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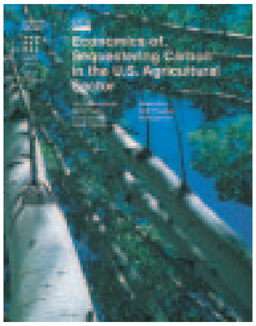

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Economics of Sequestering Carbon in the U.S. Agricultural Sector

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Increasing the quantity of carbon sequestered—or stored—in soils is an alternative to reducing atmospheric emissions of carbon and other greenhouse gases (GHG) in the context of an overall strategy to mitigate global climate change and its impacts. Under relatively constant management and environmental conditions, rates of carbon additions through photosynthesis and of carbon emissions through decomposition tend to equilibrate and the amount of organic carbon in soil stabilizes at a new equilibrium. Since wide-scale cultivation began in the 1800s, the stock of carbon in U.S. agricultural soils has declined, on average, by about one-third. Soil science studies have estimated the technical possibilities for sequestering additional carbon. This study explores the economic potential of sequestering additional carbon in the U.S. agricultural sector by providing farmers with incentives to expand the adoption of land uses and production practices that increase the quantity of carbon stored in soils and vegetation.

What Is the Issue?

In February 2002, the President directed the Secretary of Agriculture to develop recommendations for incentives to encourage adoption of production practices and land uses that extract carbon from the atmosphere and sequester it in soils and vegetation. *Economics of Sequestering Carbon in the U.S. Agricultural Sector* examines the economic implications of carbon-based incentives that might be used to expand such land uses and production practices in the U.S. farm sector. Two primary issues are addressed:

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

How Was the Study Conducted?

To assess the economic potential to sequester carbon in the farm sector, we adapted the ERS U.S. Agricultural Sector Model (USMP) to include sequestration and emissions parameters associated with switching into and out of land uses and production practices that build carbon levels in soils and vegetation. From the sequestration/emission parameters, we could implement alternative designs for carbon-based incentive payments to farmers. The three sequestering activities studied were afforesting croplands and pasture, shifting cropland to permanent grasses, and

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increasing the use of production practices (particularly no-till) and rotations that raise soil-carbon levels. Model simulations were run reflecting 15-year sequestration contracts for four alternative payment designs and six alternative payment levels for additional sequestered carbon. Estimates of carbon sequestration potential are developed for payment structures with *asset price* payments, which compensate farmers for (presumed) permanent carbon sequestration, and with *rental price* payments, which compensate farmers for storing carbon for a finite time period.

What Did the Study Find?

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 million metric tons (MMT) of carbon could be sequestered annually; 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 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 part because conversion to forest was more profitable with its higher sequestration rate per acre.

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 MMT additional carbon annually. 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 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 studied, $125 per ton. For the *other activities* studied—afforestation and, particularly, conversion to grassland—the estimated economic potential also was less than the previously estimated 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 will 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.

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 subsidy program makes per ton payments equal to the value of permanent sequestration, 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 substantially more cost effective than a system with payments only. For example, at a carbon price of $125 per ton for permanently sequestered carbon, changes in tillage practices account for an estimated 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 at the different prices per ton are minimal.