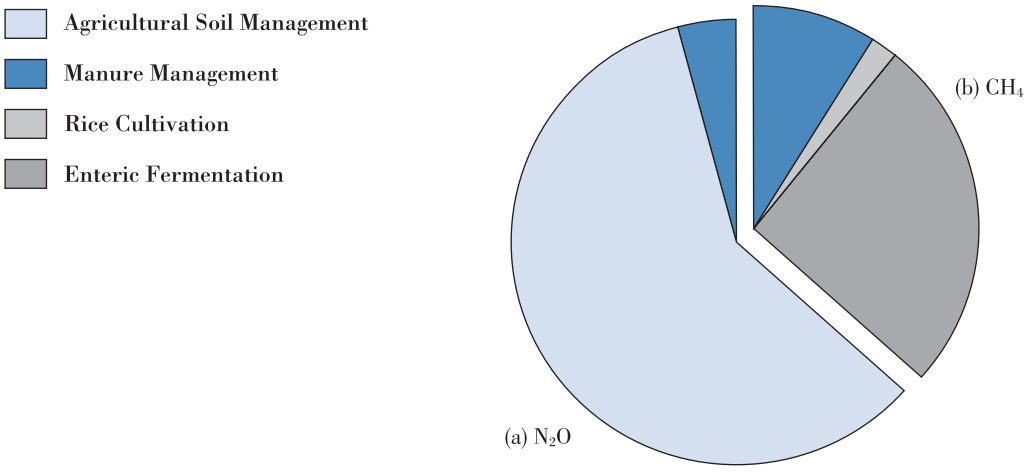
In order for farmers to benefit financially from providing carbon offsets using these best management practices, policymakers will need to develop systems for inventorying and monitoring soil carbon in agricultural lands. These protocols will become even more important if emissions trading legislation is passed in Congress and the agricultural sector is used as a source of offsets.

Increasing Climate Change Mitigation Options in Farm Bill Programs

The legislative language in Title II-Conservation of the 2002 Farm Bill leaves identification of the specific natural resources of concern largely to the implementing agency, the USDA. Aside from the programs listed in Table 1, there are two programs whose purposes are broad enough to encompass specific climate change mitigation actions—the Environmental Quality Incentives Program (EQIP) and the Conservation Security Program (CSP).

Two purposes of EQIP, as outlined in the legislative language, are to assist producers in complying with "regulatory requirements concerning water, soil, and air quality, wildlife habitat and surface and ground water conservation," and to provide

FIGURE 1 GHG Emissions and Sources from the U.S. Agricultural Sector[14]



Notes:
1. GHG amounts are expressed in CO_2 equivalent. Therefore, pie slices are based on Global Warming Potential rather than actual emissions of the specific gas.[15]
2. Field burning of agricultural residues also emits negligible amounts of N_2O and CH_4. Emissions from this source are not represented in the chart.
3. Agriculture also emits negligible amounts of direct CO_2 emissions, though these emissions are not represented in the chart.

assistance to producers "to install and maintain conservation practices that enhance soil, water, related natural resources and wildlife while sustaining the production of food and fiber" (see Section 1240 of 2002 Farm Bill).[16] GHG reduction and mitigation options could be further encouraged in the 2007 Farm Bill by explicitly adding air to the list of resources that conservation practices are aimed at improving in the second specified purpose above. CIG language (briefly outlined in Table 1) in the 2007 Farm Bill should also be broadened to include all GHG reduction opportunities, not just the storing of carbon in the soil.

The USDA Natural Resources Conservation Service (NRCS) further refines more precisely how EQIP will be implemented. For example, NRCS lists air quality as a national resource priority, which is used to help allocate program funding. However, for this purpose, air quality is defined as "reduction of emissions, such as particulate matter, nitrogen oxides (NOx), volatile organic compounds, and ozone precursors and depleters that contribute to air quality impairment violations of National Ambient Air Quality Standards"[17] and does not specifically include GHGs. Broadening the scope of 'air quality' to include GHGs in the USDA implementation language should further promote actions to reduce GHG emissions or enhance carbon sequestration from the agricultural sector.

Therefore, to promote greater climate change mitigation, both the 2007 Farm Bill and its implementation language for EQIP should be broadened to explicitly include climate change actions. In addition, if and when climate change regulations are adopted, GHGs should be added to the list of regulated resources. Similarly, GHGs should also be added to the program's list of national resource priorities to better focus EQIP funding toward climate change mitigation efforts.

The CSP is aimed at assisting farmers to promote the "conservation and improvement of the quality of soil, water, air, energy, plant and animal life, and any other conservation purpose" (see Sec 1238A of 2002 Farm Bill), with conservation priorities being determined at the state and local levels. Soil and water quality are the two nationally identified resource concerns in the implementation language;[18] the USDA can identify additional resources for each sign-up. For the 2006 sign-up, depending on the level of conservation being undertaken by producers, there are minimum conservation standards relating to soil and water quality, water quantity, wildlife, riparian corridors, and grazing lands. Enhancement payments, or additional payments, are also available to producers who undertake measures beyond the required standards for soil quality, nutrient management, irrigation water management, grazing, air and energy management, or any locally identified

resource concerns.[19] Explicit reductions or C sequestration activities, however, are not included. To better address climate change concerns within CSP, conservation measures to mitigate climate change should be included specifically as a resource of concern in the sign-up announcements, or included as a component eligible for enhancement payments.

Evaluating Environmental Trade-offs

Both EQIP and CSP have broad environmental goals and focus on many natural resources. Inevitably there will be conservation practices that benefit one natural resource while harming another. Leaving water on land under rice cultivation to promote wildlife habitat, for example, can increase wetland acreage and enhance wildlife benefits, but can also accelerate the generation of CH_4. An example with positive benefits is where reduced nitrogen fertilizer applications improves water quality and also reduces N_2O emissions. Similarly, riparian buffers enhance wildlife habitat, improve water quality, and increase carbon storage.

Conservation practices may also have varying effects on different GHGs. For instance, capturing CH_4 from livestock manure and urine involves storing the material. Storage reduces the exposure of the urine and manure to oxygen, thus decreasing the release of N_2O. This illustrates how one conservation practice can simultaneously lead to reductions in two GHGs.

To evaluate possible tradeoffs, the 2007 Farm Bill should include language that requests an assessment of environmental tradeoffs when evaluating applications for cost-share and incentive payments. USDA should further specify that environmental tradeoffs are to be considered while allocating funding for conservation practices at the state and county level, and establish protocols to do so. These protocols do not currently exist, but additional notes in this series outline why estimating environmental outcomes from conservation practices is important and describes some quantitative tools that can be used by farmers, agricultural consultants, county conservation districts, and USDA personnel to estimate these environmental outcomes.[20] Incorporating these tools into cohesive protocols will assure the adoption of conservation practices that not only promote advancements in water quality, soil nutrient content, and wildlife health and diversity through best management practices, but also reduce GHG emissions and enhance carbon sequestration potential.

About the Authors

Evan Branosky is a Research Analyst at the World Resources Institute. Ph: (202) 729-7630. Email: ebranosky@wri.org

Suzie Greenhalgh is a Senior Economist at the World Resources Institute. Ph: (202) 729-7786. Email: suzieg@wri.org

Acknowledgments

The authors would like to thank the following for their constructive feedback, suggestions, and support: Hyacinth Billings, Greg Fuhs, David Jhirad, John Larsen, Jeff Logan, Jonathan Pershing, Zach Sugg, and two anonymous reviewers. We would also like to thank the John D. and Catherine T. MacArthur Foundation for their support in making the publication of this policy note possible.

NOTES

1. See the World Resources Institute Climate Analysis Indicators Tool (CAIT), http://cait.wri.org.
2. See http://www.wri.org/policynotes for this publication.
3. A complimentary series of policy notes dealing with biofuel policy can be found at www.wri.org/policynotes.
4. Protocols that evaluate environmental tradeoffs are particularly relevant for the Rural Development Title. Currently, industries that emit large quantities of GHGs (such as coal-fired power plants) are offered loan guarantees within this title. Policymakers should consider the contribution to global warming of GHG emissions from these polluting industries, as well as their long-term viability in a greenhouse gas constrained world.
5. The Food Security and Rural Investment Act of 2002 is often referred to as the 2002 Farm Bill.
6. N_2O has a global warming potential of 310, meaning it is 310 times more potent than CO_2.
7. United States Environmental Protection Agency, *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2004*. Washington, DC: U.S. Environmental Protection Agency, April 2006.
8. Soil and plant nitrogen content can be tested using pre-plant nitrogen soil analysis, pre-side dress soil core tests, and corn stalk nitrogen tests before applying liquid nitrogen or dry manure to increase the amount of soil organic material. Ideally, soil cores are analyzed before planting in the spring and again in the fall to determine the actual nitrogen uptake by crops. Even more precise fertilizer applications can be made by using mapping systems to plot soil test results, allowing farmers to see how much nitrogen should be applied in different sections of a field.
9. In years with ideal growing conditions, insufficient nitrogen can be a limiting yield factor. Further, 'ideal growing conditions' do not commonly occur.
10. See United States Environmental Protection Agency, *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2004*. Washington, DC: U.S. Environmental Protection Agency, April 2006.
11. Liquid manure can be collected in enclosed tanks and anaerobic digesters can be used to convert the released methane to electricity. Excess methane can also be converted to CO_2, which is less potent than methane.
12. For an explanation of cap-and-trade, see WRI Policy Note Agriculture and Climate Change No. 1: *Agriculture and Climate Change: the Policy Context* at www.wri.org/policynotes.
13. Sequestered carbon only includes total sequestered organic carbon from agricultural land use and land management activities on mineral soils. For information on the Intergovernmental Panel on Climate Change/U.S. Environmental Protection Agency (EPA) reporting methodology as described by the Energy Information Administration for agricultural carbon sequestration, visit http://www.eia.doe.gov/oiaf/1605/gg05rpt/land.html. For total U.S. CO_2 emissions, see www.cait.wri.org (excludes land-use change).
14. United States Environmental Protection Agency, *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2004*. Washington, DC: U.S. Environmental Protection Agency, April 2006.
15. For an explanation of Global Warming Potential, see WRI Policy Note Agriculture and Climate Change No. 1: *Agriculture and Climate Change: the Policy Context* at www.wri.org/policynotes.
16. See the Farm Security and Rural Investment Act of 2002, http://www.nrcs.usda.gov/about/legislative/pdf/PLaw107171.pdf.
17. For the list of EQIP national resource priorities, visit http://www.nrcs.usda.gov/programs/natprgmpriorities/FY2006/natprgmprior.html#Environmental%20Quality%20Incentives%20Program.
18. For the complete CSP final rule, visit http://www.nrcs.usda.gov/programs/csp/pdf_files/cspfedregcomments.pdf.
19. For details of the 2006 sign-up announcement visit http://www.nrcs.usda.gov/programs/csp/pdf_files/csp0601signup.pdf.
20. See WRI Policy Note Environmental Markets No. 1: *Paying for Environmental Performance: Investing in Farmers and the Environment* and No. 4: *Paying for Environmental Performance: Estimating the Environmental Outcomes of Agricultural Best Management Practices* for information on tools/methodologies that can be developed to estimate the environmental outcomes from agricultural conservation practices.

About WRI

The World Resources Institute is an environmental think tank that goes beyond research to find practical ways to protect the earth and improve people's lives. Our mission is to move human society to live in ways that protect the Earth's environment and its capacity to provide for the needs and aspirations of current and future generations.

WRI Policy Note topics currently available include:

- **Energy**
- **Environmental Markets**
- **Climate**
- **Trade**

Please visit www.wri.org/policynotes for links to available Policy Notes.

ISBN 1-56973-646-4