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AGRICULTURE AND CLIMATE CHANGE: THE POLICY CONTEXT

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How will U.S. agriculture be affected by climate change and how do farmers benefit by decreasing their greenhouse gas emissions?

RECOMMENDATIONS: Policymakers consider the impacts of climate change on agricultural states and craft policy options that benefit farmers while reducing greenhouse gas (GHG) emissions. Specifically, Congress harnesses market forces to reduce GHGs through a cap-and-trade program, creates legislation that recognizes the ability of the agricultural sector to provide GHG reductions through N_2O and CH_4 mitigation actions, and implements adaptation projects that slow the impacts of climate change.

Man-made GHG emissions are already affecting the global climate system. These changes could impact the U.S. agricultural sector, as climate variability is expected to increase the occurrence of extreme weather events. This policy note describes the impact that climate change is expected to have on U.S. agriculture, explains how agriculture contributes to climate change, and outlines agricultural sector participation in some of the more prominent climate change legislation currently being proposed. Many of the opportunities for climate change mitigation action by the agricultural sector are outlined briefly below but are discussed in more detail in the forthcoming note in this series titled: "Agriculture and Climate Change: Greenhouse Gas Mitigation Opportunities."

CLIMATE CHANGE IMPACT ON U.S. AGRICULTURE

Studies describing the impacts of climate change on agriculture are limited in their ability to analyze all environmental and financial factors affecting crop yields (Adams et al., 1999; Mendelsohn, 1999; Adams et al., 2001; McCarthy et al., 2001). For this reason, predictions vary widely. Some studies assert that U.S. agriculture will benefit in the long term from incremental changes to the climate system because higher temperatures, increased carbon dioxide (CO_2) levels, and investments in adaptation measures generally increase crop yields in some regions. However, these studies often do not account for water and wind damage from severe weather events which can cause the agricultural industry significant loss of revenue. For example, in 2005 alone the United States Department of Agriculture (USDA) allocated $2.8 billion either directly to farmers for crop and livestock losses or to government agencies for refurbishment of infrastructure and watersheds damaged by hurricanes.

Climate change could have strong regional effects on U.S. agriculture. Studies in North America show that food production, on the whole, may increase from a warmer climate with higher concentrations of CO_2, but production centers will shift. For instance, southern states under some scenarios are projected to either increase agricultural productivity at a lower rate than other U.S. regions or decrease net yields altogether (Figure 1). These shifts may be attributed to longer growing seasons, higher temperatures, and more frequent and intense drought caused by climate change.

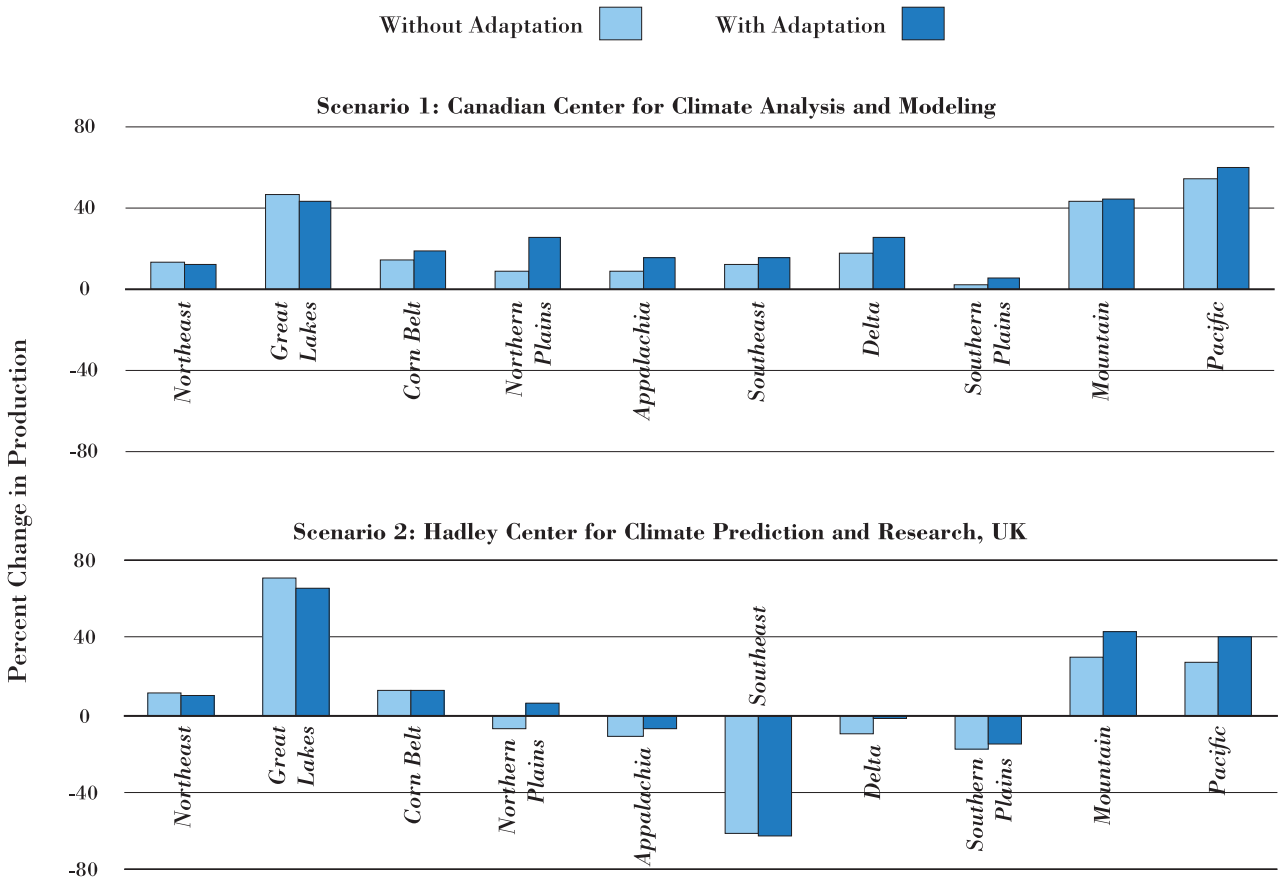
In addition, changing weather patterns may alter pest life spans and migration patterns, forcing U.S. farmers to plant hardier crops or use more pesticides to maintain current crop yields. This could result in pesticide application increases of 2–5

percent for soybeans and cotton, 5–15 percent for potatoes, and 10–20 percent for corn. Another prediction is that the melting snow pack in the western United States will increase water availability in the spring but decrease availability during summer months. Affected farmers will be forced to change their cropping practices in order to adapt, or risk declining crop yields as recreational and industrial users compete with them for limited water supplies.

Agriculture's Contribution to Greenhouse Gas Emissions

CO_2 is the most abundant greenhouse gas and is responsible for most human-induced climate change. However, it is not to blame for all warming. Nitrous oxide (N_2O) and methane (CH_4) also retain heat that warms the climate. Agriculture contributes large quantities of these more potent GHGs, emitting 85 percent of total U.S. emissions of N_2O and 32 percent of total U.S. CH_4

FIGURE 1 Possible Regional Agricultural Production Changes in 2030 Resulting from Climate Change

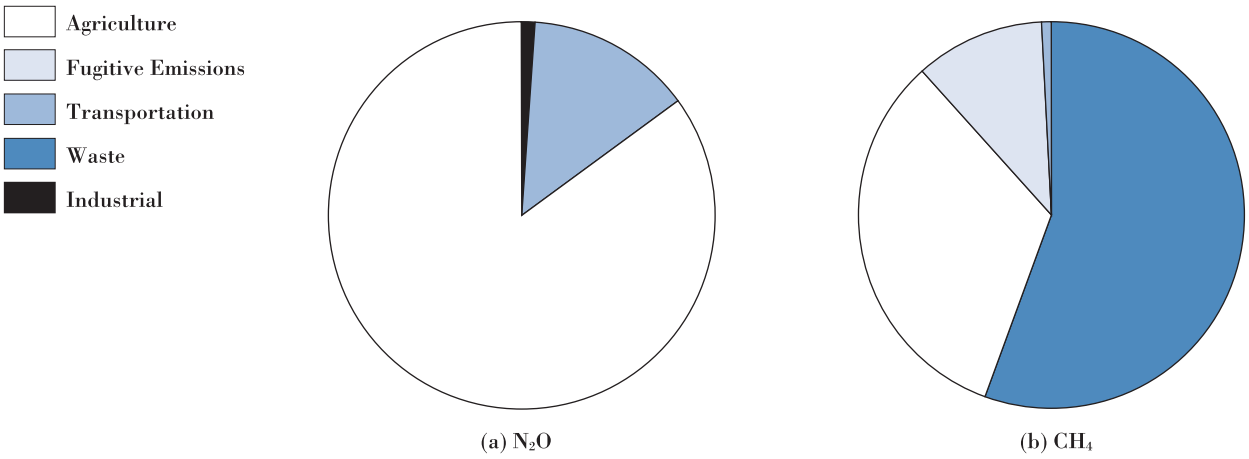


Source: U.S. National Assessment (Reilly, et al., 2001)

Notes:

1. These changes are alarming because of the speed with which they could occur. Agricultural producers could see dramatic changes in crop yields in less than 25 years.
2. Without Adaptation indicates a business- as- usual approach. With Adaptation includes adoption of preventative measures that negate certain impacts of climate change. These measures could include rainfall harvesting, dyke and canal construction, wider use of no-till agriculture, and establishing windbreaks.
3. Model projections differ because of their varying assumptions. The Canadian model assumes a greater temperature increase and drier climate over the 21st century than the Hadley model, but both assume conditions to be wetter overall than they are at present. Because of this, the Canadian model demonstrates a positive impact on production while the Hadley model shows crop yield declines from current levels. This demonstrates the inherent uncertainty in modeling of impacts where the worst-case scenario is as likely as the best case. Therefore, policies should be crafted to mitigate a worst-case scenario.

FIGURE 2 U.S. N_2O and CH_4 Emissions by Sector in 2001



Source: WRI CAIT

Notes:
1. Charts only include sectors that emit significant quantities of N_2O and CH_4. The waste, commercial, and residential sectors are not included in the N_2O chart because they collectively emit less than 1 percent of this GHG. Likewise, the commercial, residential, and industrial sectors emit negligible amounts of total U.S. CH_4.
2. "Waste" includes emissions from waste management and treatment activities not related to agriculture. "Fugitive Emissions" include emissions from fossil fuel extraction and delivery (i.e. extracting and refining oil and gas, transport via truck, rail, or pipeline, etc.).

(see Figure 2 and Box 1). Motor vehicles further contribute to U.S. N_2O emissions, while CH_4 is also released during fossil fuel production and through waste management.

Unplowed land naturally stores carbon and plants use CO_2 to respirate, so forests and agricultural lands store more CO_2 than they emit. This is good news for the farming community; just by implementing agricultural best management practices like no-till planting and cover cropping, they are assured of virtually no direct, land-use related CO_2 emissions. This is not true, however, for other farming activities. Large quantities of CO_2 are emitted from fossil fuels used to power farm machinery, irrigation pumps, and from drying grain. Fertilizer and pesticide production also affect GHG emissions as large amounts of CO_2 are emitted during the manufacture of these inputs.

N_2O emissions predominantly come from nitrogen fertilizer applications and related cropping practices such as manure applications and decomposition of agricultural wastes, while most CH_4 is released through livestock digestive processes. Fortunately, many of the opportunities to mitigate GHG emissions from these sources also increase crop and livestock yields while saving farmers money. Agricultural N_2O and CH_4 mitigation opportunities include proper application of nitrogen fertilizer, effective manure management, and use of feed that increases livestock digestive efficiency.

Agricultural Sector Involvement in Climate Change Legislation

Americans and policymakers are becoming increasingly concerned about global warming, resulting in an increasing number of U.S. policy initiatives and proposals that address climate change. Agriculture should be prepared to take a proactive role in the development of this climate change legislation (see Figure 3 for a description of some major legislative proposals).

Most of the legislation currently being proposed covers the agricultural sector by focusing on carbon stored in agricultural lands. For instance, the McCain-Lieberman "Climate Stew-

BOX 1 **Potency of Greenhouse Gases**

The impact of a GHG differs depending on its potency and lifespan: some gases are able to stay in the atmosphere longer and reflect more heat than others. GHG potency is measured by its Global Warming Potential (GWP), a standardized measure of impact that compares the total warming effect of the gas over a given time period to the warming effect of CO_2. The GWP for CH_4 is 21, which means that one ton of CH_4 warms as much as 21 tons of CO_2. N_2O, by comparison, has a GWP of 310, making it a far more potent gas than CH_4 or CO_2.

ardship Act of 2005" and the Waxman "Safe Climate Act of 2006" allow for carbon stored in agricultural soils to be traded in their proposed emissions trading markets (see Box 2 for a description of emissions trading). Sectors that have regulated limits (or caps) placed on their GHG emissions can purchase the credits associated with the carbon stored by agricultural soils to meet their GHG emissions targets. Depending on the legislation, the number of credits sold by the agricultural industry may or may not be limited.

Farmers can benefit financially depending on the amount of credits generated through carbon storage projects under some of the proposed legislation. Despite some transaction costs associated with quantifying and maintaining stored carbon, farmers who simply switch to no-till agriculture help address climate change and can profit financially by selling their credits in an emissions trading market. No current proposed federal legislation, however, has recognized the ability of the agricultural sector to provide other substantial sources of GHG reductions through N_2O and CH_4 mitigation actions.

Opportunities for the Agricultural Sector

Policymakers and organizations concerned with the potential impacts of climate change on U.S. agriculture should implement policies and actions to curb these impacts. This requires a two-tiered approach:

1. Congress should invest in technologies that counteract the impacts of climate change on agriculture.
2. Any legislation, including national emissions trading legislation, should actively include the agricultural sector. This legislation should benefit farmers by recognizing their ability to contribute to reductions in atmospheric GHG concentrations, including N_2O and CH_4.

Effective climate policy that includes the agricultural sector will benefit the global climate system while providing farmers with financial and environmental benefits.

BOX 2 Emissions Trading

A significant number of Federal climate change proposals seek to establish GHG emissions trading programs. In such programs, specified sectors have regulated amounts of GHGs that they can emit. This is commonly called a 'cap.' To meet their GHG emission caps, companies in these sectors can either reduce their GHG emissions directly, or purchase reduction credits from other companies that have exceeded their reduction targets or from companies or entities in sectors that do not have caps. The commonly capped sectors are electrical utilities and large industries (such as iron, steel, aluminum, cement, and chemical).

The agricultural sector is uncapped in most bills, but can be an important participant in emissions trading programs. When farmers take steps to mitigate tons of GHG emissions (through soil carbon storage, manure management, etc.), they essentially substitute their GHG reductions for GHGs of companies in capped sectors. The capped sector companies pay for these reduction credits, providing an additional source of income to farmers who participate in the market. This ability to provide offsets is the most direct path for agriculture to link to broader GHG emissions policies.

Further Reading

The U.S. Environmental Protection Agency (EPA) offers an excellent series of fact sheets detailing projected impacts on a state-by-state basis:

- http://yosemite.epa.gov/oar/globalwarming.nsf/content/ImpactsStateImpacts.html (Last accessed September 25, 2006).

The Pew Center on Global Climate Change tracks and explains pending climate legislation. All information is available online through:

- http://www.pewclimate.org/what_s_being_done/ (Last accessed September 25, 2006).

The Natural Resources Defense Council explains the fundamental science of global warming and analyzes the role of agriculture in selected legislation:

- http://www.nrdc.org/globalWarming/default.asp (Last accessed September 25, 2006).

FIGURE 3 **Role of U.S. Agriculture in Selected Pending and Proposed Climate Change Legislation**

State Government | U.S. House of Representatives | U.S. Senate

Title of Legislation	Bill Number	Sponsor(s)	Climate Goals	Role of Agriculture
Regional Greenhouse Gas Initiative	N/A	State Governors	Reduces GHG emissions in the electric power sector to 10 percent below current levels by 2018.	Electric utilities may use GHG emission reduction credits to offset 3.3–10 percent of their total GHG emissions. The percent of allowable reductions depends on market conditions. Agriculture can provide these offsets by using manure management to avoid CH_4 emissions.
California Global Warming Solutions Act of 2006	California Assembly Bill No. 32	Speaker Fabian Núñez and Assemblywoman Fran Pavley	Begins in 2010 to reduce total state emissions to 1990 levels by 2020.	Does not design an emissions trading system, but requires the State Air Resources Board to adopt a statewide GHG limit and regulations that allow the state to reach that limit. They could choose to implement an emissions trading program which could include agriculture as a source of offsets. The Bill also requires the Board to identify emissions reductions opportunities through carbon sequestration regardless of their decision to implement or not implement an emissions trading program.
Safe Climate Act of 2006	H.R. 5642	Representative Henry Waxman	Restricts GHG emissions in 2010 to the 2009 level. GHG emissions are reduced by 2 percent each year beginning in 2011, reaching 1990 levels by 2020. GHG emissions are further reduced by 5 percent per year starting in 2021 to reach 80 percent below 1990 levels by 2050.	Grants the President, in consultation with Congress, power to distribute allowances free of charge to the agricultural sector. Farmers can receive credit for stored carbon and sell it on the emissions trading market.
Climate Stewardship and Innovation Act of 2005	S.1151	Senators John McCain and Joseph Lieberman	Decreases GHG emissions from power, transportation, industrial, and commercial sectors to 2000 levels by 2010.	Participating companies can offset up to 15 percent of their cap using GHG emissions reduction credits. Agriculture competes with other sectors to provide these credits. Only credits from carbon storage are allowed.
Clean Air Planning Act of 2006	S.2724	Senator Tom Carper	Restricts GHG emissions from the electric power sector at the 2006 level between 2010 and 2014. Further reduces GHG emissions to the 2001 level beginning in 2015.	GHG emission reduction credits from sectors outside of the electric power sector can offset 100 percent of a company's regulated GHG emission level. Agriculture must compete with other sectors that also provide credits.
Global Warming Pollution Reduction Act of 2006	S.3698	Senators Jim Jeffords and Barbara Boxer	Starting in 2010, reduces GHG emissions from the electric power sector to 1990 levels by 2020. From 2020, GHG emissions are further reduced to 80 percent below 1990 levels by 2050.	Like the California Bill, it does not specifically design an emissions trading market, but instructs the U.S. Environmental Protection Agency to set standards for measurement, monitoring, and verification of carbon storage in agricultural soils.
Global Warming Reduction Act of 2006	S.4039	Senators John Kerry and Olympia Snowe	Freezes emissions in 2010 and reduces them yearly to a final goal of 65 percent below 2000 levels by 2050.	Requires the Secretary of Agriculture to establish standards for accrediting, monitoring, measuring and verifying biological carbon sequestration. Establishes a National Climate Change Vulnerability and Resilience Program that assesses potential local, State, regional and national climate change impacts.

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