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Agricultural Land Tenure and Carbon Offsets

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If agricultural producers are allowed to participate in a national cap-and-trade system to curb greenhouse gas (GHG) emissions, the opportunity to sell carbon offsets could prompt farmers to manage their land in a way that increases the amount of carbon stored in soil organic matter and plant biomass, including residue. (See box, "Agriculture and Carbon Offsets.") Farmers who own the land they farm, however, may be in a better position to generate offsets than those who rent their land.

Because carbon is sequestered over time, offset agreements would likely require that sequestration practices be maintained for 5-10 years. For agricultural producers who rent land, insecure land tenure could be a barrier to long-term investment and/or farming practice commitments. Renters may be less interested than landowners in the long-term productivity of the soil and, therefore, less willing than owners to adopt practices that sequester carbon and preserve long-term productivity (e.g., long-term no-till or grass cover), especially if such practices might reduce current returns to the farm.

The reluctance of renters to make long-term conservation investments has been observed in a number of previous studies (e.g., Soule et al., 2000). Even if renters are willing to take action, they would be unable to sign long-term carbon offset agreements—or adopt the necessary practices—without a long-term lease. Landowners who want the flexibility to change renters or alter rental rates and other contract terms may be reluctant to enter into long-term leases. For example, landowners who rent land for cash may want to consider bids from other producers when crop prices or Government payments rise. Landowners who receive a share of the crop as rent may prefer the option to replace farmers who fail to achieve expected yields. Even if some farmers and landowners work together to generate carbon offsets on rented land, the complexity of the associated lease agreements and the negotiation challenges will continue to act as a deterrent. By contrast, farm operators who own their land will have greater incentives to engage in long-term conservation and will face fewer barriers to signing long-term contracts to generate carbon offsets.

Agriculture and Carbon Offsets

The agriculture and forestry sectors have the ability to remove carbon dioxide from the atmosphere and store ("sequester") it in soils and plant matter. While agriculture is generally excluded from environmental regulations, its ability to offset greenhouse gas (GHG) emissions from regulated sources means agriculture could play an important role in climate policies.

Proposals to combat climate change generally include a national GHG cap-and-trade system that caps the GHG emissions of producers or distributors of fossil fuels and large energy users, but allows these firms to buy and sell excess emissions. Regulated firms could either reduce their pollution levels below the cap or purchase additional emissions allocations from other firms. The ability to trade emissions allows regulated firms to minimize the total cost of pollution control. Costs could be reduced further if regulated firms could buy offsets from unregulated landowners willing to provide low-cost mitigation through soil and biomass sequestration.

While agricultural participation in a cap-and-trade market might be cost effective, implementation poses major challenges. The extent to which farmers would be willing to participate depends on a host of program design issues, including eligibility criteria, baseline standards (below which credits would not be generated), allowable interactions with USDA conservation programs, and farm characteristics and offset prices. This publication examines farms that may be in the best position to participate in a cap-and-trade system.

Could land tenure be a limiting factor in generating agricultural carbon offsets? The answer depends, in part, on the intersection of land tenure patterns and carbon sequestration potential. If a large proportion of farmers who own all or most of the land they farm are willing to offer extensive opportunities to generate carbon emission offsets, tenure is less likely to be a limiting factor. This report assesses the intersection of land tenure and carbon sequestration potential based on an assumed scenario for generating carbon offsets. (See box, "Carbon Sequestration Potential: Definition, Data, and Methods.") While we do not know how large carbon offset payments will be or how individual farm operators will respond to them, a rough approximation of the distribution of potential carbon sequestration is possible based on current land uses and practices. Whether land tenure will actually be a limiting factor can be assessed only in the context of future market demand for offsets and the ability of agriculture to generate offsets within the legal framework that may be established for carbon offset trading.

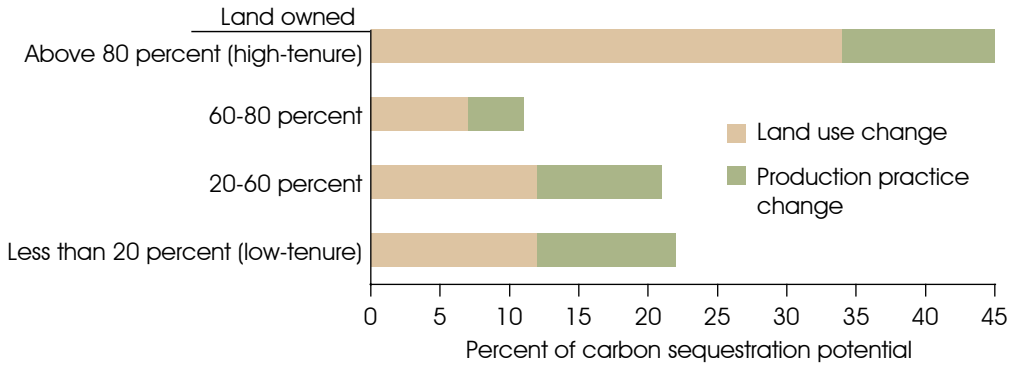
Land Tenure and Carbon Sequestration Potential

We separate farms and ranches into four tenure classes (fig. 1). High-tenure operators, for example, own at least 80 percent of the land they farm or ranch; low-tenure operators own less than 20 percent.

Carbon sequestration in U.S. agriculture (for offsets or other purposes) will be determined by (1) the amount of carbon that can be sequestered per acre through adoption of carbon sequestering practices

Figure 1

Potential carbon sequestration, by land tenure and practice type



Note: Percentages do not add to 100 because of rounding.
Source: ERS tabulations based on USDA's 2002 Agricultural Resource Management Survey, conducted by the National Agricultural Statistics Service and the Economic Research Service, and Eve et al., 2002.

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and (2) the number of acres on which farmers are willing to adopt such practices. Carbon sequestration potential differs across practices and regions and depends on previous land use. On average, conversion of cropland to permanent cover (e.g., grass or trees) yields larger per acre increases in sequestered carbon than do changes in production practices (e.g., conservation tillage) on cultivated cropland. As a source of carbon sequestration offsets, land-use change may also be easier to confirm and enforce than changes in tillage or other crop production practices.

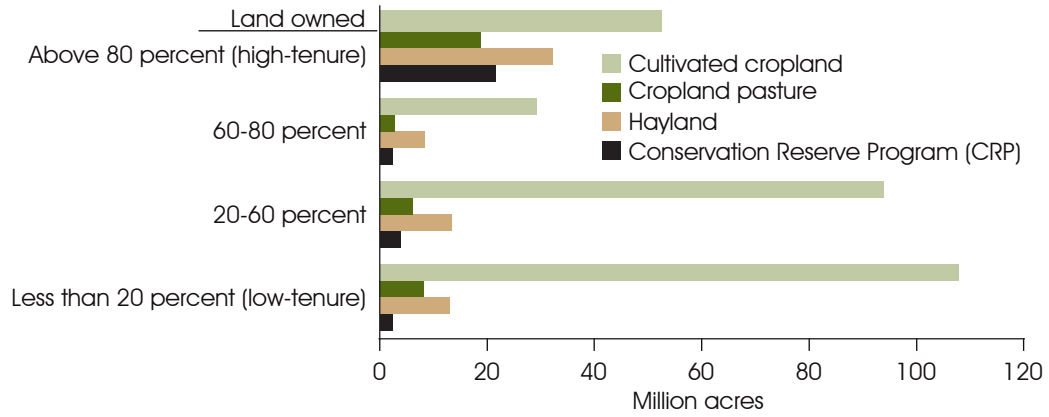
About two-thirds of estimated carbon sequestration potential comes from landuse change: shifting cultivated cropland to grass cover for conserving use (e.g., Conservation Reserve Program (CRP)) or for use as hay or pasture. On high-tenure farms, three-quarters of sequestration potential is derived from land-use change (fig. 1). Given the correlation between high-tenure farms and land in permanent grass cover or CRP, high-tenure farms are generally assigned higher carbon sequestration potential. In this simple simulation, high-tenure farms account for about 45 percent of the sector's carbon sequestration potential (fig. 1).

An examination of the intersection between land tenure and farming practice patterns shows why high-tenure farms may be in the best position to adopt carbon-sequestering practices. These farms and ranches maintain a relatively large proportion of land in hay and pasture (fig. 2). This land-use pattern may signal willingness to pursue low-intensity production consistent with carbon sequestration goals. Unlike producers in other land tenure categories, these farmers and ranchers focus more on livestock production and account for more than half of all livestock sales (fig. 3). These farms may be in the best position to utilize additional pasture and hay land created by carbon sequestration incentives. High-tenure farms are also more likely than other farms to enroll land in the CRP, accounting for about two-thirds of CRP acreage (fig 2). Because it provides financial incentives for farmers and landowners to establish conservation cover on cultivated land and to maintain the cover for at least 10 years, CRP may be a good barometer of willingness to participate in carbon offset markets. CRP rules also require landowners to offer tenants the opportunity to participate in the CRP contract and receive CRP payments.

In contrast to the high-tenure group, farms in the two low-tenure groups (those owning 0-20 percent and 20-60 percent of the land they operate) are far more likely to use land in cultivated crop production and less likely to enroll land in the CRP (fig. 2). Farms in these two tenure classes account for more than 70 percent of cultivated cropland and more than 60 percent of crop production (by value). Low-tenure farms include roughly 40 percent of hay and cropland pasture acreage, roughly 40 percent of livestock production (by value), and only 20 percent of CRP acres. These farms tend to focus more on crop production and are reluctant to retire land rather than farm it.

Figure 2

Land use, by tenure class



Source: ERS tabulations based on USDA's 2002 Agricultural Resource Management Survey, conducted by the National Agricultural Statistics Service and the Economic Research Service.

Carbon Sequestration Potential: Definition, Data, and Methods

Carbon sequestration potential is the amount of carbon that could be sequestered (held) within farmland in response to financial incentives generated by a GHG offset market. In the broadest sense, carbon sequestration potential can be estimated as the total number of farmland acres where emission reduction practices could be applied, multiplied by an estimate of the amount of carbon sequestration per acre. For our purposes, we assume that, at least initially, incentives will induce relatively small or *marginal* changes in land use and production practices on individual farms and ranches.

Specifically, we assume that all farmers increase their use of carbon sequestering practices by 10 percent. For example, a producer who has 20 percent of land in pasture would increase grazing acreage to 22 percent by shifting land from crop production. A simple index value for potential carbon sequestration can be created by multiplying the shifted acreage by the coefficients reported in table 1. Similar values can be calculated for marginal (10 percent) changes in other carbon sequestering practices. By summing all of these calculations, we arrive at an overall index of carbon sequestration potential. This index is intended for illustrative purposes only; actual land use or production practice changes will depend on a host of economic, policy, and bio-physical factors.

High levels of sequestration are reported for the conversion of cultivated cropland to grass or tree cover, relative to changes in cropland management in table 1. Land-use data, based largely on the implementation of farm commodity programs, also may make it easy to confirm that offsets are being generated on land that was previously in crop production, at least for the 75 percent of U.S. cropland on farms that receive Federal farm commodity program payments.

Reported coefficients also show larger carbon sequestration for pasture and hayland than for land enrolled in the Conservation Reserve Program (CRP), under the assumption that CRP lands are never harvested. CRP land can, however, be used for hay or grazing under certain conditions, possibly increasing carbon sequestration. Hay and pasture may also receive fertilizer, potentially creating additional GHG emissions. Nonetheless, our larger point remains valid—land-use change is likely to yield larger and more readily verifiable GHG reduction than changes in crop production practices.

Data on land use and farm practices come from the Agricultural Resources Management Survey (ARMS) conducted jointly by USDA's Economic Research Service and National Agricultural Statistics Service. The ARMS data are based on an annual survey of 34,000 farms that elicits information on farm businesses and farm households. Farm-specific weights can be used to expand estimates to the full farm population. For each observation (surveyed farm), ARMS data include information on land use, land tenure, CRP participation, production practices, and production of crop and livestock commodities. The 2002 ARMS data are used because data from that year provide a full accounting of agricultural land use, including pasture and rangeland.

Table1

Descriptive statistics for carbon sequestration coefficients

	Appa-lachian States	Corn Belt	Delta States	Lake States	Moun-tain States	North-east	Northern Plains	Pacific States	South-east	South-ern Plains
	Metric tons of carbon per acre per year									
Change from conventional tillage to reduced tillage	0.06	0.09	0.11	0.07	0.06	0.06	0.06	0.05	0.04	0.06
Change from conventional tillage to no tillage	0.13	0.17	0.21	0.15	0.13	0.13	0.13	0.10	0.08	0.13
Increased residue through use of manure or cover crops	0.13	0.17	0.21	0.15	0.08	0.13	0.13	0.10	0.08	0.13
Change from cultivated summer fallow to continuous cropping	0.00	0.00	0.00	0.15	0.08	0.00	0.13	0.10	0.00	0.13
Retire land from cultivated crop production (CRP)	0.19	0.25	0.30	0.21	0.12	0.19	0.19	0.14	0.11	0.18
Conversion of cultivated cropland to pasture or hay	0.38	0.50	0.59	0.42	0.23	0.38	0.37	0.29	0.23	0.36

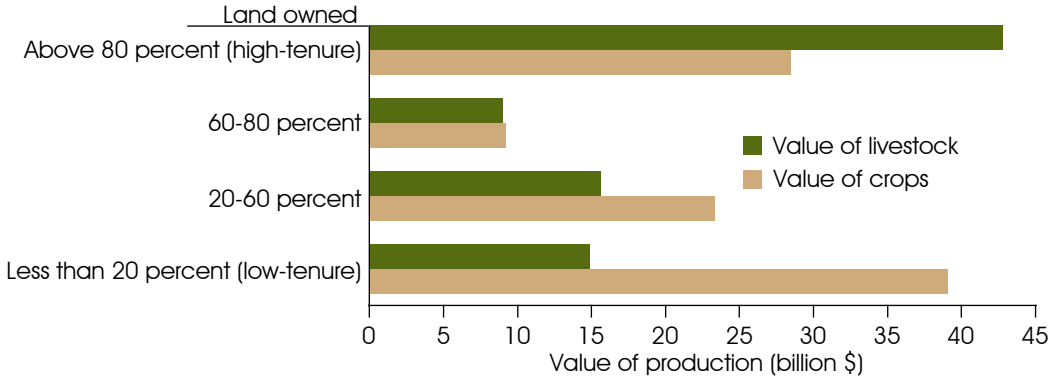
Source: Eve, M.D., M. Sperrow, K. Howerton, K. Paulson, and R.F. Follet. "Predicted Impact of Changes on Soil Carbon Storage for Each Cropland Region of the Conterminous United States," *Journal of Soil and Water Conservation* 57,4 (July-August 2002): 196-204.

The propensity of high-tenure farms toward hay, pasture, and CRP land use may be explained in a number of ways. First, these farms may be on land that is less productive when used for crops. Low-productivity land could also explain why high-tenure farms focus on livestock production that can effectively utilize pasture and hay, relative to other tenure classes (fig. 3). Land productivity could also explain their willingness to enroll formerly cultivated land in the CRP. An alternate explanation is that small, rural residence farms, which account for 72 percent of all high-tenure farms (fig. 4), are engaged in agricultural production only as a side venture and are more likely than other farms to be engaged in cow-calf operations (Hoppe et al., 2007). Such farms may be more willing than others to place land in retirement (CRP) or low-intensity use (pasture or hay) because their income derives mostly from off the farm.

From a carbon sequestration perspective, however, the largest share of sequestration potential is on large farms. Half of the total carbon sequestration potential is concentrated on just 7 percent of farms (high and medium-high carbon potential farms in fig. 5) that tend to be located in the Northern Plains and Mountain regions. While small in number, these farms operate 38 percent of all farmland. On average, they operate three times the acreage of the remaining 93 percent of farms that account for the other half of potential carbon sequestration. This "high sequestration potential" group is similar to (and overlaps with) the high-tenure group in that it accounts for a large share of hay and cropland pasture (52 percent) and CRP enrollment (58 percent). As a group, its relatively high participation in CRP demonstrates a willingness to participate in environmental land-use change programs.

Figure 3

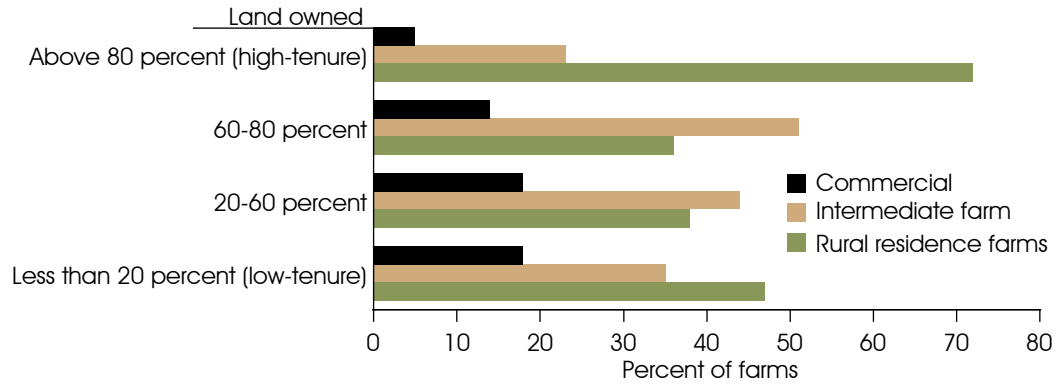
Value of livestock and crop production, by tenure class



Source: ERS tabulations based on USDA's 2002 Agricultural Resource Management Survey, conducted by the National Agricultural Statistics Service and the Economic Research Service.

Figure 4

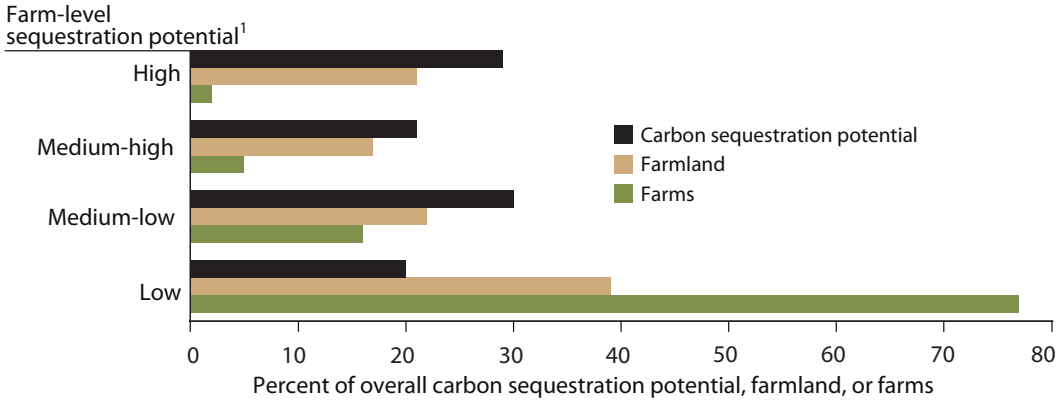
Farms by tenure and typology



Source: ERS tabulations based on USDA's 2002 Agricultural Resource Management Survey, conducted by the National Agricultural Statistics Service and the Economic Research Service.

Figure 5

Carbon sequestration potential, farms, and farmland, by farm-level sequestration potential



[1] Individual farms, ranked by their carbon sequestration potential. The top set of bars indicates that the 2 percent of farms with the highest level of sequestration potential account for roughly 30 percent of the agricultural sector's total carbon sequestration potential, as measured in this simulation.
Source: ERS tabulations based on USDA's 2002 Agricultural Resource Management Survey, conducted by the National Agricultural Statistics Service and the Economic Research Service.

Conclusions

If the United States adopts a national cap-and-trade system to curb GHG, and if agricultural producers are allowed to sell carbon offsets, participation is likely to require long-term commitments. Land ownership could play a role in the participation decisions of agricultural producers. A large share of agricultural carbon sequestration potential is on high-tenure farms. As a group, these farms are more likely to focus on livestock production. They may also be more willing than nonlivestock farms to convert marginal cropland to grazing use. High-tenure farms are also more likely to enroll land in CRP, direct evidence of their willingness to accept payments for land use change. While it is not yet known whether or to what extent farmers will be eligible to participate in a carbon offset market, previous land-use and farming practice decisions suggest that high-tenure farm operators will account for a large part of the agricultural sector's carbon sequestration potential. If so, distribution of farmland ownership should not be a limiting factor in the sector's participation in climate change programs for the foreseeable future.

The analysis presented here is illustrative. We assumed that the price signals from a national cap-and-trade system would encourage farm operators to make marginal changes in their operations, but would not encourage nonoperator landlords to make radical changes in their rental arrangements. If carbon offset prices are high enough (relative to applicable agricultural commodity prices), landowners may choose to alter their leasing arrangements, taking land out of production or placing restrictions on the farming practices operators can adopt. In this case, the sector's carbon sequestration potential could be more broadly distributed than this analysis indicates. Additional research is needed to better quantify the role of land tenure in producer response to carbon sequestration-related incentives for land use and production practice change.

References

Hoppe, Robert A., Penni Korb, Erik J. O'Donoghue, and David E. Banker. *Structure and Finances of U.S. Farms: Family Farm Report, 2007 Edition*, EIB-24, p. 9, U.S. Department of Agriculture, Economic Research Service, June 2007.

Soule, M.J., A. Tegene, and K.D. Wiebe. "Land Tenure and the Adoption of Conservation Practices," *American Journal of Agricultural Economics* 82:993-1005, 2000.

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