Summary

Strategies that have been proposed to mitigate global climate change typically focus on reducing energy-related emissions of greenhouse gases (including carbon dioxide) into the atmosphere. But atmospheric concentrations of greenhouse gases also can be reduced by withdrawing carbon from the atmosphere and storing, or sequestering, it in soils and biomass. In examining the economics of sequestering carbon in the U.S. farm sector through changes in agricultural land use and management practices, this study focuses on two questions:

- How much of the estimated "technical" potential for carbon sequestration is economically feasible?
- How cost effective are alternative designs for incentive payments that might be used to encourage carbon-sequestering activities?

Model-based findings reflect the provision of financial incentives to landowners for sequestering carbon through changes in land use (converting cropland to forest or grassland) and cropland management practices (adopting conservation tillage or alternative crop rotations):

- **Agriculture can provide low-cost opportunities to sequester additional carbon in soils and biomass.** At a price of $10 per metric ton for permanently sequestered carbon, the ERS model estimates that from 0.4 to 10 MMT of carbon could be sequestered annually from adoption of the land-use changes or management practices analyzed; and at $125 per ton, from 72 to 160 MMT could be sequestered, enough to offset 4 to 8 percent of gross U.S. emissions of greenhouse gases in 2001.

- **The different sequestration activities studied become economically feasible at different carbon prices.** The model predicted that farmers would adopt cropland management (primarily conservation tillage) at the lowest carbon price, $10 per metric ton permanently sequestered carbon, and would convert land to forest as the price rose to $25 and beyond. The model predicted farmers in most regions would not convert cropland to grassland up through a $125 carbon price (in the absence of other incentives, such as Conservation Reserve Program payments), in part because conversion to afforestation was more profitable with its higher sequestration rate per acre. These estimates are comparable with estimates in earlier studies.

- **The estimated economic potential to sequester carbon is lower than previously estimated technical possibilities.** Soil scientists have estimated that increased adoption of conservation tillage on U.S. cropland has the technical potential to sequester as much as 107 million metric tons (MMT) additional carbon. The ERS model estimates *economic potential* by factoring into farmers' adoption decisions the tradeoff between the additional costs of sequestering practices, relative to the additional returns from the per ton carbon payments. We estimate that farmers could sequester up to an additional 28 MMT by adopting *conservation tillage* on additional lands at the top carbon price we studied, $125 per ton. For the *other activities* studied—afforestation and, particularly, for conversion to grassland—the estimated economic potential also was less than the literature estimates of technical potential.

- **Incremental sequestration from agricultural activities can continue for decades.** Conversion to conservation tillage could sequester additional soil carbon for 20-30 years, at which point a new equilibrium level of soil carbon would be attained. But carbon may be released relatively rapidly if farmers shift back to conventional tillage. Additional sequestration from afforestation may continue for many more decades, depending on region, species of trees, and harvest decisions.

These findings have implications for policy:

- **Payments for carbon sequestration may exceed their value if sequestration is not permanent.** To have the same greenhouse gas mitigation value as a unit of carbon emissions reduction, a unit of additional carbon sequestration must remain stored in soils or biomass permanently. If a program makes per ton payments equal to the value of permanent sequestration ("asset" payments), overpayments will occur if subsequent changes in land use or management practices release carbon back into the atmosphere—unless compensation is adjusted for the releases. "Rental" payment mechanisms, which pay farmers to store carbon for specific periods by maintaining carbon-sequestering practices, can help avoid this problem—particularly for contract renewals after the period when a new equilibrium level of soil carbon is reached and no more carbon is being added to the soil.

- **An incentive system that includes both payments for carbon sequestration and charges for carbon emissions may be much more cost effective than a system with payments only.** For example, at a carbon price of $125 per ton of permanently sequestered carbon, changes in tillage practices account for 7 MMT of additional sequestered carbon with a rental payment system that includes both payments and charges. Annual government expenditures for storage of this carbon during the 15-year contract period total $300 million. In contrast, when the incentives include only carbon payments, a price of $125 per ton results in half the sequestered carbon (3.5 MMT), while annual government expenditures increase tenfold to $1.5 billion.

- **Adding a cost-share subsidy does not appear to improve the cost effectiveness of incentive systems.** A 50-percent cost-share for cropland conversion to forestry or grasslands would increase sequestration at low carbon payment levels but not at high payment levels. The implications for cost per ton are minimal.