SPECIAL ISSUE

July 2006

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Amber Waves

The Economics of Food, Farming, Natural Resources, and Rural America

Agriculture and the Environment

A Closer Look at Agriculture and the Environment

Long-time readers may recall that when ERS launched Amber Waves in 2003, one of our goals was to capture the full breadth of the ERS research program—the economics of food, farming, natural resources, and rural America—under a single cover. By combining accessible coverage of a broad range of issues with links to indepth analysis on the ERS website, we hoped to offer our readers the best thing since sliced bread, and we've been pleased with readers' responses to date.

This issue slices the loaf a different way. Rather than focusing broadly, we have reprinted and updated a selection of articles from our first 18 issues on a single topic: the relationship between agriculture and the Nation's land, air, water, and biological resources. Recent years have seen important changes in policy approaches to addressing the environmental impacts of agriculture, as well as in our understanding of those impacts. With farm policy again under discussion, it is timely to take stock of lessons learned from experience to date and consider emerging issues and options for the future.

Selected articles in this issue examine, among other things, the increasing policy emphasis on conservation on "working lands" (which remain in agricultural production), design options for enhancing program cost-effectiveness, characteristics of farmers who adopt conservation practices and participate in conservation programs, challenges in measuring program impacts, and the potential to address emerging environmental concerns through market-oriented solutions—within agriculture as well as between agriculture and other sectors of the economy. Such a review not only sheds light on the links between agriculture and the environment but also illustrates the opportunities and hurdles involved in balancing public goals and private choices more generally.

Any way you slice it, we hope you find this special issue both informative and enjoyable. We will return to the broader focus of our regular format in September.

Keith Wiebe
Deputy Director
Resource and Rural Economics Division

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Send questions, requests, and letters to Sheila Sankaran, Editor, *Amber Waves*, USDA/ERS, Rm. N4165, 1800 M St., NW., Washington, DC 20036-5831, or to ssankaran@ers.usda.gov.

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Amber Waves

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PhotoSpin

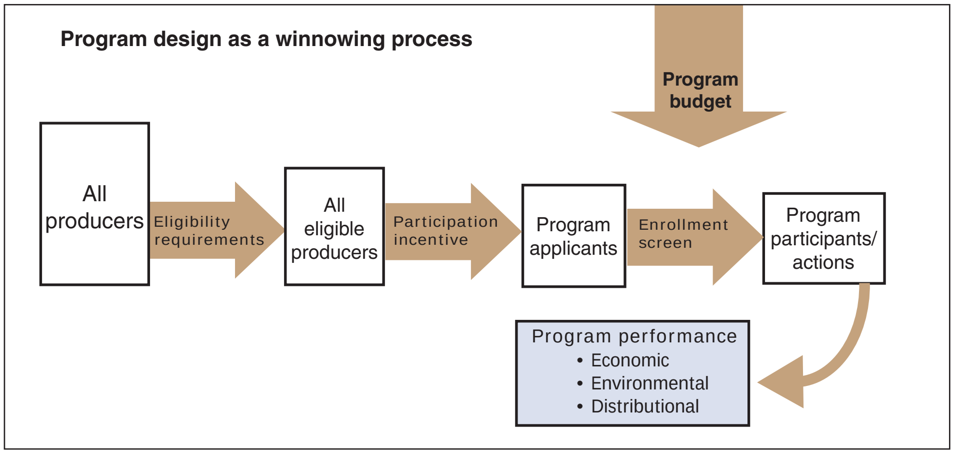
A Multitude of Design Decisions Influence Conservation Program Performance

Designing a voluntary conservation program requires several types of decision criteria to encourage farmers to apply and to determine who can participate in the program. These decisions act as a winnowing process, starting with all farmers and ranchers and resulting in a pool of program participants. *Eligibility requirements* determine which producers can apply, based on type of farm (e.g., crops versus livestock), resource concerns (e.g., erodible lands), or geographic locations. *Participation incentives* (payment levels) specify what actions (e.g., application of a conservation practice) or levels of environmental performance qualify for payments and how large the payments will be. Payment rates can be fixed or set by bidding. *Enrollment screens* determine which applicants are accepted: They range from first-come, first served to the use of a benefit-cost index to rank applications by expected performance. Once these design decisions are made, most actions by program managers to meet program objectives are locked in place.

A recent ERS report finds that conservation program design features that promote the highest level of environmental benefits per program dollar include structuring the application process for enrolling farm operators as a "request for proposals," including the benefits and costs of enrollment; establishing a bidding process for financial assistance; and using a benefit/cost ranking to select program enrollees. ERS research exploring specific aspects of program design highlights the many tradeoffs involved:

- Achieving environmental and income objectives with a single program involves tradeoffs in terms of which goal is emphasized. Conservation programs can support farm income but at a potential cost in terms of environmental gains. Commodity programs can be made "greener" but likely will not fix every agri-environmental problem or do so efficiently.
- "Targeting" conservation efforts through eligibility requirements, participation incentives, or enrollment screens can be used to focus payments on fields, practices, or specific resource concerns most likely to generate the greatest environmental benefits.
- Bidding—a process in which farmers compete in an auction for conservation payment contracts—can reveal the costs of participating and the benefits program applicants would likely supply. Feeding those bids into benefit-cost indices to enroll producers enhances the cost effectiveness of conservation programs.
- Programs that retire land award payments based on different actions than those focused on working lands, resulting in different benefits and tradeoffs. Land retirement generally provides greater environmental benefits (per contract acre) but at a higher cost than a working land program, in which land remains in production.
- Similarly, paying farmers to adopt specific conservation practices and paying for the level of environmental performance are two different approaches with distinct benefits. Paying for performance is more cost effective than paying for practices because program incentives are directly linked to the environmental indicator of interest. However, agri-environmental performance is not easily observable, so performance-based payments are difficult and costly to implement. Practice-based payments that increase with expected benefits may be a practical compromise.

Cost effectiveness, environmental performance—the level and types of environmental gains delivered by the program—and the distribution of program benefits can vary widely according to the package of decisions ultimately made about eligibility, participation incentives, and enrollment screening.



Marca Weinberg, weinberg@ers.usda.gov

Roger Claassen, claassen@ers.usda.gov

This finding is drawn from . . .

Program, Payments, and People: 5 Economic Briefs on Conservation Program Design, available at: www.ers.usda.gov/features/economicbriefs/

Originally published Vol. 1, Issue 1 (February 2003)

RURAL AMENITIES: A KEY REASON FOR FARMLAND PROTECTION

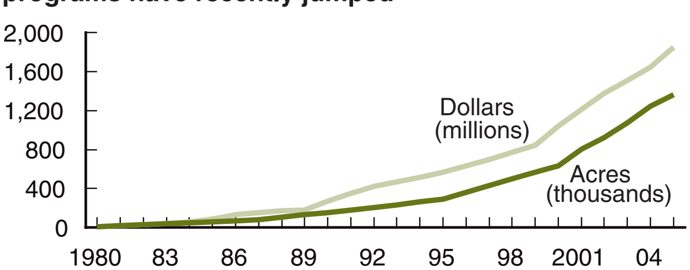
While conversions of farmland to urban uses represent less than 0.1 percent of U.S. farmland per year, local farmland losses continue to cause concern and motivate growing public support for farmland protection. The Federal Government, all 50 States, many local jurisdictions, and over 1,200 land trusts and nonprofit conservation programs seek to maintain more land in farming uses than would otherwise be the case.

Measures used to protect farmland include zoning, preferential tax assessments, agricultural districts, right-to-farm laws, and purchase of development rights (PDR) programs. Currently, 19 States and 41 local jurisdictions operate PDR programs, which pay farmers to give up rights to develop their land. To date, State PDR programs have spent over $1.8 billion to protect almost 1.4 million acres of farmland, while local PDR programs have spent $762 million to protect an additional 241,000 acres. At the Federal level, the 2002 farm bill authorized more than a tenfold increase in funding for the Federal Farm and Ranch Lands Protection Program from about $53 million spent during 1996-2001 to $597 million authorized for 2002-07. Through 2005, the Federal program had helped protect about 430,000 acres.

ERS analysts found various objectives mentioned in the authorizing legislation for State farmland protection programs, including protecting "rural amenities," local food supplies, water and air quality, and natural resource jobs, and reducing urban sprawl (36, 30, 29, 23 and 18 States, respectively). Rural amenities include open space, scenic views, rural agrarian character, and wildlife habitat that are enjoyed through viewing or recreation, depending upon the degree of access permitted. The presence of "natural amenities," such as varied topography, trees, bodies of water, and temperate climate in rural areas, may contribute to rural amenities. States and counties use several criteria to select land parcels for preservation in PDR programs. Of 13 programs examined by ERS, 10 assigned the most weight to lands with high-quality soils often used for crop farming. Nine PDR programs assigned the second-most weight to larger farms or blocks of farms, a strategy that favors clustering of farming-related amenities. Five programs favored a "least cost" strategy, which can result in a more scattered pattern of protected land, or in protection of lands distant from urban centers. These differences in strategies reflect different objectives but also highlight the difficult decisions faced by policymakers and program managers.

ERS also found that State farmland protection measures are generally tied to State-specific circumstances, such as the amount of land remaining in agriculture, types of agricultural industries, and lands in parks, forests, and other protected areas. While parks and protected lands provide many rural and open-space amenities, State legislators and the people they represent believe farmland, too, provides unique and valuable attributes worth protecting. AW

Cumulative expenditures and acreage in State PDR programs have recently jumped



PDR = Purchase of Development Rights.
Source: Analysis by USDA, Economic Research Service of data from American Farmland Trust. Data for some years are interpolated.

Cynthia J. Nickerson, cnickerson@ers.usda.gov
Daniel Hellerstein, danielh@ers.usda.gov

This finding is drawn from . . .

Farmland Protection: The Role of Public Preferences for Rural Amenities, by Daniel Hellerstein, Cynthia Nickerson, Joseph Cooper, Peter Feather, Dwight Gadsby, Daniel Mullarkey, Abebayehu Tegene, and Charles Barnard, AER-815, November 2002, USDA, Economic Research Service, available at: www.ers.usda.gov/publications/aer815/

See also the ERS Briefing Room on Land Use, Value, and Management: www.ers.usda.gov/briefing/landuse/

FEATURE

Tim McCabe, USDA/NRCS, 1999

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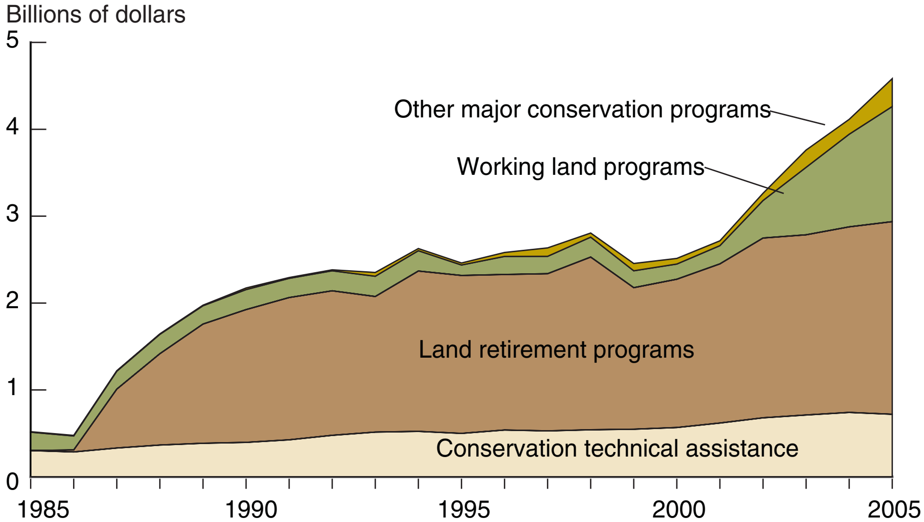
Emphasis Shifts in U.S. Conservation Policy

Roger Claassen
claassen@ers.usda.gov

Recognizing the potential negative impact that some farming practices (excess fertilization and manure, for example) can have on our Nation's natural resources, policymakers have been devoting more attention and funding to conservation policies and programs. From the mid-1980s until 2002, the bulk of USDA conservation funds went toward land retirement: paying farmers to remove environmentally sensitive land from crop production for a time period specified under contract. As of February 2006, almost 36 million acres were retired from crop production— about 10 percent of U.S. cropland.

With the passage of the 2002 Farm Security and Rural Investment Act (2002 Farm Act), Congress substantially increased conservation funding and made changes in program emphasis. The 2002 Act directed the largest share of new spending to programs emphasizing financial assistance for conservation on working lands—lands used for crop production and grazing—and livestock-related issues. Between 1986 and 2001, funding for working land programs that emphasize financial assistance accounted for about 9 percent of conservation-related financial and technical assistance to farmers, with the remainder allocated to land retirement programs (69 percent), Conservation Technical Assistance (CTA) (22 percent), and other programs (less than 1 percent). Between 2002 and 2006, however, working land programs accounted for 25 percent of funding while land retirement programs accounted for 54 percent of funding, CTA for 18 percent, and other programs for 4 percent. Meanwhile, the Conservation Reserve Program (CRP)—the largest U.S. land retirement program—has increasingly funded practices that complement or support working agricultural lands, including edge-of-field filter strips,

The 2002 Farm Act authorized substantially increased conservation funding, particularly for working lands programs



Source: Analysis by USDA, Economic Research Service of data from USDA, Office of Budget and Program Analysis.

Gary Kramer, USDA/NRCS

A farmer adjusts the water level in a restored wetland.

riparian buffers, and grassed waterways. While not prompted by the 2002 Act, this trend is part of the movement toward support for conservation on working land.

A second point of greater program emphasis in the 2002 Act is wetland restoration. While the Act modestly increased funding for land retirement, a large portion of the increase was directed to the restoration of wetlands, largely through a major expansion of the Wetland Reserve Program.

A third—more subtle but nonetheless notable—change in program emphasis is reflected in the way funds are awarded through these programs. On balance, the Act decreased the use of decisionmaking tools that increase environmental cost effectiveness (i.e., the level of benefits per dollar of program cost). Certainly, funding increases will expand the amount of land enrolled in conservation programs and the number of participating producers. What isn't so certain, however, is whether these changes will add up to more cost-effective conservation overall.

Expanding Conservation on Working Lands

By 2002, land retirement programs had already succeeded in improving environmental quality by removing much of the more fragile land from production. The remaining land available for retirement was likely to produce fewer overall environmental benefits and come at a higher cost than land already in the program. If true, conservation program funding may be better spent on land in production.

Moreover, working land program incentives could encourage conservation practices by some producers who are unlikely to retire land. Smaller operations—those with sales of less than $250,000 per year—produce roughly one-third of U.S. agricultural output. Households operating these farms often receive a large share of their income from land retirement payments and nonfarm sources, rather than from crop or livestock production. Larger farms, on the other hand, produce two-thirds of U.S. agricultural output. These farms are generally more commercially oriented, and the households that operate them depend less on income from nonfarm sources, and are less likely to participate in land retirement programs. The increased funding for conservation on working lands, and the focus of these programs on livestock-related issues, may have increased conservation participation by farmers who are not interested in land retirement.

Funding for the Environmental Quality Incentives Program (EQIP), the largest working lands program, was $3.95 billion for the 5 years 2002 through 2006, an average of almost $800 million per year. Annual funding under the 1996 Act (1996-2001) was limited to $200 million per year. Through this program, crop and livestock producers can get technical and financial assistance to plan and implement conservation practices on land in production. Since 2002, at least 60 percent of EQIP spending has been slated, by statute, for livestock-related resource concerns, up from 50 percent under the 1996 Act. Limits on the size of participating livestock operations and on maximum payment levels per operation were also loosened in the 2002 Act. In 2004, livestock-related practices accounted for 63 percent of EQIP funding.

The Conservation Security Program (CSP) was created by the 2002 Farm Act and first implemented in 2004. Overall, about $500 million was allocated for CSP for 2004-06. Unlike EQIP, CSP provides payments to eligible producers based on ongoing environmental performance or "stewardship," rather than just for newly installed or adopted practices. Before they can enroll land in CSP, producers must first address soil quality and water quality concerns. CSP stewardship payments (and "existing practice" payments) are based on local land rental rates and the extent of conservation on the entire farm, rather than on conservation costs or benefits (see box "Major USDA Conservation Programs").

CSP is similar to EQIP in the sense that it seeks to improve environmental performance on working agricultural lands. The large majority of CSP funds—about 80 percent in 2005—support environmental "enhancements." Enhancements include addressing additional resource concerns, such as air quality, or going beyond basic conservation standards (collectively referred to as "nondegradation" standards) to a higher level of conservation effort. For example, meeting a nondegradation standard on soil quality involves maintaining soil conditions while CSP soil quality enhancement payments support producer efforts to improve soil condition.

The Conservation Reserve Program, although primarily a land retirement program, also funds buffer practices associated with working land (e.g., edge-of-field filter strips, riparian buffers, and grassed waterways). At the beginning of 2006, about 20 percent of CRP funding was devoted to these practices, up from about 10 percent at the beginning of 2002. While these practices cover only 10 percent of CRP acreage, their impact is arguably larger than this percentage would suggest because buffer practice acreage is strategically located to intercept sediment, nutrients, and other pollutants before they leave the farm.

While the expansion of conservation on working lands has significant advantages, implementing it poses additional challenges. Payments for a broader range of conservation practices, available to a wider range of producers, complicate both conservation planning and the monitoring of practice implementation and maintenance. This is particularly true for some conservation management practices, such as crop nutrient management, which are less visible and thus more difficult to monitor than changes in tillage or contour cropping. Multiple conservation programs for working lands could increase the challenge in making programs work together seamlessly for producers while keeping the cost of program administration low. And producers participating in conservation programs need conservation planning services and technical assistance. To help handle the increased workload, the 2002 Act included authorization for producers to directly contract with NRCS certified third-party technical service providers (TSPs) to supplement USDA's Natural Resources Conservation Service (NRCS) field staff.

Wetlands Restoration Coming of Age

While the expansion of working lands programs was the big story in the conservation portion of the 2002 Farm Act, a greater emphasis on wetlands restoration in the modest expansion of land retirement programs is also significant. The legislation augments authority for land retirement in the CRP and the Wetlands Reserve Program (WRP) by 4 million acres, up about 11 percent. While wetlands restoration accounts for about 3 percent of current land retirement, 40 percent or more of the authorized increase may be devoted to wetlands restoration. In addition to the 1.2 million acres added to WRP, the CRP routinely enrolls farmed wetlands that are restored to wetlands condition. By the end of 2005, WRP acreage was up to 1.8 million acres, compared to roughly 1 million acres in 2002. Up to 500,000 acres of the 2.8-million-acre rise in the CRP acreage cap could be specially earmarked for restoration of currently farmed wetlands. As of March 2006, CRP included 2 million acres of wetland. The shift toward wetlands restoration is significant because of the relatively high environmental benefits per acre provided by wetlands.

De-emphasizing Cost-Effectiveness?

In addition to increasing the amount and scope of conservation funding, policymakers changed how conservation program managers decide which producers receive funds through the various programs. The 2002 Act reduced the use of traditional targeting tools: competitive bidding and environmental benefit-cost indices. Payments based on past conservation efforts—stewardship payments—may not leverage the same level of environmental gain as payments that support new practices. On the other hand, a new environmental targeting tool—performance-based payments—has been used to implement some CSP enhancements.

Competitive bidding is a process in which producers submit bids on installation of conservation practices and the proposed level of cost sharing in percentage terms (that is, the percentage of total installation or implementation cost paid by the Government). Through comparing the submitted bids, program managers can identify farms and fields where the costs of retiring land or installing conservation practices are relatively low.

The elimination of competitive bidding in EQIP may have resulted in lower environmental benefits per dollar of program spending. EQIP data show that producers have often been willing to accept cost-share rates (what the government pays) well below the pre-2002 Farm Act maximums of 75 percent of cost for structural practices, such as terrace installation, and 100 percent of a local (usually county) maximum for management practices, such as integrated pest management. Between 1996 and 2001, the overall national average cost-share rate for structural practices in EQIP was 35 percent. For management practices, payments averaged 43 percent of local maximums. For 2003-05, the average EQIP cost-shares rate for structural practices has been about 60 percent (although rates can be as high as 75 percent for high-priority practices) while management practice payment rates have been fixed at the local level, usually a county.

Lowering the maximum cost-share rates may mean that some producers who might have participated in EQIP will no longer be interested, even if they could provide environmental benefits that would justify a higher payment rate. That is, some producers who may be able to make a cost-effective contribution to environmental protection would be effectively excluded from the program. On the other hand, producers who would be willing to adopt conservation practices at a lower rate could receive payments that exceed the level necessary to induce their participation, leading to higher than necessary contract costs. In other words, the environmental benefits gained may be obtained at a higher than necessary cost.

EQIP program managers can continue to use environmental benefit-cost indices to determine which proposed contracts they will accept, although many States have altered the way cost is considered. Environmental benefit-cost indices are point systems used to rank conservation practices according to expected environmental benefits and costs. Using these rankings, program managers can identify farms and fields where conservation practices on working lands would yield relatively high environmental benefits (see box,

Major USDA Conservation Programs

Land Retirement Programs

The **Conservation Reserve Program (CRP)** offers annual payments and cost sharing to establish long-term, resource-conserving cover, usually grass or trees, on environmentally sensitive land. The 2002 Farm Act increased the acreage cap from 36.4 million acres to 39.2 million acres. Funding is through the Commodity Credit Corporation (CCC). For 2002 through 2006, total CRP funding has been $7.3 billion. As of February 2006, about 36 million acres are covered by CRP contracts.

The **Wetlands Reserve Program (WRP)** provides cost sharing and/or long-term or permanent easements for restoration of wetlands on agricultural land. The 2002 Farm Act increased the acreage cap from 1.1 million acres to 2.3 million acres. The legislation requires the Secretary of Agriculture (to the greatest extent practicable) to enroll 250,000 acres per year. Funding is through the CCC. For 2002 through 2006, total WRP funding has been $1.3 billion. As of 2005, a cumulative total of roughly 1.8 million acres were under contract through WRP.

Working Lands Conservation Programs

The **Environmental Quality Incentives Program (EQIP)** provides technical assistance and cost-sharing or incentive payments to assist livestock and crop producers with conservation and environmental improvements on working lands. EQIP funding has been $3.95 billion for the 5 years 2002 through 2006. Additional CCC funding of $300 million has been available for ground and surface water conservation. EQIP's focus on livestock increased in 2002, with 60 percent of funding slated for livestock-related issues, up from 50 percent in the 1996 Farm Act. Moreover, much of this funding could be used to cost share nutrient management on large, concentrated animal feeding operations (CAFOs) that will be required to comply with new Clean Water Act regulation of manure handling and disposal.

Previous limits on the size of participating livestock operations, which excluded operations with more than 1,000 animal units, were eliminated in the 2002 Farm Act. Payment limits previously set at $50,000 total per operation were raised to $450,000 per operation over the 6-year life of the 2002 Farm Act.

The **Wildlife Habitat Incentives Program (WHIP)** provides cost sharing to landowners and producers to develop and improve wildlife habitat. For 2002-06, WHIP received $171 million, an average of $35 million per year, compared with just over $62 million during the 1996 Farm Act, 1996-2001, an average of about $9 million per year.

The **Conservation Security Program (CSP)** focuses on good stewardship, but also provides incentives for improving conservation performance. Producers become eligible for one of three CSP "tiers" only after treating nationally significant resource concerns—soil quality and water quality – on at least a part of their farm. To qualify for tier I, soil and water quality concerns must be addressed on at least part of the farm. Producers who have addressed soil and water quality concerns throughout their farm are eligible for tier II. Tier III participants must have treated all resource concerns present on their farm—not just soil quality and water quality.

"Tools for Cost-Effective Conservation"). At this time, some state-level EQIP program managers use environmental benefit-cost indices to determine which proposed contracts they will accept, others make cost effectiveness part of the ranking score, and some States no longer use costs in the ranking process. NRCS is currently field testing a web-based EQIP ranking tool—that includes cost effectiveness as one of the ranking criteria—in all States and will require its use for ranking all EQIP applications effective October 1, 2006.

Performance-based payments are just what they sound like—payments that vary with the level of environmental performance achieved. Performance-based payments direct the largest participation incentives to those producers who can achieve environmental improvement at a low cost. Producer payments for some CSP enhancements are established using performance indices. For example, payments for soil quality and water quality enhancements depend on the condition of the soil and the potential for water quality improvement, respectively. Those producers who can take actions necessary to achieve high index scores at a relatively low cost have the greatest incentive to undertake soil and water quality enhancements.

Finally, stewardship and existing practice payments are unlikely to produce a significant level of new environmental gain because they do not directly fund new practices. By reducing the overall level of environmental gain leveraged per dollar of expenditure, these payments may reduce the cost effectiveness of environmental gains. Nonetheless, these payments do offer some opportunity for environmental gain. Producers who receive stewardship and existing practice payments may be more likely to maintain existing practices, particularly those producers who installed practices without government assistance (practices that are not subject to ongoing maintenance requirements). These payments could also encourage other producers to seek assistance for basic conservation treatment through other programs (e.g., EQIP), particularly for soil quality and water quality, in the hope of qualifying for CSP at some

CSP offers several types of payments. "Stewardship" and "existing practice" payments are based, roughly, on a percentage of the county average rental rate for the specific type of land involved. In some situations, new practices can be cost-shared through "new practice" payments. Payments for environmental "enhancements" accounted for about 80 percent of CSP payments in 2005. For the 2005 CSP signup, two enhancements were available: producers may (1) address local resource concerns (e.g., resource concerns other than the nationally significant concerns of soil quality and water quality) and (2) adopt practices or engage in activities that improve or enhance resource quality beyond the minimum (nondegradation) standard. In a number of cases, enhancement payments are based not on cost but on environmental performance as measured by indices like the soil condition index. Payments are to be based on the *improvement* in index values, ensuring that payments reflect a measure of potential environmental gains.

CSP was first implemented in 2004. For 2004-06, total CSP funding is $502 million. While CSP is available nationally, it is being offered only in selected watersheds for any given signup. For 2004-05, CSP was available in 220 watersheds. Producers in 60 watersheds are eligible in 2006 (different from the 2004-05 watersheds). Part of the USDA Natural Resources Conservation Service (NRCS) strategy is to make every watershed eligible for CSP enrollment once over the next 8 years. In limiting (signup-specific) eligibility by watershed, NRCS is focusing first on those watersheds where producers, on whole, have demonstrated a high level of stewardship.

Other Conservation Programs

Through **Conservation Technical Assistance (CTA),** USDA provides ongoing technical assistance to agricultural producers who seek to improve the environmental performance of their farms. CTA funding was about $3.5 billion for 2002-06.

The **Farm and Ranch Lands Protection Program (FRPP)** provides funds to State, tribal, or local governments and private organizations to help purchase development rights and keep productive farmland in agricultural use. For 2002-06 FRPP funding totaled $426 million. In contrast, its predecessor, Farmland Protection Program, received just over $50 million total during 1996-2001.

The **Grassland Reserve Program (GRP)** is designed to improve and conserve native-grass grazing lands through long-term rental agreements (10, 15, 20, or 30 years) and 30-year or permanent easements. While normal haying and grazing activities are allowed under GRP, producers and landowners are required to (1) restore and maintain appropriate grasses, forbs, and shrubs; (2) address all relevant resource concerns (e.g., soil erosion); and (3) refrain from converting the land for crop production, development, or other uses. For rental agreements, annual rental payments equal (up to) 75 percent of grazing value. Permanent easements are to be purchased at fair-market value, less grazing value, while 30-year easements are to be purchased at 30 percent of the value of a permanent easement. Cost sharing is provided for up to 75-90 percent of the restoration and maintenance costs, depending on the type of grassland. GRP enrollment is limited to 2 million acres of grassland. Funding of up to $254 million is authorized over the 6-year life of the 2002 Farm Act. During FY 2003-06, $236 million in financial assistance has been made available to producers through GRP.

Tools for Cost-Efffective Conservation

Competitive bidding—A process in which producers submit bids on the conservation practices they are willing to adopt (or the type of cover they are willing to establish on retired land) and the level of payment they would be willing to take in exchange for taking these actions. Bids are selected for program participation based on potential for environmental gain and the level of payment requested by the producer. Thus, producers can improve bids by offering to install more environmentally beneficial (but more expensive) practices or by reducing the level of payment they are willing to accept.

Environmental indices—A point system used to rank the proposed application of conservation practices according to expected environmental benefits. Points may be awarded for the use of particularly effective practices, the environmental sensitivity of the land where practices are to be applied, or proximity to particular resources, such as lakes or streams. The use of an environmental benefit-cost index in the CRP (land retirement program) has resulted in increased public benefits of the program, according to ERS research. By using these tools to identify land for retirement, public benefits from water-based recreation, pheasant hunting, and wildlife viewing have increased by at least $370 million per year, while program acreage and costs have remained virtually unchanged.

Performance-based payments—Payments that vary with the level of environmental gain attributed to the action that triggered the payment. For example, payments could be commensurate with water quality gains attributed to the use of practices that reduce nutrient and sediment loss to water. To maximize environmental gain performance-based payments, the payment per unit of environmental change (e.g., ton of soil erosion reduction) would have to equal the value of the environmental gain attributed to the last unit of change (e.g., the water quality gain attributed to the last or marginal ton of soil erosion reduction). Because these values are rarely known, however, environmental indices may be used as proxies.

Jeff Vanuga, USDA/NRCS

A USDA conservationist discusses cultivation practices with a farmer.

future date. Finally, in the absence of payments for good stewardship, there is some concern that producers may be reluctant to adopt conservation practices on their own. If stewardship payments encourage some producers to install conservation practices where they would have otherwise hesitated to do so, environmental gain would be realized.

Opposing Directions?

The net effect of the seemingly opposing directions of the increased emphasis on working land conservation and reduced emphasis on cost effectiveness is difficult to discern. The emphasis on working lands, wetlands, and performance-based payments pushes toward increasing the overall cost effectiveness of conservation policy in producing environmental benefits. On the other hand, moving away from competitive bidding and toward stewardship payments may pull in the opposite direction by decreasing the environmental gains per program dollar.

This article is drawn from . . .

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Conservation Compliance May Reduce Soil Erosion

Between 1982 and 1997, the annual rate of soil erosion on U.S. cropland declined from 3.1 billion tons to 1.9 billion tons—a reduction of 1.2 billion tons per year, or about 40 percent. Of the 1.2-billion-ton drop in annual cropland soil erosion, 732 million tons occurred on highly erodible cropland (HEL). During the same period, USDA phased in a requirement designed to reduce erosion on HEL. Conservation compliance requires farmers who crop HEL to apply an approved soil conservation system or risk losing most agriculture-related Federal payments, including farm income support. Though these reductions coincide with the 10-year phase-in of conservation compliance, not all of the erosion reduction can be attributed to program requirements.

By breaking down the 732 million tons of erosion reduction into components, ERS researchers identified the portion that could be attributed to conservation compliance. First, about 365 million tons—roughly 50 percent—of erosion reduction on HEL cropland occurred on land that was cropped in 1982 but not in 1997. Because conservation systems were designed to maintain the viability of crop production, erosion reduction due to land use change was not likely to stem from conservation compliance. Excluding these erosion reductions leaves 367 million tons.

Second, conservation compliance requires farmers to eliminate only "excess" soil erosion—erosion deemed to be damaging to soil productivity. Typically, excluding the 36 million tons of nonexcess erosion (reduction to levels less than 5 tons/acre/year) leaves 331 million tons.

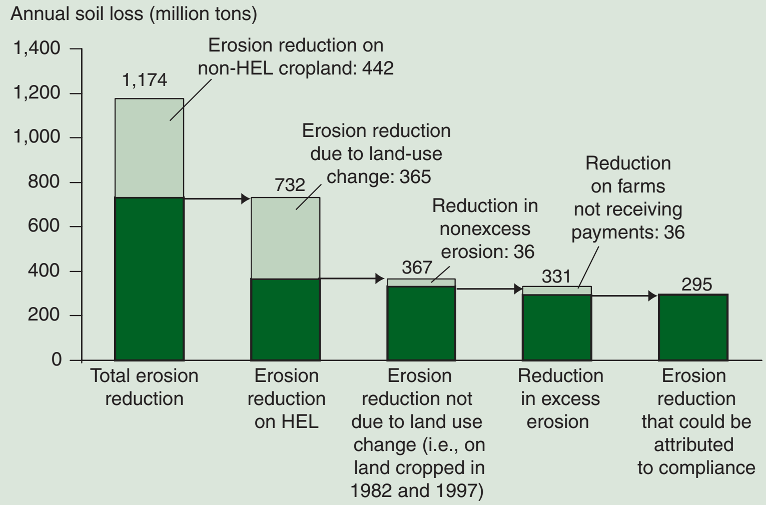
Finally, erosion reduction can be attributed to compliance only if it occurred on a farm that receives farm program payments. Thirty-six million tons are estimated to have occurred on farms not receiving payments. The remaining 295 million tons of erosion reduction—25 percent of the total—are estimated to have occurred in the context of the conservation compliance requirement.

It is not certain whether these erosion reductions can be attributed to conservation compliance. Soil erosion was also reduced on non-HEL, which is not subject to conservation compliance. Erosion reductions could also be attributed, at least in part, to the development of less erosive farming systems. For example, the development of machinery that allows planting crops directly into minimally tilled or untilled fields can reduce both costs and soil erosion. However, even if these farming systems would have eventually been adopted by many farmers, conservation compliance may have prompted faster and broader adoption. W

Roger Claassen, claassen@ers.usda.gov

Tim McCabe, USDA/NRCS

Erosion reduction during 1982-1997 has many components



Source: Analysis by USDA, Economic Research Service of 1997 National Resources Inventory and 1997 Agricultural Resource Management Survey data.

This finding is drawn from . . .

Environmental Compliance in U.S. Agricultural Policy: Past Performance and Future Potential, by Roger Claassen, Vince Breneman, Shawn Bucholtz, Andrea Cattaneo, Robert Johansson, and Mitch Morehart, AER-832, USDA, Economic Research Service, May 2004, available at: www.ers.usda.gov/publications/aer832/

Originally published Vol. 4, Issue 2 (April 2006)

U.S. Organic Farm Sector Continues To Expand

Most segments of the U.S. organic farm sector have expanded since USDA set uniform organic standards in 2000. About 50 organic certification programs—State and private—are currently accredited by USDA to certify U.S. farmers, ranchers, and processors, about the same as before USDA made certification mandatory. USDA's organic rules also streamlined organic import procedures, and over 40 foreign programs are now accredited to U.S. standards.

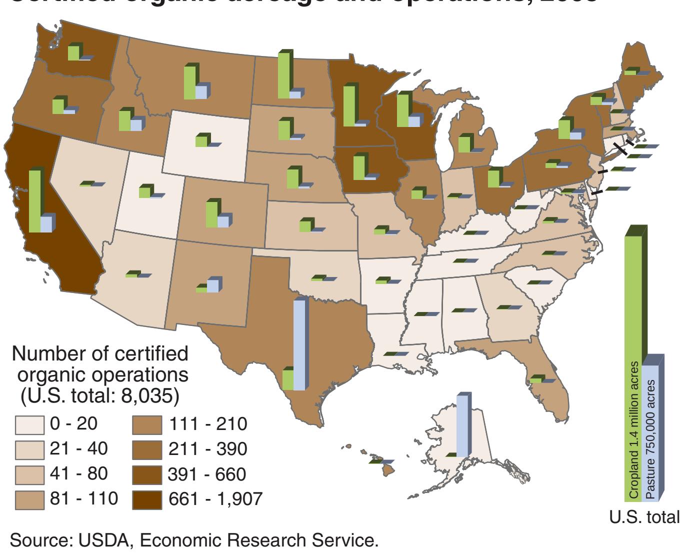
Certified organic crop acreage increased 11 percent between 2001 and 2003, with large increases for fruits and vegetables and for hay crops used in dairy. Overall, certified organic acreage declined slightly in 2002 from the previous year, as USDA implemented national organic rules, but rebounded in 2003. Farmers in 49 States dedicated 2.2 million acres of cropland and pasture to organic production systems in 2003. Nearly 1.5 million acres were used for growing crops. California, North Dakota, Minnesota, Montana, Wisconsin, Colorado, and Iowa had the most organic cropland, and Texas, Alaska, and California had the largest amount of organic pasture and rangeland. Certified organic cropland accounted for 0.1 percent of U.S. pasture and 0.4 percent of U.S. cropland, although the share is much higher in some crops, such as vegetables at nearly 4 percent and fruit at about 2 percent.

The number of certified organic livestock animals—beef cows, milk cows, hogs, pigs, sheep, and lambs—increased more than fivefold from 1997 to 2003, and rose 15 percent between 2002 and 2003 alone. Dairy has been one of the fastest growing segments of the organic foods industry. Milk cows accounted for over half of the certified livestock animals during 1997-2003, and organic milk cows accounted for 1 and 2 percent of the total in California and Wisconsin, the two top dairy States for both organic and conventional production in 2003.

Organic cotton and soybeans acreage declined after 2001, despite growth in retail sales of organic cotton and soy-based products. Import competition likely played a role in this. USDA's Foreign Agricultural Service estimates that the value of U.S. organic imports was $1.0- $1.5 billion in 2002, while the value of U.S. organic exports was $125- $250 million. Although consumer spending on organic foods is still small—approximately 2 percent of at-home food sales in 2003—rapid growth is expected to continue in the U.S. and other major markets, while the competition for these markets is likely to increase considerably.

Organic pasture and rangeland also declined (6 percent) between 2001 and 2003, mostly for rangeland in the West. As USDA implemented uniform organic standards—including stringent standards for livestock—some organic ranchers switched to the natural meat market exclusively. Although natural meat products may be produced under private standards that go beyond USDA's guidelines, natural meat producers are not prohibited from using antibiotics in production and are not required to use certified organic feed grains or pasture or provide cows with access to pasture. W

Certified organic acreage and operations, 2003

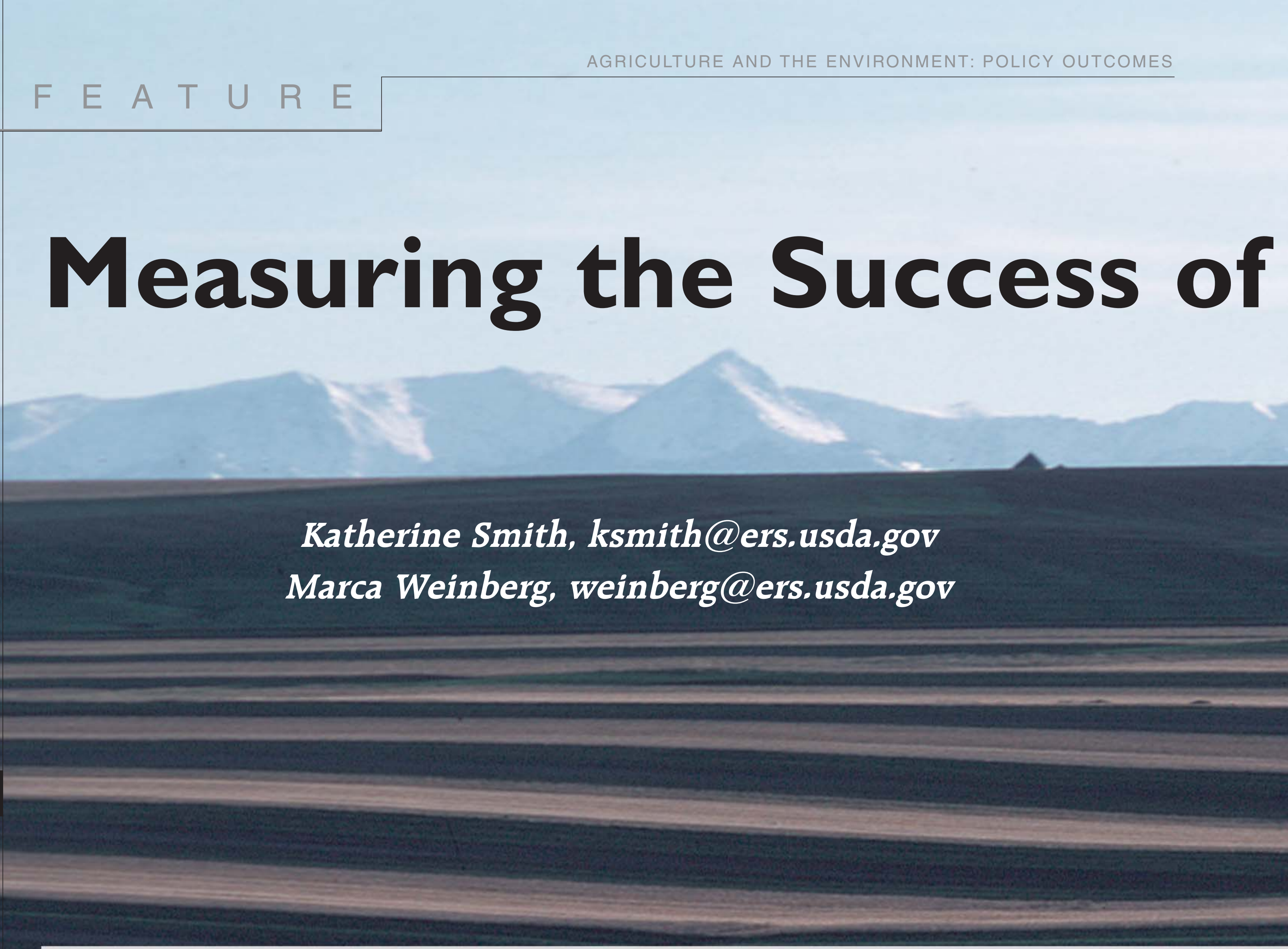


Source: USDA, Economic Research Service.

Catherine Greene, cgreene@ers.usda.gov

For more information . . .

See ERS Data on U.S. Organic Agriculture, 1992-2003, www.ers.usda.gov/data/organic/



Measuring the Success of

Katherine Smith, ksmith@ers.usda.gov
Marca Weinberg, weinberg@ers.usda.gov

Defining and measuring success is easy—if you are Rube Goldberg. A widely acclaimed 20th century cartoonist, Goldberg depicted outlandish inventions that accomplished simple tasks through an intricate series of linked steps, each one triggering another until a desired outcome was reached. Success, in Goldberg's world, was clearly defined and could be attributed directly to the completion of several sequential, though highly improbable, cause-and-effect actions. Success, in the real world, even when it is clearly defined, is not so easily measured. Gauging the success of government programs, in particular, can be downright complicated, even when the principles used in designing them are rather simple.

Most conservation programs, for example, are designed to improve the environment by offering incentive payments to farmers, who are thereby induced to change their farming practices. Those changes in farmers' practices—be they reducing pesticide use, adopting conservation tillage, or constructing a riparian buffer—should then lead to enhanced environmental quality. But, unlike the chain of events in a Goldberg invention, the actions involved in a conservation program take place not in isolation, but, rather, within a larger set of complex interactions, making it difficult to link programs to actions to outcomes.

The first step in measuring the success of agricultural conservation programs—and other programs designed to address agri-environmental issues—is linking a change in farmers' stewardship behavior to the program being evaluated. Because many other factors (including other government programs) influence farmers' choices, it is critical to determine the extent to which it was a given conservation program incentive that stimulated some farmers to do something that they would not otherwise have done. A second step requires assessment of how the portion of

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Conservation Programs

observed stewardship behavior that can be linked back to conservation program incentives then affects environmental quality—given that other factors also affect the environment.

Gauging Farm Operators' Responses to Program Incentives

Farm operators are the target of conservation program incentives, even though the program itself aims to target one or more environmental enhancements. Thus, to evaluate the program, one must determine exactly how program incentives induced operators of farms of various types, sizes, or features to "sign up" as program participants. Then, for those who become program participants, it is important to find out how the type and extent of conservation practices they adopted relate to the levels of incentives provided through the program. Only by separating the influence of program incentives from other factors that affect farmers' conservation choices can the program evaluator be confident that it was the program being evaluated that had an effect, not other circumstances.

A farmer may adopt conservation practices for a myriad of reasons. He or she may be an ardent environmental steward who would implement a particular practice (like maintaining grassed buffers between cropland and water sources) regardless of program incentives. Alternatively, a farmer may adopt an environmentally friendly practice wholly or partly in order to increase profits. ERS research on conservation tillage, for example, demonstrates that good stewardship can also be good business. Policy incentives aren't usually required to induce a farmer to adopt what he or she views as good business practice; market forces should do the trick in this regard.

In evaluating the effectiveness of incentives to induce farmers to participate in conservation programs, it is important to note that conservation programs are not implemented in a policy

Ron Nichols, UDSA/NRCS

vacuum. Both the costs and benefits of participating in a given program will vary as a direct result of the confluence with other government programs. For example, commodity programs influence some crop prices, making it more or less economically advantageous to manage the crops in ways that enhance environmental quality. Input use is sometimes controlled through quantity restrictions and use regulations. Input prices may also be influenced by policies—including labor laws, pesticide regulation, and subsidization of irrigation water—that influence relative input prices and, thus, the financial costs or benefits of conservation practices that shift input use patterns. Finally, technological change, economy-wide variables (such as interest rates and unemployment rates), and farm household constraints (such as the role of off-farm work in farm household income) are also likely to influence farmers' decisions about farming practices—whether or not a conservation program incentive is added to the mix.

Because farmers may adopt conservation practices for reasons unrelated to the conservation program, *simply identifying changes in farmers' practices (let alone environmental quality) is an insufficient basis for judging the success of a conservation program.* One has to be able to determine what proportion of farmers' practices can be attributed to a particular program before the success of the program can be assessed.

Isolating the effects of program incentives from the effects of other factors potentially influencing farmers' observed conservation practices demands a lot of data of particular sorts. A necessary requirement is the collection of data that enable statistically reliable comparisions of farming practices by farmers before and after program implementation, or by farmers who did and did not participate in the program in a given year or years. Statistical analysis of such data can support or refute a correlation between farm practices and conservation program provisions.

However, supporting or refuting simple correlation is not sufficient because that correlation may be spurious and because it does not prove causality. A "before-and-after" comparison, for example, might miss the strong influence of a new program on participants' behavior if other factors, such as unusual weather conditions, prevented a large number of the participants from following through on their program-induced good intentions. Similarly, a "with and without" comparison could falsely attribute observed conservation practices to the conservation program if all farmer participants in the program were pre-inclined toward voluntary environmental stewardship even without the program, and nonparticipants were disinclined. More information is needed than simply who participated and what practices they employed if a strong case is to be made that the program was the stimulus for farmers' adoption of observed practices.

Additional data are necessary to separate the effect of a conservation program incentive from the effects of concurrent changes in market prices, weather, other policies, and technology. Identifying the farmers for whom program incentives induced adoption of conservation practices requires data on the characteristics—types and locations—of both participating and nonparticipating farmers, the circumstances under which they made a participation decision, the amount of the incentive to which they did or did not respond, and regional and other variables.

A close look at outcomes associated with the Conservation Compliance provision of the 1985 Food Security Act reveals the importance of isolating the effects of the program in order to measure its success. The provision requires agricultural producers to implement soil conservation systems on highly erodible (HEL) cropland to remain eligible for farm program pay-

Lynn Betts, UDSA/NRCS

Lynn Betts, UDSA/NRCS

Without protective measures in place, water and wind can lead to soil losses, which can harm farm fields and, through runoff, neighboring water bodies.

ments. Annual soil erosion on U.S. cropland declined by 40 percent between 1982 and 1997, suggesting that compliance mechanisms encouraged greater conservation effort. However, erosion also declined on cropland not subject to compliance requirements, demonstrating that other factors must also have played a role in reducing soil erosion. On farms for which conservation practices could have increased net returns to farming, for example, adoption may have eventually occurred regardless of effects on soil erosion. In fact, after accounting for other factors, such as erodibility, commodity program payments, and land use changes, ERS research shows that only about 25 percent of overall erosion reduction between 1982 and 1997 could be directly attributed to Conservation Compliance. Even on the HEL lands targeted by the provision, about 11 percent of erosion reduction during that period was due to factors other than Conservation Compliance.

Linking Farmers' Choices to Environmental Quality

Measuring changes in farmers' practices that result directly from conservation program changes tells only part of the story. Conservation programs are not designed simply to induce a change in conservation practices, but to change those practices in order to improve water quality, air quality, wildlife habitat, or a host of other environmental attributes. More and more frequently, conservation programs aim to improve all of those environmental attributes at once.

Connecting the dots that link a program's incentives to success in achieving that program's environmental goal(s) is difficult in general, but can be especially challenging when evaluating conservation programs. Most of these programs address "nonpoint" sources of pollution, such as the nutrients, sediments, pesticides, and salts that enter water diffusely in runoff. In comparison to "point" sources, such as factories and municipal plants, which discharge through a pipe, ditch, or smokestack on which a meter can be installed, nonpoint sources are not so easily measurable and have an environmental effect only in the aggregate.

For example, the goal of a particular conservation program might be to address water quality problems caused by agricultural production. Evaluating a program based on that objective would require data on the entire set of actions and outcomes associated with agricultural production. Farmers control their inputs and crop production practices. Their management decisions, including which crop is produced on which field and with what combination of inputs, *can* affect water quality, but gauging whether or not and how much they actually *do* affect water quality is a difficult task. Farmers' decisions may lead to field-level emissions (through runoff or leaching) of potential pollutants, such as sediments, nutrients, and chemicals, which are difficult to monitor. Depending on the location of the field and other physical and environmental factors, an emission may or may not find its way to the target water body.

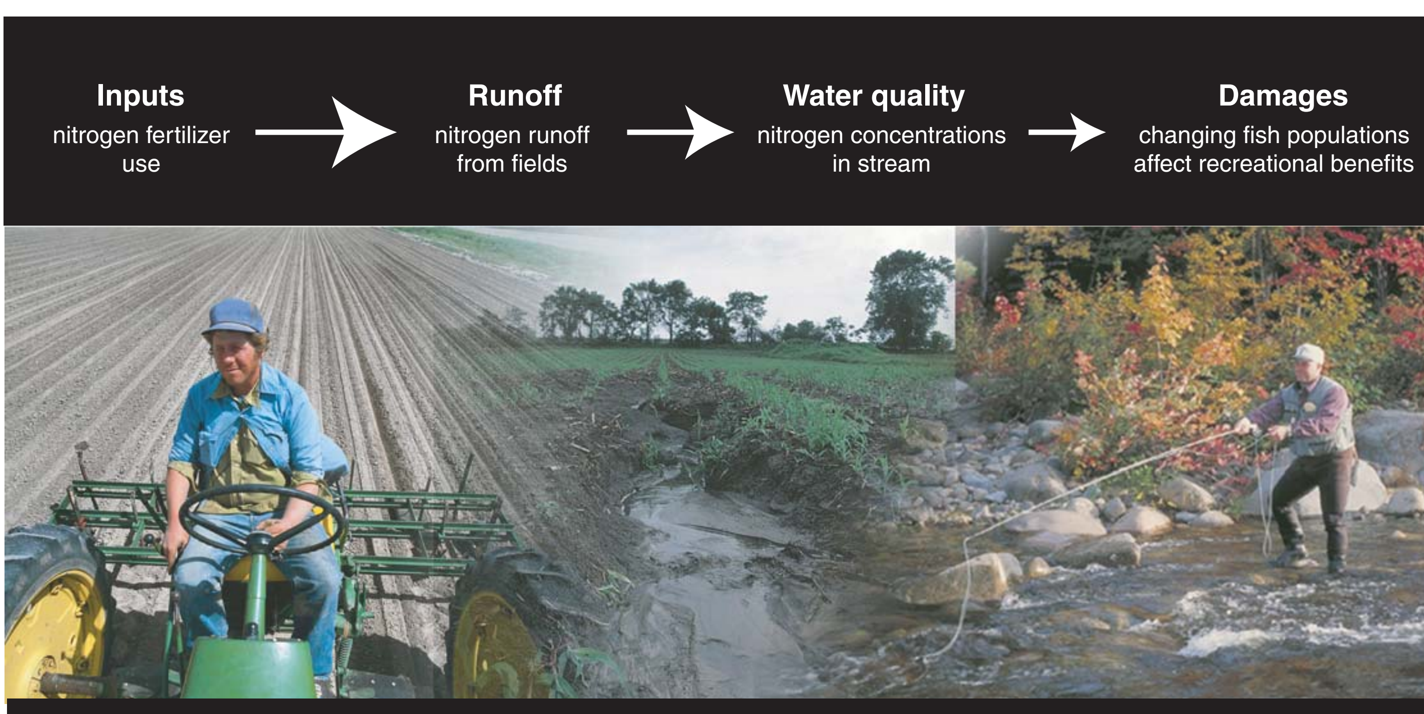
But even that sequence of events is only part of the story. The last piece involves the underlying objective: What is it about water quality that concerns us? Is the goal to reduce nutrient concentrations in drinking water? Is it to provide improved fish habitat, perhaps to increase recreational fishing benefits? Once a (potential) pollutant reaches an environmental sink, such as a river or aquifer, it may or may not have ecological or human health implications, depending upon its toxicity, the number of other sources emitting the same pollutant, interactions with other pollutants, and the total emissions simultaneously reaching the environmental sink. While scientists know much about the relationship between nitrogen runoff and tillage practices, and the effects of nitrogen levels on biological functions, less is known about how nitrogen is transported from a myriad of individual fields to specific water bodies or other sinks.

In evaluating the effects of a conservation program on environmental quality, the nonpoint source issue is compounded by the exceptional site specificity of many agri-environmental events. Soil losses (or other pollutants) at one location may have a different effect on the environment than an identical level and type of soil loss in another location. Furthermore, similar levels of environmental effects vary in value among locations depending upon the proximity of human populations or economic activity to the site of the damage. For example, if a program objective is to help restore a recreational fishery, water quality improvements that increase fish populations closer to cities and where interest in fishing is particularly high will be higher valued than equivalent changes in fish populations in regions of the country that are sparsely populated or where interest in fishing is low. Estimating monetary-equivalent values for environmental improvement is a particularly difficult task that, while not necessary for judging whether or not a conservation program met its goals, is essential to determining how efficiently those goals were met.

Models Simulate What We Cannot Observe

Environmental process models can help overcome the nonpoint source and site specificity complications of conservation program evaluation by substituting predictions from models for direct observa-

Farmers' management practices affect ambient environmental quality. . .



Corbis | Lynn Betts, UDSA/NRCS | Ken Hammond, USDA tions of effects. For example, site-specific changes in (in-field) soil erosion due to particular erosion control practices can be estimated using the Universal Soil Loss Equation and the Wind Erosion Equation. Both models provide reasonably accurate results and require only minimal data (a total of six variables) describing climate, topography, soil, and cropping information at the field level. In contrast, models of nutrient and pesticide runoff are far more complex, simulating multiple environmental effects from the transport and fate of multiple pollutants into environmental sinks. These "fate and transport" models require a lot of data, often necessitating the use of dozens of variables.

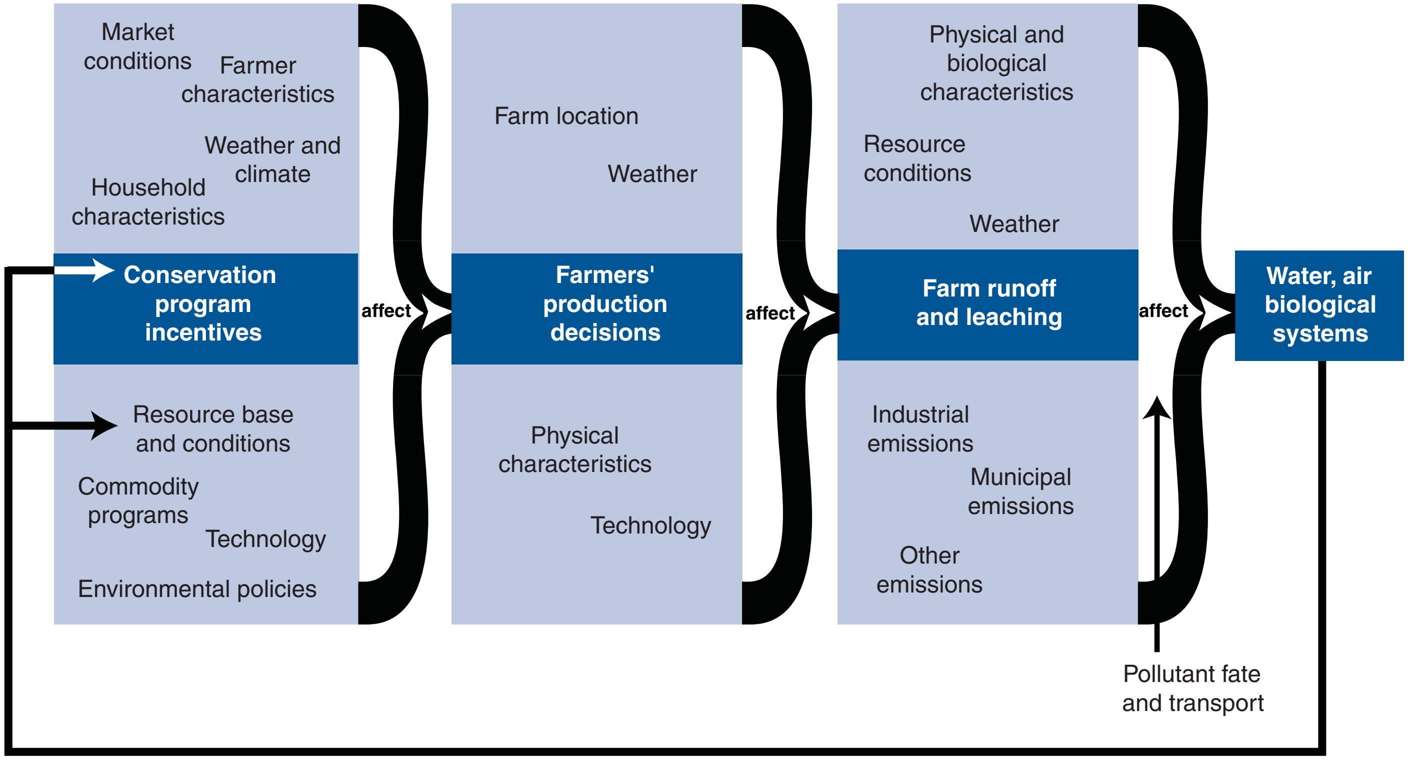
Any one process model has unique advantages and disadvantages, depending on the indicator of interest, but relatively few are capable of simulating the environmental effects of changes in agricultural practices on a national scale. (See box, "Some Agri-Environmental Process Models.")

A final complication: Model results are unlikely to match real world observations because farming practices aren't the only things that affect environmental quality. Floods or drought can damage the environment even under the very best management practices. A given level of runoff may cause no environmental damage in a wet year but may significantly harm fish and wildlife in a dry year when streams have insufficient flows to dilute the runoff to nonharmful levels. Likewise, a single watershed may well experience pollutant discharges not only from agriculture, but also from industrial sources, municipal water treatment plants, urban runoff, aerial deposition, and even natural seepage. Thus, the influence of unmodeled events needs to be extracted to reconcile simulation results with measurements made on the ground.

Identifying Appropriate Environmental Indicators

Just what *is* the best indicator by which to measure environmental quality change in the policy evaluation context? Regardless of whether it will be measured directly or simulated with an agri-environmental process model, the indicator(s) by which a given program will be evaluated must be carefully selected. Reflecting broadened public concerns, conservation programs increasingly target multiple environmental quality goals. Along with reductions in soil erosion, potentially measurable goals have expanded to include improved water quality and conservation of wetlands and wildlife habitat. Newer program objectives may include preserving open space, managing nutrients from fertilizers and livestock waste,

. . .but numerous other factors also affect environmental quality through a multistep process.



Some Agri-Environmental Process Models

A myriad of agri-environmental process models exist, ranging from simple linear calculations suitable for a handheld calculator to extraordinarily complex computer programs requiring high-powered machines and extensive training to operate, and from those calibrated to a single watershed to models developed to provide national-scale estimates. Three process models with acceptance among a wide range of analysts include one that is particularly comprehensive and predicts emissions at "edge of field" and two that attempt to link practices to water quality.

- USDA's Erosion-Productivity Impact Calculator (EPIC)—a mechanistic simulation model used to examine long-term effects of various components of soil erosion on crop production. The model has several components: soil erosion, economic variables, hydrologic conditions, weather, nutrient composition, plant growth dynamics, and crop management (www.brc.tamus.edu/epic/).
- USDA's Soil & Water Assessment Tool (SWAT)—a river basin scale model developed to predict the water quality impact of land management practices in large, complex watersheds. Required input data include weather, soils, crops, pesticides and nutrients (www.brc.tamus.edu/swat/index.html).
- U.S. Geological Survey's SPAtially Referenced Regressions On Watershed Attributes (SPARROW)—a statistical model that relates in-stream water-quality measurements to spatially referenced characteristics of watersheds, including contaminant sources (such as farm fields) and factors influencing terrestrial and stream transport (http://water.usgs.gov/nawqa/sparrow/).

reducing pesticide runoff, improving air quality, reducing greenhouse gas emissions, or sequestering carbon in soil.

The appropriate indicator for evaluating a program's success must map to an aspect of environmental quality that the program aims to address. But that's not enough. It must also link directly to those changes in conservation practices induced by the program. For example, a measure of ambient downstream water quality, such as nitrogen concentration, may appear to be an ideal indicator of the success of a conservation program that aims to improve water quality. But if agriculture is only a small part of the aggregate water quality problem, ambient water quality may be getting worse, even with a wildly successful conservation program in place. The ambient water quality indicator may not measure the factor of interest, which, in this example, is *agriculture's* contribution to water quality, and thus is not a good choice for evaluating this agri-environmentally oriented program. In this case, a less direct measure of water quality, such as pounds of nitrogen discharged into the water body from farm fields, may actually be a better indicator.

Appropriate indicators are:

- Policy relevant—provide a direct link to both the environmental attributes of concern *and* the behavioral changes associated with the evaluated program incentives;
- Measurable—based on sound science and make use of data that are available or could feasibly be collected;
- Reasonably priced—cost-effective in terms of data collection, processing, and dissemination; and,
- Easy to interpret—communicate essential information to policymakers and other stakeholders.

Putting It All Together

The voluntary nature of most U.S. conservation programs, the human factors involved in farmers' decisions to participate (and to what extent), the complexity of farm household decisionmaking, and the nonpoint source and site-specific nature of agri-environmental problems combine to make evaluation of conservation programs a data-intensive and technically challenging process. To be successful, program evaluations must answer both of the following questions explicitly, through estimated, simulated, or directly measured means.

1. How do different farm operators in different circumstances decide what production and conservation practices to implement, in the presence and absence of the conservation program being evaluated, at different levels of incentives provided by that program?

Isolating the unique effect of conservation program incentives on farmers' practices requires analysis to extract the influence of other (policy, household, general economic, etc.) factors that affect farm-level decisionmaking. This, in turn, requires evaluators to collect data on the full set of factors potentially affecting farmers' decisions, in sufficient volume and across diverse farm and land types and locations, to allow statistical segregation of program-related effects from those of other influential factors.

2. How do the farm practices attributable to conservation program incentives affect environmental quality?

Isolating the unique effect of farm practices on environmental quality requires program evaluators to determine where, and under what resource conditions, practices implemented in response to the program are located, and to designate appropriate agri-environmental indicators for measuring program success. Process models that

Charlie Rahm, UDSA/NRCS

Soil losses can be reduced through several means, including grassed waterways and conservation tillage.

Lynn Betts, UDSA/NRCS

simulate the complexities involved in the transport of agricultural runoff from multiple fields to environmental sinks may help link environmental performance with farm practices. But even then, additional analysis is required to reconcile model predictions with real world observations.

The complicated series of cause-and-effect relationships associated with conservation program evaluation seem beyond even the imagination of Rube Goldberg. Many factors must be accounted for to determine the portion of environmental enhancements directly attributable to program incentive-induced changes in farmers' practices. Still, carefully designed survey and monitoring programs encompassing each of those relationships in a coordinated fashion make such evaluation not only feasible, but well within reach. AW

This article is drawn from . . .

Economics of Water Quality Protection from Nonpoint Sources: Theory and Practice, by Marc O. Ribaudo, Richard D. Horan, and Mark E. Smith, AER-782, USDA/Economic Research Service, December 1999, available at: www.ers.usda.gov/publications/aer782/

"Beyond Environmental Compliance: Stewardship as Good Business," by Jeffrey Hopkins and Robert Johansson, *Amber Waves*, USDA/Economic Research Service, April 2004, available at: www.ers.usda.gov/amberwaves/april04/features/beyondenvironmental.htm

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FEATURE

Originally published Vol. 4, Issue 3 (June 2006)

Land Retirement and Working-land Conservation Structures

A Look at Farmers' Choices

Dayton Lambert, dlambert@ers.usda.gov
Patrick Sullivan, sullivan@ers.usda.gov

- Roughly 37 percent of farm operators had retired cropland from production or had working-land conservation structures in place in 2001. Of these, 36 percent received conservation payments.
- Operators of smaller retirement and lifestyle farms are more likely to retire farmland.
- Operators of larger farms are more likely to adopt conservation measures that are compatible with farm production.

Operators of all types and sizes of farms have adopted conservation-compatible farming practices and installed conservation structures. Many farmers do so for sound business reasons—to protect the productive capacity of their farmland, to reduce seed, fertilizer, and other input costs, or to save time and labor. However, the costs of conservation practices that primarily create off-site benefits to society—in the form of cleaner air, improved water quality, and a healthier ecosystem—often pose significant barriers to their adoption by farm operators. To encourage these efforts, USDA provides technical and financial support to farm and ranch operators through a diverse set of conservation programs that either retire environmentally fragile land from production or encourage the adoption of conservation-

Creatas

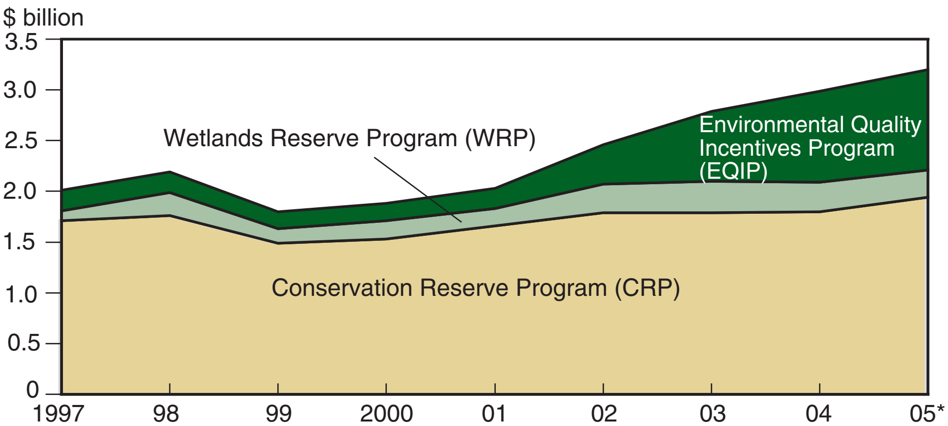
friendly farming practices. Recent ERS research suggests that farms and farm households that install working-land conservation structures (such as contour strips or grass waterways) often differ from those that retire farmland. Therefore, as working-land program budgets increase, the mix of farms participating in USDA's conservation programs may change.

The effectiveness of a conservation program depends on the choices farm operators make because adoption of conservation practices is voluntary. But, despite the importance of farmers in determining environmental outcomes, relatively little is known about those who adopt conservation practices and participate in USDA's conservation programs, and why they do so. A recent study by ERS found that household characteristics and operator attributes such as age, gender, educational attainment, household size, and dependence on off-farm income affect the types of conservation efforts farm operators are likely to engage in, as well as the types of conservation programs they are likely to find appealing (see box, "An Array of Conservation Programs Is Available to Farmers"). For example, older farm operators and those focused on a nonfarm occupation are less likely to install working-land conservation structures than younger farm operators whose primary occupation is farming. As a result, programs supporting a wide array of alternative conservation practices are most likely to match the interests of a wide range of farmers.

Different Conservation Structures Are Used by Different Types of Farms

Farm practices that are potentially compatible with USDA's conservation goals fall into three broad categories: (1) adopting farm management practices, such as conservation tillage; (2) installing working-land structures, such as grass waterways; and (3) retiring land from agricultural production. While a high percentage of farms have adopted one or more conservation-compatible farm management practices (see the February 2006 issue of *Amber Waves*), the focus here is on working-land structures and land retirement. These two types of practices account for most of the conservation payments that farmers receive and their adoption is likely to depend more on conservation program subsidies than the adoption of new farm management practices.

Working-land conservation program budgets have been expanding recently, but land retirement programs still account for most conservation spending



*Estimated
Source: ERS analysis of USDA's Office of Budget and Program Analysis data.

USDA's 2001 Agricultural Resource Management Survey (ARMS) provides data on characteristics of farm businesses and households that have installed a select group of conservation practices, with or without the financial support of conservation programs. About 37 percent of farm operators had retired whole farmland fields from production; dedicated farmland to wildlife habitat; or installed grass waterways, filter strips, and riparian buffers (trees planted along stream banks) as of 2001. Each of these vegetative structures can reduce unwanted environmental impacts of cultivation and, when farm operators install them on environmentally

An Array of Conservation Programs Is Available to Farmers

Efforts to mitigate unwanted environmental side effects of agricultural practices are not new. For more than a century, the Federal Government has managed programs to curtail soil erosion caused by farming. Earlier conservation efforts focused on the onsite benefits of reducing soil erosion. But in recent decades, USDA has broadened its emphasis to include water and air quality improvement and wildlife habitat protection. The following programs support these goals by reimbursing farmers and farmland owners for eligible conservation practices.

- The ***Conservation Reserve Program* (CRP)** was authorized by the Food Security Act of 1985 to retire environmentally sensitive land from agricultural production for 10-15 years. In return for an annual rental payment and partial reimbursement for the cost of establishing and maintaining approved groundcover, program participants agree to take enrolled land out of production and plant grasses, trees, and other conservation-cover crops. Since 1996, farmers have also been allowed to enroll land through a continuous signup program focused on developing riparian buffers and other working-land conservation structures. On roughly 35 million acres of enrolled cropland in 2004, farmers and landowners received $1.8 billion in cost-share and rental payments from the CRP.
- The ***Wetlands Reserve Program* (WRP)** was first implemented in the early 1990s to retire and restore wetlands that had been converted to cropland. The Farm Security and Rural Investment Act of 2002 (the 2002 Act) authorized enrolling slightly over 2 million acres in WRP.
- The ***Conservation Reserve Enhancement Program* (CREP)** was initiated in 1997. This Federal-State partnership targets farmland for retirement in specific geographic areas to achieve local conservation goals. Nearly 600,000 acres have been enrolled in CREP, which is administered through the Conservation Reserve Program.
- The ***Environmental Quality Incentives Program* (EQIP)** provides financial and technical assistance to help participants adopt conservation practices on eligible agricultural land. EQIP is a working-land program that shares with farmers the costs of installing approved structural practices (grassed waterways, riparian buffers, etc.) or of implementing conservation management practices (integrated pest management, fertilizer management, etc.). Funding for EQIP increased substantially under the 2002 Act, from roughly $200 million annually in the early part of the decade to $1.3 billion in 2007. By statute, at least 60 percent of EQIP funds go to livestock producers, including large confined-livestock operations.
- The ***Conservation Security Program* (CSP)** was authorized in the 2002 Act to support continuing conservation practices on working lands. In 2004, the first year of the program, 2,200 farmers received $35 million for conservation practices on roughly 2 million acres of working land.

Other conservation programs administered by the Federal Government include the Farm and Ranch Lands Protection Program, the Conservation Technical Assistance Program, the Grassland Reserve Program, the Wildlife Habitat Incentives Program, and Agricultural Management Assistance.

sensitive land, they can be eligible for support from USDA's Conservation Reserve Program. The installation of grass waterways, contours, and riparian buffers also qualifies farmers for Environmental Quality Incentives Program support because these structures offer larger environmental benefits when integrated into the activities of farms producing crops and/or livestock for sale.

Significant differences across farm types are evident in both adoption of conservation practices and participation in conservation programs. Of the farms that had one or more conservation structures in place in 2001, over half had planted whole fields to conservation cover (grasses, legumes, etc.), while another third had installed working-land structures, such as riparian buffers. Operators of retirement and lifestyle farms, which are generally smaller and whose operators are less engaged in farming as an occupation, are more likely to adopt land retirement practices than operators who report farming as a primary occupation. In contrast, larger farms are more likely to install working-land structures than smaller farms. Households operating farms with higher sales rely more on income from farming, and their operations are large enough that investments in land improvements pay off. In addition, farms retiring land from production are more likely to participate in a conservation program than farms installing working-land conservation structures.

What motivates decisions to retire farmland or to install working-land conservation structures? Certainly, environmental factors (such as the erodibility of farmland) and financial considerations (such as profitability, or costs associated with changing a practice) play major roles. But other factors are also likely to influence farm operator decisions.

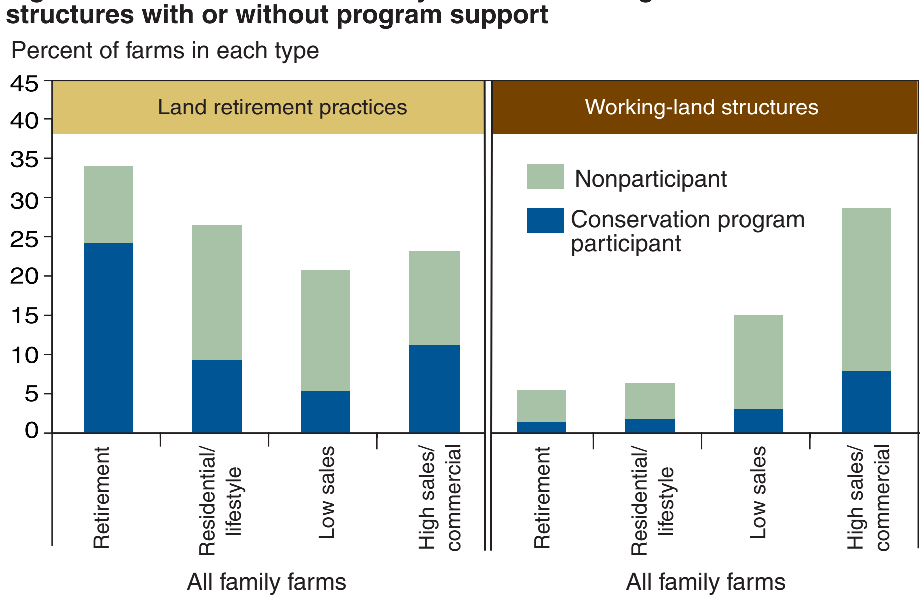
Using economic modeling techniques, ERS measured the associations between individual farm, operator, and household attributes and the adoption of conservation practices, holding other factors, such as environmental conditions, constant. Farms that had retired whole fields from production had a significantly higher share of retired farm operators, a higher level of conservation program payments, and a smaller share of production from high-value crops (vegetables, fruits, and nursery products) than farms that had not retired land and had not installed conservation structures. Differences abound between farms that retired whole fields and those that installed grass waterways, filter strips, and other structures compatible with working land. Farms that installed working-land conservation structures were generally larger grain farms that received lower conservation payments. These farms had operators who were more likely to consider farming their primary occupation, slightly younger, and less reliant on off-farm income than farm operators who retired whole fields from production.

While conservation program participants are reimbursed for some of the costs of installing one or more conservation practices on their farmland, many farm operators not enrolled in a conservation program and, thus, not receiving payments, have retired land or installed conservation structures for other reasons. On the other hand, while eligibility rules determine whether a farm operator can participate in a conservation program, the operator's business and personal goals determine whether or not eligible land is enrolled.

Who Participates in Conservation Programs?

Among all farms that had retired land from production or had working-land con-

Retirement and residential farmers are more likely to retire land, while high-sales farmers are more likely to install working-land conservation structures with or without program support



Notes: The bottom portion of each bar represents farms that have conservation structures in place and that currently receive conservation funding. Farm types are: Retirement farms (small family farms—those with sales less than $250,000/year—whose operator is retired); Residential-lifestyle farms (small family farms whose operator reports a nonfarm business as primary occupation); Low-sales farms (family farms whose operators report farming as primary occupation, with sales less than $100,000/year); High-sales farms (family farms whose operators report farming as primary occupation, with farm sales between $100,000 and $250,000/year, and all family farms with sales exceeding $250,000). Nonfamily farms are excluded.
Source: Prepared by USDA, Economic Research Service using data from USDA's 2001 Agricultural Resource Management Survey, Costs and Returns Report.

servation structures in place in 2001, roughly 36 percent received conservation payments. In general, of the farms that have adopted these conservation practices, smaller operations participate in conservation programs at a higher rate than larger operations. Program choice, however, varies by farm size, with small farms participating more heavily in land retirement programs and larger farms participating more heavily in working-land programs (see box, "Larger Farms More Likely To Use Conservation Structures Than Smaller Farms").

A different pattern emerges, however, for farms that continue producing a farm commodity while receiving conservation payments versus those that cease production. About half of farms participating in conservation programs do not produce farm commodities—these are overwhelmingly small farms that have chosen to rent their farm assets to the government, through conservation program enrollments, and to other farm operators rather than continue producing commodities themselves. Among farms producing crops and/or livestock for sale, high-sales operations participate in both land-retirement and working-land programs at higher rates than other farms.

Not surprisingly, farms participating in conservation programs but no longer growing crops or raising livestock tend to own a large portion of their land, their operators tend to be older, and the farm households tend to have fewer children and receive a higher percentage of income from nonfarm sources than other farms.

Among farmers still producing crops and/or livestock for sale, program participants tend to rent more of the land they operate, farm more cropland, have more children in the household, and rely less on off-farm income than nonparticipating farmers. In general, among participants who continue to focus on farm produc-

Larger Farms More Likely To Use Conservation Structures Than Smaller Farms

Larger farms are often perceived to behave differently than smaller farms, and agricultural pollution is sometimes viewed as a "big-farm" problem. While this study has not analyzed either the level or the source of environmental problems from the agricultural sector, the observed patterns of participation in conservation efforts raise doubts about the general validity of this notion.

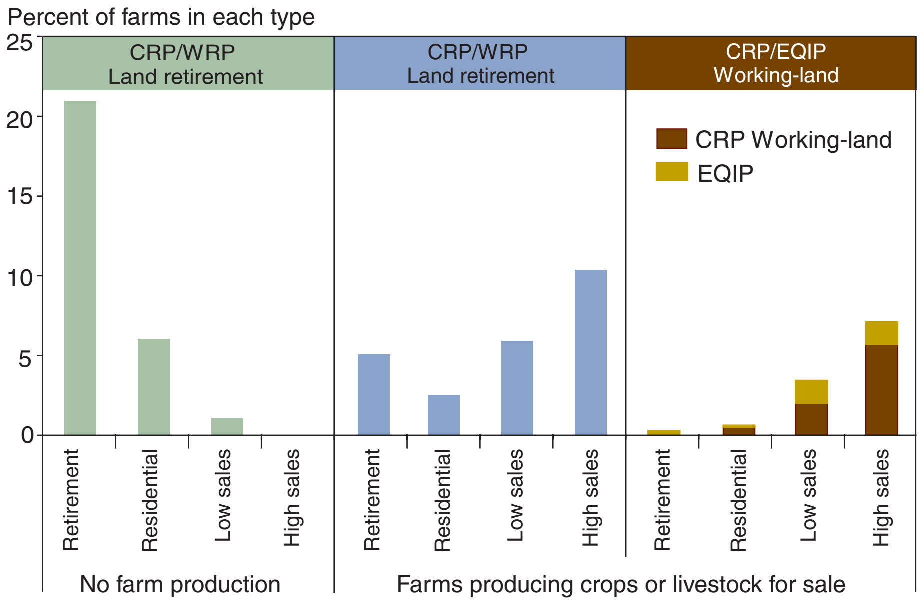
Conservation practices adopted by farmers and ranchers often vary by size of farm, but both large and small farms have adopted conservation-compatible practices and participate in USDA's conservation programs. Working-land conservation practices appeal more to farms focused on agricultural production. These tend to be larger operations producing most of the Nation's farm commodities. Alternatively, farm households with resources more focused on off-farm activities find land retirement more appealing. These operations tend to be smaller, lower production farms that control roughly 25 percent of the Nation's farmland.

Simply examining the proportions of large and small farms that have adopted conservation practices ignores the fact that large farms generally control more land and thus are more likely to encompass environmentally sensitive parcels of land in need of special treatment. To adjust for this, ERS researchers tied the rate of increase in conservation program participation to farm size.

Looking only at farm operations that produce crops or livestock, a 1-percent increase in farm size (as measured by acres of cropland operated) is associated with more than a 1-percent increase in the *probability* of participating in CRP to retire land. The decision to install conservation structures on CRP land is largely unaffected by farm size. But, once a farm operator decides to participate, a 1-percent increase in farm size is associated with more than a 1-percent increase in the *amount of land* enrolled. The evidence suggests that as farms grow in size, they are likely to install more conservation structures or plant more native grasses, legumes, or trees under the provision of the CRP, even after adjusting for the amount of land they control.

Lynn Betts, USDA/NRCS

Among farms that continue producing crops or livestock for sale, occupational farmers participate in conservation programs at a higher rate



Notes: Land retirement participants refer to farms that retire land from production or that install wildlife habitat structures. Working-land participants had installed one or more vegetative working-land structures, such as grassed waterways, contours, and riparian buffers. These data are based on type of program payment rather than on specific conservation practices and so differ slightly from the previous chart.
Source: Prepared by USDA, Economic Research Service using data from USDA's 2001 Agricultural Resource Management Survey, Cost and Returns Report.

tion, few major differences are apparent between those who retire land and those who have installed structures. Working-land program participants are more likely than land-retirement program participants to depend on revenue from high-value crops and to rent relatively more of the land they operate, both of which make land retirement less attractive. They also receive relatively more commodity program payments than working farms that retire land from production.

Participation Depends on a Variety of Factors

While environmental considerations are associated with the decision to participate in conservation programs, farm size, farm operator goals, and farm household characteristics also play a role. But not all conservation programs appeal to all farm operators who decide to participate. Over half of the participants in land retirement programs take land out of production while curtailing their farming activity, perhaps to retire or to take advantage of off-farm activities. These participants have little incentive to participate in working-land programs. But land retirement need not signal retrenchment from agriculture. In many instances, farm operators focused on agricultural production enroll farmland in a land retirement program as a farm management strategy, perhaps to diversify their income.

Working-land programs seem to appeal especially to those who report farming as their primary occupation and can invest time and managerial oversight to incorporate new farming practices and conservation structures into their operations. And, as these farms grow in size, they may equip more of their farmland with working-land conservation structures. Thus, the importance of conservation programs in influencing conservation practice decisions varies by the type of program, practice, farm cost structure, operator skill, and household goals. This suggests that conservation programs offering a wide array of practice alternatives are most likely to match farmers' interests and enable USDA to meet program goals cost effectively. W

This article is drawn from . . .

Conservation-Compatible Practices and Programs: Who Participates? by Dayton Lambert, Patrick Sullivan, Roger Claassen, and Linda Foreman, ERR-14, USDA, Economic Research Service, February 2006, available at: www.ers.usda.gov/publications/err14/

You may also be interested in . . .

"Use of Conservation-Compatible Farm Practices Varies by Farm Type," by Dayton Lambert and Patrick Sullivan, *Amber Waves*, Vol. 4, Issue 1, February 2006, available at: www.ers.usda.gov/amberwaves/february06/findings/findings_re2.htm

Manure Nutrients Relative to the Capacity of Cropland Pastureland to Assimilate Nutrients: Spatial and Temporal Trends for the United States, by Robert L. Kellogg, Charles H. Lander, David C. Moffitt, and Noel Gollehon, NPS00-0579, USDA, Natural Resources Conservation Service and Economic Research Service, December 2000, available at: www.nrcs.usda.gov/technical/land/pubs/manntr.html

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Farmland Retirement's Impact on Rural Growth

Patrick Sullivan
sullivan@ers.usda.gov

David McGranahan
dmcg@ers.usda.gov

Daniel Hellerstein
danielh@ers.usda.gov

Stephen Vogel
svogel@ers.usda.gov

Partial-farm CRP enrollments can provide a stable source of income to farm operators in addition to the environmental benefits they provide.

Conventional wisdom holds that efforts to protect natural resources and the environment affect resource-related jobs, and consequently the economies of nearby communities. Recent ERS analysis of the impact of the Nation's largest farmland retirement program—the Conservation Reserve Program—on rural economic growth suggests otherwise.

The Conservation Reserve Program (CRP) aims to reduce soil erosion, improve air and water quality, enhance wildlife habitat, preserve the productive capacity of the Nation's farmland, and support farm income by taking land out of production for 10-15 years and putting it into conservation uses. Landowners and farm operators have voluntarily enrolled over 35 million acres of highly erodible and environmentally sensitive farmland in the program. In return for planting qualifying land to grasses, trees, and other protective vegetative cover, enrollees receive an annual rental payment, are reimbursed for roughly half the cost of establishing approved ground cover, and may be eligible for other incentive and maintenance payments. The program provides a stable source of income to participants and produces a wide range of environmental benefits. But by retiring farmland, it also reduces local demand for farm inputs, marketing services, and labor. To limit the local economic impact of taking land out of production, no more than 25 percent of a county's cropland can normally be enrolled in the CRP without formal approval to exceed this cap. Nonetheless, the program is often blamed for the loss of farm-related jobs and the depopulation of nearby communities that provide agricultural and retail services.

The conservation benefits attributable to the CRP do not appear to come at the expense of a permanent slowdown of local job growth or to systematically threaten the survival of rural counties.

ERS analyses of CRP enrollment patterns and employment/population trends indicate that high levels of CRP enrollment tend to reduce local job growth by a small but statistically significant amount in the years immediately following cropland retirement. Farm and farm-related employment is likely to decline as farmland is taken out of production. Over time, however, local economies adjust to changing business opportunities, and employment trends return to levels typical of similar areas with little or no CRP enrollment. In addition, nonfarm output and employment may increase due to CRP's impact on farm household income and the CRP-enhanced recreational opportunities created. Contrary to popular belief, no statistically significant evidence was found that CRP results in a systematic loss of population, even among counties with high enrollments. Thus, the conservation benefits attributable to the CRP do not appear to come at the expense of a permanent slowdown of local job growth or to systematically threaten the survival of rural counties.

Farm and Nonfarm Responses to CRP Largely Offset in Short Term

Past studies have predicted the employment impact of enrolling cropland in the CRP. They generally conclude that CRP enrollment reduces farm and nonfarm employment, particularly in areas where enrollment is high. ERS recently estimated the economywide impact of allowing all CRP contracts to expire, freeing enrolled acreage to return to production. Consistent with previous research, allowing CRP land to return to production would increase farm employment, but the impact on nonfarm jobs varies considerably by region and depends on underlying assumptions.

Based on market conditions in 2000, only about half of the land enrolled in CRP would be expected to return to crop production in the short term if CRP contracts expired. The remainder would likely go into pasture or be left undisturbed. Holding prices constant, roughly $3 billion in additional farm commodities could be produced on CRP land coming back into production. (However, the resulting increase in crop production could lower affected farm commodity prices slightly, resulting in a net decline in farm income nationwide.) Of course, the environmental benefits attributed to CRP would likely decline as land reenters production. For example, as wildlife habitat degrades and water quality deteriorates, outdoor recreational expenditures in rural America could decline by as much as $300 million annually.

As these CRP-induced changes in production and spending work their way through the economy, nonfarm jobs would be created or lost. Land brought back into production would increase local demand for farm-related goods and services (farm inputs, labor, marketing and transportation services, etc.), leading to job growth in these industries. But reduced outdoor recreational spending could lead to job losses in other industries. And as income is redistributed from farm households to other sectors of the economy, shifting demand for consumer goods and services could lead to other job changes as well. Each of these changes affects production, income, and consumption.

Nationally, the economic effects of allowing CRP land to return to production are expected to be very small (less than one-tenth of 1 percent), with positive and negative effects within particular industries and regions largely canceling each other out. But the effects could be noticeable in areas of the country where CRP enrollment is high. By focusing on possible output, employment, and income effects in three regions having significant CRP enrollments, the regional implica-

Nationally, the economic effects of allowing CRP land to return to production are expected to be very small (less than one-tenth of 1 percent), with positive and negative effects within particular industries and regions largely canceling each other out.

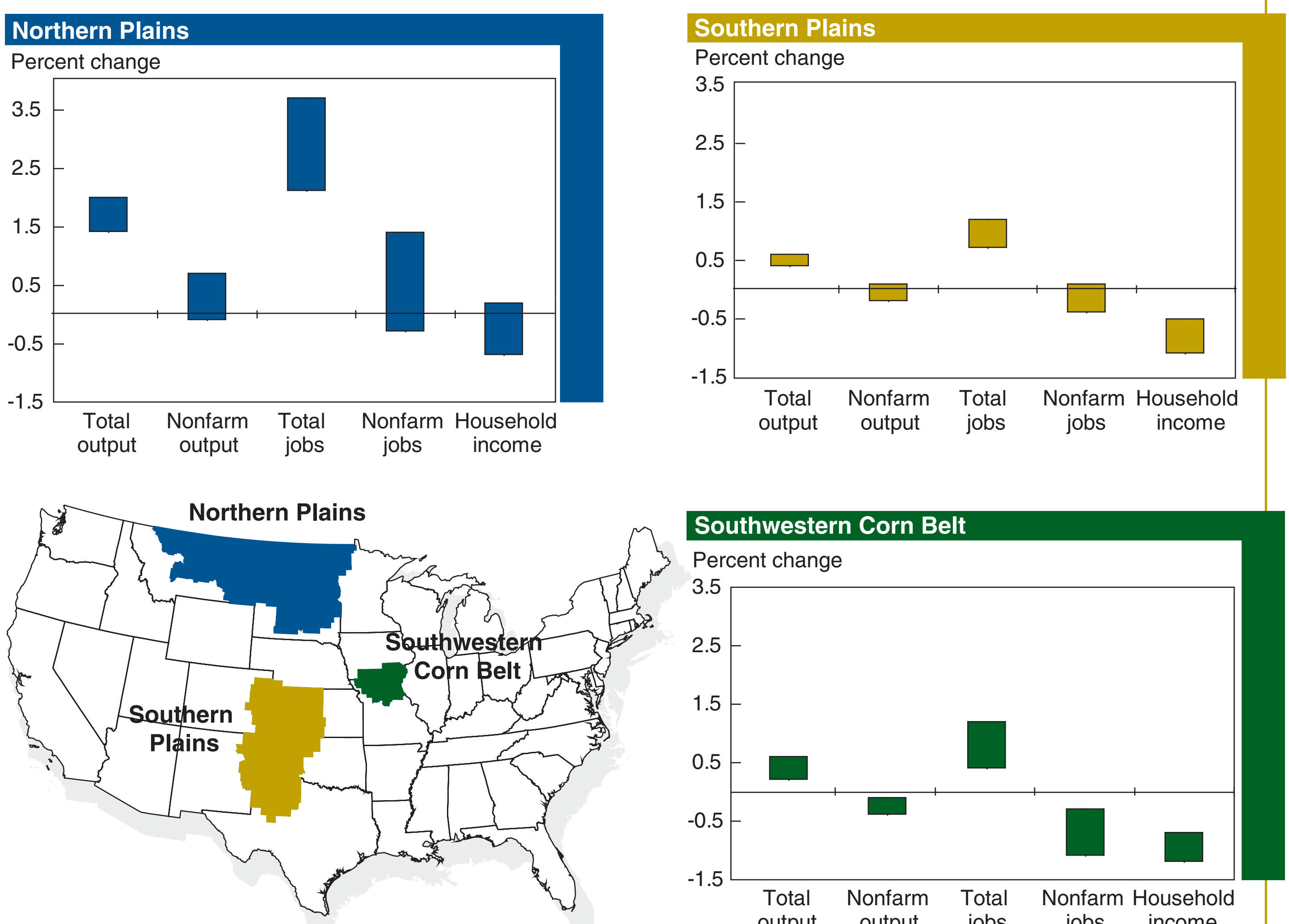
Farmland retirement has a direct impact on demand for farm inputs and marketing services.

Howard Buffett, Grant Heilman Photography tions of allowing all CRP contracts to expire become clearer.

ERS researchers assessed the implications of allowing CRP contracts to expire using two sets of assumptions. In the traditional approach, CRP enrollment is assumed to have no influence on outdoor recreational expenditures or farm commodity prices. A newer approach developed by ERS allows CRP enrollments to influence recreational spending and commodity prices, both of which tend to counter CRP's impact on farm output and employment with opposite changes in nonfarm output and employment. As a result, the upper bound of the predicted impacts from allowing CRP land back into production (based on traditional assumptions) is often positive while the lower bound (reflecting recreational and price effects) is often negative.

The Northern Plains and the Southern Plains regions, as defined here, each have slightly more than 8 million acres of cropland enrolled in CRP, while enrollment in the southwestern Corn Belt is less than 2 million acres. Despite similar CRP acreage, the expected outcomes of eliminating CRP contracts in the Northern and Southern Plains are very different. The Northern Plains is more geographically isolated, has a lower population density, and is more dependent on agriculture than the other two regions. As a result, the output, employment, and household income responses to allowing CRP land to

Economic impacts of CRP's modeled expiration vary by region and economic sector



The bars represent the range of estimated percentage changes in aggregate measures of economic activity that could have followed CRP's expiration in 2000. The upper bound of each estimate reflects constant commodity prices and recreational expenditures while the lower bound accounts for changes in these prices and expenditures.

return to production in the Northern Plains are estimated to be roughly three times greater (in terms of percentage change under both sets of assumptions) than in the Southern Plains. Part of these differences is due to the larger dollar size of the economy in the Southern Plains. However, when impacts are measured in absolute rather than percentage changes, the responses in the Northern Plains are still twice the size of the those in the Southern Plains. This suggests that CRP's impact on local economies is sensitive to local conditions.

In addition, there are likely to be winners and losers within local economies. While aggregate output and jobs are estimated to increase at least slightly in all three regions if CRP contracts expired under both sets of assumptions, this outcome is largely due to gains in the farm sector. However, if commodity prices and recreational expenditures are allowed to adjust, nonfarm output and employment are estimated to decline if CRP contracts expired, as would aggregate household income.

CRP's Job Impacts Fade With Time

Previous results imply that farm and farm-related employment and output are lower than they would be in CRP's absence. But CRP's impact on the nonfarm economies of the three multistate regions analyzed appears small (never over 1.5 percent) and may be positive or negative, depending upon assumptions about recreational spending and commodity prices.

Another approach to estimating CRP's local economic impacts is to examine what actually happened before and after CRP was implemented in 1986. Doing so illustrates how local businesses and entrepreneurs reacted to changing economic opportunities as land entered the CRP.

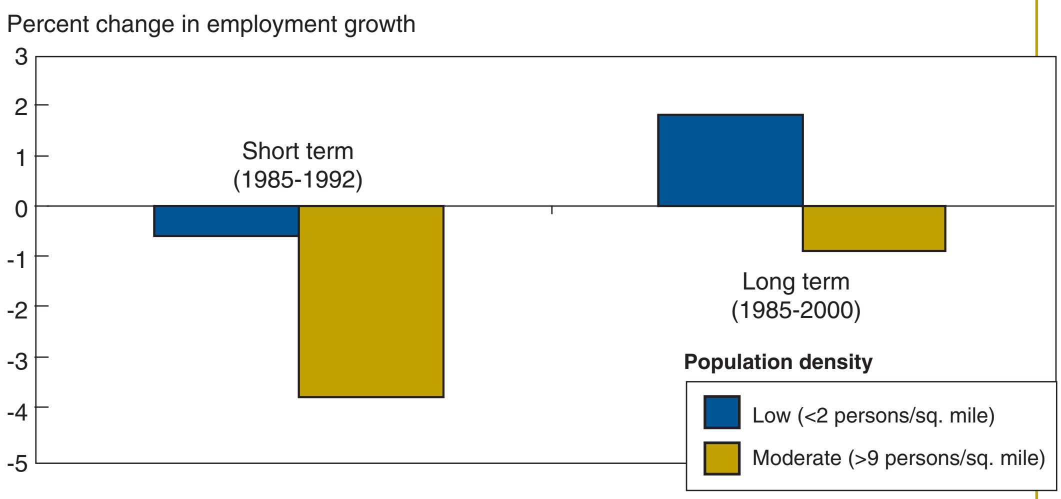
To assess the local impact of high CRP enrollment, roughly 200 rural counties with over 20 percent of cropland enrolled in the CRP or where the ratio of CRP rental payments to total county household income exceeded 2.75 percent were identified. These "high-CRP" counties were then matched with counties that had little CRP enrollment but had similar pre-CRP socioeconomic conditions. By charting the economic course of high- and matching low-CRP counties following CRP's implementation, any systematic effect of high CRP enrollment should become clear.

The results generally confirm previous analyses. In the years immediately after land was enrolled in the CRP, job growth in high-CRP counties was significantly lower than in comparable low-CRP counties. However, job growth is indistinguishable over the longer term (1985-2000). Either entrepreneurs were able to adapt to the changing opportunities that CRP offered (such as improved recreational opportunities) with time or CRP merely sped up economic adjustments that other rural communities experienced more gradually. In either case, CRP's impact on local trends in job growth was not permanent.

One might expect land retirement programs to affect communities that serve as regional agricultural business service centers more than other communities. Population density was used as a proxy for whether a county is likely to include one or more agricultural service centers. For low-density counties (fewer than two persons per square mile), CRP made little difference in job growth over the short term and may have had a positive impact over the longer term (perhaps by keeping farmer participants in place who might otherwise have moved elsewhere as the farm sector continued its consolidation). For counties with slightly higher population densities (over nine persons per square mile), the pattern was very different. In the short term, high-CRP enrollment led to a nearly 4-percent decline in job growth. But over time, this discrepancy dissipated.

Together, the forward-looking economic impact simulations of CRP contract expirations and the

CRP's impact on job losses is temporary and varies with population density, based on matched-pair analysis



Note: Bars represent predicted changes in employment due to an increase in the ratio of CRP payments to income. Predictions are determined by computing estimates with no difference in CRP payments between high- and low-CRP counties, recomputing estimates with high-CRP counties having a ratio of CRP rental payments to household income set to 4 percent, and subtracting the second from the first estimates.

By improving wildlife habitat, CRP can increase outdoor recreational opportunities such as hunting, fishing, and wildlife viewing.

backward-looking comparison of pre- and post-CRP economic trends suggest that, as farmland is taken out of production, job growth in high-CRP areas could initially suffer. However, these impacts appear to be temporary, and they vary widely depending on local economic conditions. In lightly populated areas, high CRP enrollment could support local job growth over the long term by helping program participants stay on their farms. In other areas, CRP's impact on farm-related industries is severe enough to significantly slow total job growth or speed its decline over the short term. But even in these areas, job growth rebounds over the long term as growth in other industries replaces jobs lost by farm-related firms.

CRP Does Not Accelerate Population Loss

CRP is particularly popular in areas of the country that have long been prone to population loss. That observation, combined with CRP's impact on farm-related employment and the belief that retired participants move elsewhere after enrolling their entire farms in the program, has led many to argue that high CRP enrollments can lead to depopulation, threatening the survival of nearby communities. It is commonly suggested that CRP could exacerbate rural population loss by allowing participants to take their farms out of production and move out of farming communities, thereby eliminating farm jobs and both farm-related and consumer service jobs in nearby communities.

Absentee landownership (as measured by the outflow of CRP funds from counties where farmland is enrolled) tends to be highest in high-CRP areas of the country. Using ERS's farm resource regions, the Northern Great Plains, the Prairie Gateway, and the Mississippi Portal all lost 10 percent or more of the 2001 payments earned on their CRP land to enrollees residing elsewhere. But CRP participants seem to be vacating rural areas no more than other farmers. The distribution of CRP payments among counties classified by degree of urbanization is very similar to the distribution of commodity payments for the corn, cotton, and wheat programs. Thus, payment flows more likely reflect pre-existing landownership patterns than residential relocation by CRP participants.

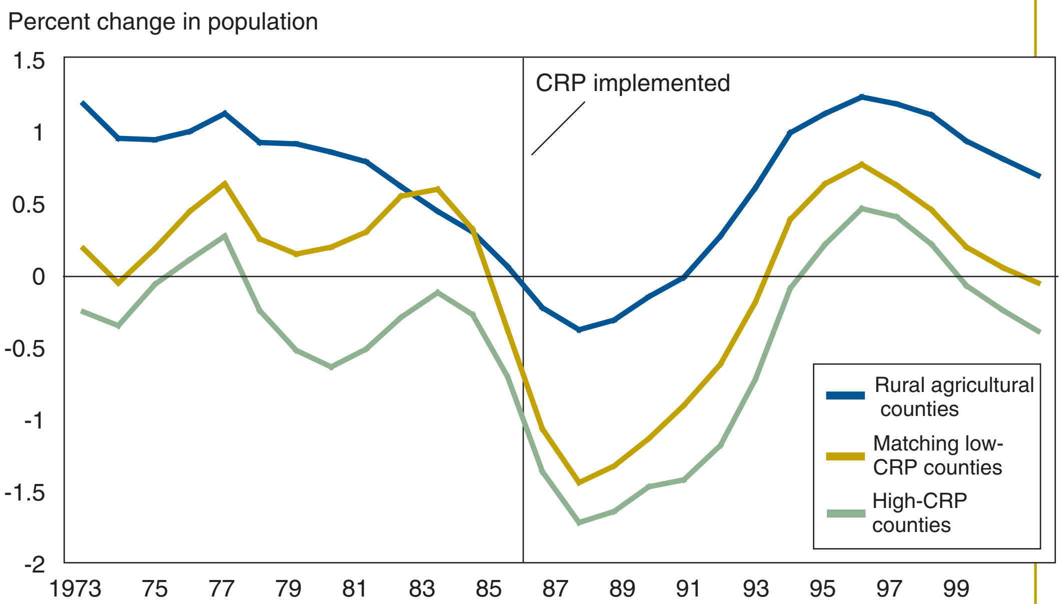
Further analysis suggests that while the number of farms is declining nationwide, counties with high CRP enrollment had no more trouble attracting beginning farmers or retaining farm operators than did low-CRP counties with similar farm

Distribution of CRP payments was similar to major commodity program payments in 2001

Urban influence at destination*	Cropland	CRP	Corn	Cotton	Wheat
	Percent	*Percent of total payments*			
None	74	63	57	66	65
Low urban influence	7	9	11	9	9
Medium urban influence	8	9	11	8	9
Strong urban influence	11	19	21	18	17

*Urban influence at destination refers to the degree of urbanization in the location where the program payment was delivered. Urban influence increases as population size and urban proximity increase (or distance to an urban center decreases). A difference in the distribution of cropland and the distribution of program payments serves as a rough measure of the incidence of absentee ownership of program acres.
Source: Producer Payments Reporting System data from USDA's Farm Service Agency.

Population trends track closely for high- and matching low-CRP counties



Note: Lines portray a 3-year moving average change in population. Rural agricultural counties were non-metro with fewer than 20,000 urban residents and more than 5 percent employed in agriculture in 1980. High-CRP counties are those where the ratio of CRP payments to household income exceeds 2.75 percent. Matching low-CRP counties have similar socioeconomic characteristics to high-CRP counties, but have little CRP enrollment.
Source: ERS analysis of Bureau of Economic Analysis Income Files.

sectors. Thus, even high CRP enrollment does not systematically spur the loss of farm populations.

Finally, many counties with high CRP enrollment have experienced population loss since the program's inception. However, the data also show that high-CRP counties were experiencing depopulation long before CRP's implementation in 1986. This suggests that the program may be particularly attractive in areas that are struggling, perhaps because of a lack of off-farm employment opportunities or limited demand for cropland that would be leased or sold to other farm operators in the absence of CRP. But, does CRP exacerbate population problems?

Comparing population trends in high-CRP counties with trends in similar counties having little CRP enrollment highlights the lack of systematic differences that might be attributable to CRP. Once other factors—such as low population density, isolation from urban centers, and dependence on agriculture—are taken into account, CRP has no statistically significant effect on population trends over either the short or the long term. There may be specific cases where CRP enrollment had a positive or negative effect on population, but in general, CRP enrollment is unrelated to underlying population trends.

CRP and Farm Communities

CRP is now in its 20th year of operation. From its inception, concerns have been raised that by retiring millions of acres of cropland, the program could disadvantage farming communities already hard hit by farm sector consolidation and globalization. Clearly the CRP does not benefit everyone, and the conservation benefits enjoyed by society may come at the expense of a few industries and regions. Nonethe-less, results of ERS analyses suggest that CRP does not come at the expense of longrun economic growth in nearby communities. Even high levels of CRP enrollment have only a modest impact on total county employment, and this impact is relatively short lived. ERS simulations suggest that, in the longer term, CRP enrollment may increase local nonfarm output and employment, and bolster household income if the program increases farm commodity prices and improves recreational opportunities. No statistically significant evidence was found that high CRP enrollments were associated with systematic population declines at the county level. W

This article is drawn from . . .

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Is Carbon Sequestration in Agriculture Economically Feasible?

Comstock

Increased atmospheric concentrations of carbon dioxide and other "greenhouse" gases have contributed to the gradual rise in global temperatures over the last 50 years. Two options for reducing the amount of carbon in the atmosphere are to increase the amount of land planted with permanent grassland or forest vegetation and to reduce the frequency or intensity of tillage operations. Either option would store—or sequester—additional carbon on the affected lands. In February 2002, the White House announced a plan to reduce the growth of U.S. greenhouse gas emissions, in part by developing incentives for farm and forestland owners and operators to adopt land uses and management practices that extract carbon from the air and sequester it in soils and vegetation.

U.S. agricultural soils have lost, on average, about one-third of the carbon they contained before wide-scale cultivation began in the 1800s. Soil science studies suggest that changes in land use and land management practices could increase the carbon content of crop and grazing land soils by 104-318 million metric tons per year. Forestry studies suggest that afforestation of cropland and pasture could add another 91-203 million metric tons per year.

While the U.S. farm sector's technical potential to store carbon is important to know, it is really the economic potential for storing carbon that is most directly relevant to policymakers. Using different incentive payment structures, ERS researchers analyzed the economic feasibility of increasing carbon levels in soils and vegetation by providing various levels of payments to convert croplands and pasture to trees, shift cropland to permanent grasses, and/or increase the use of conservation tillage systems.

At payment levels below $10 per metric ton of additional permanently stored carbon, landowners find it more cost-effective to adopt conservation tillage practices, as compared with other changes to land use and management practices. At higher payment levels, converting cropland to trees becomes more cost effective. For payments equal to $125 per metric ton of additional permanently stored carbon, farmer adoption of conservation tillage and afforestation of crop or grazing land could yield 72-160 million metric tons of carbon, enough to offset 4-8 percent of gross U.S. emissions of greenhouse gases in 2001. Converting cropland to grass did not prove to be a cost-effective option at any payment level analyzed.

The economic potential, even at the $125-payment level, is much less than the technical potential suggested by soil science and forestry studies because activities that are technically feasible are not always economically feasible. Furthermore, the share of the technical potential that is economically feasible varies greatly across activities because of the wide variation in the costs farmers would incur in adopting different carbon-sequestering land uses and practices. W

Jan Lewandrowski
Carol Jones,
cjones@ers.usda.gov

This finding is drawn from . . .

Economics of Sequestering Carbon in the U.S. Agricultural Sector, by Jan Lewandrowski, Mark Peters, Carol Jones, Robert House, Mark Sperow, Marlen Eve, and Keith Paustian, TB-1909, USDA, Economic Research Service, April 2004, available at: www.ers.usda.gov/publications/tb1909/

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Hypoxia in the Gulf: Addressing Agriculture's Contribution

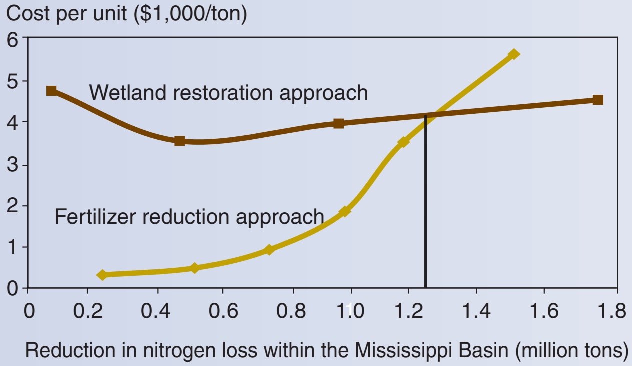
The Northern Gulf of Mexico's hypoxic zone represents one of the Western Hemisphere's largest areas of oxygen deficient waters, where lack of oxygen kills fish, crabs, and other marine life. The size of the zone varies but at its peak, it stretches along the inner continental shelf from the mouth of the Mississippi River westward to the upper Texas coast, covering about 7,000 square miles, an area as large as New Jersey. Long-term consequences to biodiversity, species abundance, and biomass in the Gulf are not yet known, but experience with other coastal dead zones has shown significant ecological deterioration and depleted fisheries.

Scientists believe that Gulf hypoxia is caused by nitrogen loads from the Mississippi River. Nitrogen fuels the rapid growth of large populations of algae and plankton. When they die and sink to the bottom, their decay robs the water of oxygen.

Because two-thirds of the nitrogen in the Mississippi River comes from use of fertilizer and manure on agricultural lands, reducing agricultural nitrogen is a major component of the strategy for controlling the hypoxic zone. Two basic approaches can be taken: (1) induce changes in the application and management of nitrogen fertilizer on farm fields, or (2) restore wetlands along rivers and streams to intercept and filter out the nitrogen before it reaches surface waters. Because the geographic scale of the problem is so large, any policy to reduce nitrogen from agriculture will affect commodity prices, and consequently farmers and consumers both inside and outside the basin.

An ERS analysis of the two approaches found farm-based controls on nitrogen fertilizer use to be more cost-effective than restoring wetlands when up to 1.2 million metric tons (26 percent) of basin-wide nitrogen losses (nitrogen leaving the land and entering the water system) must be eliminated. Until that point, crop yields are little affected by the controls on nitrogen use. But when nitrogen losses must be cut by more than 1.2 million metric tons, a turnaround occurs and wetland restoration becomes the more cost-effective strategy. The reason for the turnaround is that when reduction in nitrogen use reaches a certain point, crop yields decline significantly, causing subsequent increases in prices of some agricultural products. The price increases also result in more intense production of the commodities outside the Mississippi Basin, increasing erosion and nutrient runoff in those regions. However, these calculations don't include (because of insufficient data) other environmental benefits of wetlands not related to nitrogen reduction, such as increased habitat for wildlife. Inclusion of these benefits would cause the wetland option to become the more cost-effective approach at a lower level of nitrogen reduction.

Controls on nitrogen fertilizer use are more cost-effective than wetland restoration up to 1.2 million tons of nitrogen loss reduction



Marc Ribaudo, mribaudo@ers.usda.gov

This finding is drawn from . . .

"Least-cost Management of Nonpoint Source Pollution: Source Reduction Versus Interception Strategies for Controlling Nitrogen Loss in the Mississippi Basin," by Marc O. Ribaudo, Ralph E. Heimlich, Roger Claassen, and Mark Peters, in *Ecological Economics*, May 2001. Abstract available at: www.ers.usda.gov/publications/erselsewhere/eejs0207/

The Questions and Answers page of the ERS Briefing Room on Conservation and Environmental Policy, www.ers.usda.gov/briefing/conservationandenvironment/questions/consenvcoast1.htm

FEATURE

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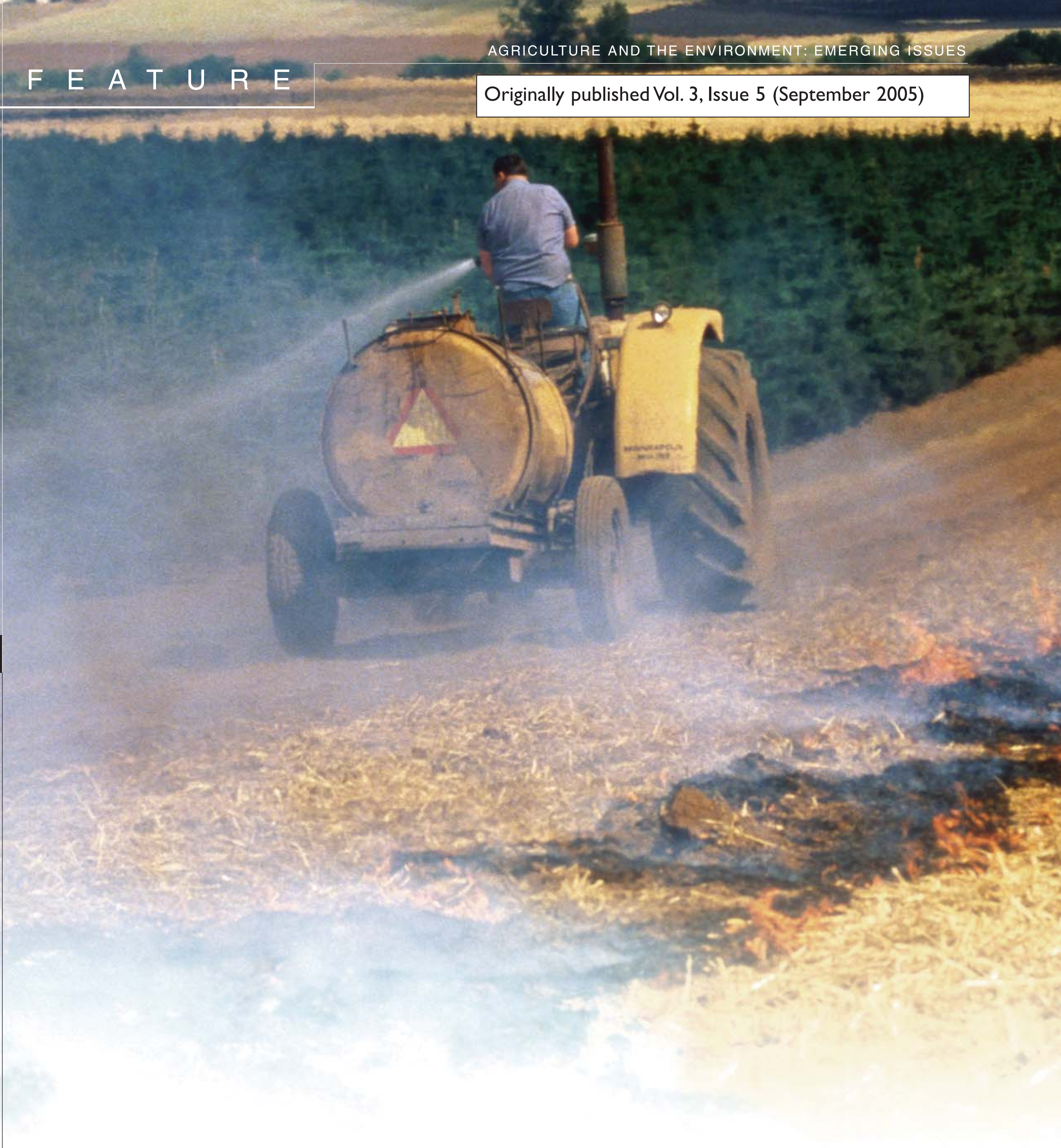


Bruce Forster, Getty Images

Improving Air and Water Quality Can Be Two Sides of the Same Coin

Marc Ribaudo
mribaudo@ers.usda.gov

Marca Weinberg
weinberg@ers.usda.gov

Rural areas have long been idealized as the place to go for good, clean air. However, the "fresh" air of the countryside may not be so fresh after all. Since farmers began tilling the soil to grow crops and raise animals, agricultural production practices have generated a variety of substances that enter the atmosphere and have the potential of creating health and environmental problems. The relationship between agriculture and air quality first entered the public psyche in the 1930s with the severe dust storms of the Dust Bowl. Although huge dust storms are long gone, and air emissions in most rural areas are not high enough to cause concern, the air in some farming communities can now be as impaired by pollutants such as ozone and particulates as air in urban areas.

Air quality policies have traditionally focused on urban areas and industrial emissions. Extending these laws to cover agriculture would require an understanding of how farmers respond to different policy incentives. Farmers have many choices in deciding on what to produce and the production practices to use. Their production decisions are based on market prices, the characteristics of the farm's resources, the technologies that are available, and the farmer's particular level of management skill. But incentives to consider wider impacts of their production choices on environmental quality are often lacking. Environmental policy can influence a farmer's decisions by changing the costs of inputs to encourage or discourage input use, or by mandating that particular management practices be used or abandoned. Currently, a lack of knowledge about air emissions from agriculture could hinder the development of cost-effective policies.

Policy formation is also compounded by the fact that possible efforts to reduce agricultural air emissions could diminish the effectiveness of ongoing efforts to address water quality concerns. At a minimum, regulations and incentives designed to address a problem in one medium (air or water) may not be as cost effective at meeting resource quality goals as those that are coordinated across multiple media.

Pollution from agriculture generally has characteristics that make it difficult to control through conventional policy tools.

Putting the Brakes on Agricultural Emissions

Agricultural production releases a wide variety of material into the air—for example, windblown soil, nitrogen gases from fields and livestock, fine particulates from diesel engines and controlled burning of fields, and pesticides. Pesticides can move in air currents in two ways: aerial drift (when applied with crop dusters), and volatilization (a process by which solids or liquids are converted into gases). Other potential pollutants associated with agricultural production include hydrogen sulfide, ammonia, odors, and other volatile organic compounds from animal manure; methane from dairy cows and cattle; and nitrogen oxides from fertilized fields and internal combustion engines. These pollutants can affect people's health, reduce visibility, contribute to global warming, or simply be a nuisance.

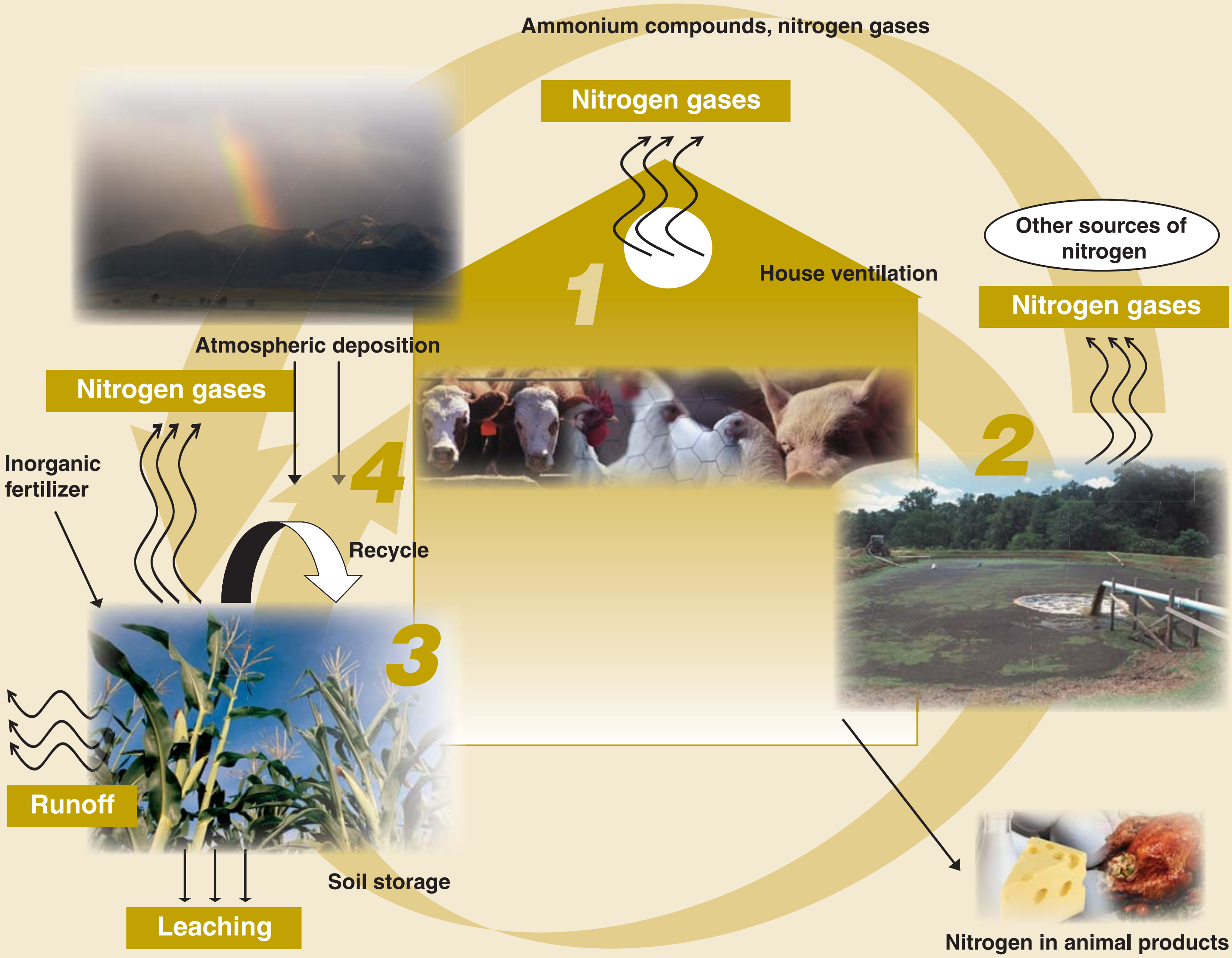
Air quality is protected primarily through the Clean Air Act and the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). The Clean Air Act sets limits on how much of a pollutant can be in the air anywhere in the United States. When the air quality standard for any of six air pollutants is exceeded, States must inform the U.S. Environmental Protection Agency (EPA) how they plan to respond. Any farm in a nonattainment region (regions where air quality standards are exceeded) found to be a "major source" of regulated emissions could be required to apply for and comply with an operating permit. CERCLA requires facilities to report to EPA when more than a "reportable quantity" (100 pounds in a 24-hour period, for example) of a hazardous substance is released.

Regulation of air emissions under the Clean Air Act and CERCLA has focused on such sources as factories and cars but not on emissions from agriculture. Part of the reason is a lack of information about the sources and effects of agricultural air emissions that would be necessary to develop regulations. Pollution from agriculture generally has characteristics that make it difficult to control through


Lynn Betts, USDA/NRCS

A California dairy farmer discusses manure management with an official from USDA's Natural Resources Conservation Service.

Nitrogen Follows Many Pathways in a Livestock Operation



The nitrogen cycle is a complex one, without a beginning, middle, or end. The principle of mass-balance ensures that the amount of nitrogen in a closed system is constant. Thus, any action to divert it from one pathway must necessarily transfer it into another. In this stylized figure:

1 animals in the "house" release nitrogen in three ways: they produce manure (which then enters a storage system); they store nitrogen internally, which is bound in animal products distributed to markets; and they produce gases (directly and indirectly in manure production), which are released as air emissions;

2 manure is stored in lagoons, tanks, pits, or other structures before being transported to fields for use as fertilizer;

3 manure nitrogen applied to fields may be stored in the soil, leached into groundwater, run off into surface water, volatilized into air emissions, and be bound in crops; or

4 nitrogen bound in crops may be used for feed for the animals, and the cycle begins again.

Nitrogen also enters and exits the system through intermediate pathways, for example, some of the nitrogen released into the air will settle back on the fields (deposition) and some new nitrogen will be added in the form of commercial fertilizer.

conventional policy tools that are applied to industrial sources. Agricultural emissions tend to be generated diffusely over a broad land area, rather than from a single pipe or smokestack, so it has not been cost effective to accurately monitor emissions from individual agricultural sources using current technology. For example, ammonia emissions from an animal operation can come from a barn, manure storage structure, and field. The difficulty and cost of monitoring agricultural pollution sources is one reason that agriculture is largely exempt from environmental regulations that were primarily designed to address urban and industrial air pollution problems.

However, new State regulations may seek to reduce air emissions from agriculture, particularly from animal feeding operations. Under the Federal Clean Air Act (and its amendments), States are responsible for achieving the air quality standards established by EPA. Recent lawsuits, court decisions, and consent agreements have induced States to start regulating emissions. California is the first State where air quality regulations are significantly affecting agriculture. Ozone and particulate levels in the San Joaquin Valley of California, which has some of the most polluted air in the country, with nonattainment areas for both Federal ozone and particulate matter standards, have led to new requirements for agricultural producers. Farmers must develop management plans showing how they will reduce dust, the burning of crop residue (e.g., rice straw, orchard trimmings) is restricted, and large dairies must manage their manure to reduce ammonia emissions.

California is the first State where air quality regulations are significantly affecting agriculture.

However, farmers do not bear the cost alone. USDA helps farmers in California's nonattainment areas with a cost-share program funded through the Environmental Quality Incentives Program to help finance farming practices that reduce airborne dust and ozone precursors. USDA also funds research to understand the processes of air pollution emissions from agricultural operations, to develop and test control measures, and to provide decision aids that can be used to reduce agricultural air pollution emissions.

Protect Air Quality, Compromise Water Quality?

An important issue in addressing pollution from agriculture is that emissions to the atmosphere do not necessarily occur in isolation, but can be linked by biological and chemical processes to emissions to water. Nitrogen emissions from animal feeding operations are the best example. Nitrogen excreted from an animal can follow any of a number of pathways between collection and disposal, and enter water or the atmosphere in the form of any of a number of compounds. These interactions have important consequences for policies to protect environmental quality. Reducing nitrogen movement along one pathway by changing its form will increase nitrogen movement along a different path. For example, reducing ammonia losses from a field by injecting animal waste directly into the soil increases the amount of nitrogen that can be made available for crop production, but, because more nitrogen is now available in the soil profile, the risk that nitrates will enter water resources is increased. The fact that these processes are linked requires that efficient management of manure consider

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An uncoordinated approach between air and water policies could reduce water quality.

Animal feeding operations are a major source of ammonia emissions.

Bob Nichols & Jeff Vanuga, USDA/NRCS

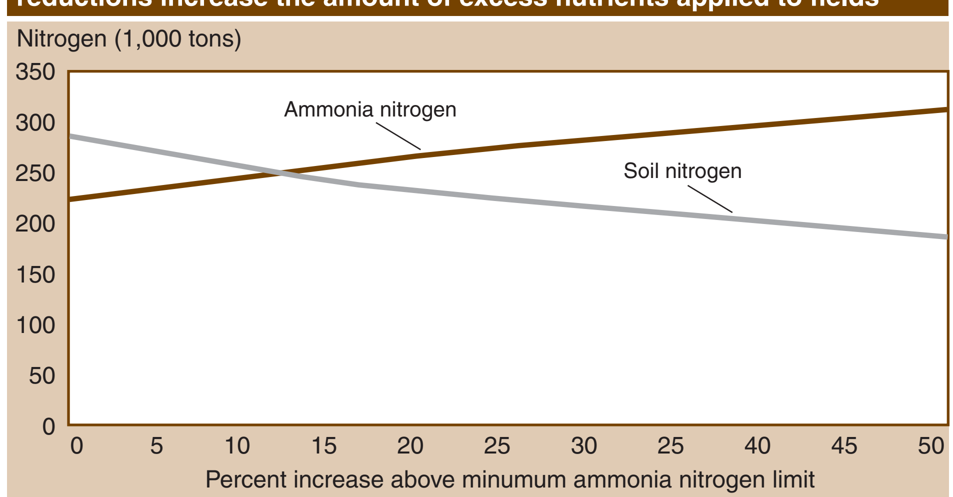
how different environmental media (that is, land, water, and air) are affected. (See box, "Nitrogen Follows Many Pathways in a Livestock Operation.")

Potential cross-media links in the emission process suggest possible advantages to a multimedia perspective in developing regulations. A multimedia perspective is neither new nor unique to agriculture. Many industries generate multiple pollutants that affect several environmental media. Yet, environmental regulations, by and large, take a single-medium perspective. The Clean Water Act addresses surface water quality (not ground water). The Clean Air Act addresses air quality. The Resource Conservation and Recovery Act (RCRA) addresses hazardous waste disposed on land.

Over the past decade, EPA has experimented with coordinated implementation of the Clean Air Act, Clean Water Act, and RCRA to reduce implementation costs and to help regulated industries organize pollution control activities more efficiently. The pulp and paper industry was the first to benefit from this multimedia approach. EPA developed integrated air and water rules that set emission levels based on the performance of a combination of source reduction technologies and management practices, air pollution control devices, and upgrades on existing wastewater treatment systems.

Why might a multimedia approach be important for agriculture? The increasing size and geographic concentration of animal feeding operations, driven by the economics of domestic and export markets for animal products, have resulted in large quantities of manure accumulating in relatively small areas. In 2003, EPA introduced revised Clean Water Act regulations to protect surface waters from nutrients from concentrated animal feeding operations (CAFOs). The regulations require CAFOs to follow a nutrient management plan to minimize nitrogen and phosphorus runoff to surface water. Those plans will specify the application rate for nutrients that must be followed when applying manure to land (the primary disposal method). The cost to farmers of complying with the plans can be relatively high because compliance often will entail moving manure to a larger land base. To meet the requirements as cheaply as possible, and without any incentives to protect air quality, farmers could continue to use (or adopt) uncovered lagoons and apply ani-

Steps farmers take to meet increasingly stringent ammonia emission reductions increase the amount of excess nutrients applied to fields



Farmers reduce ammonia emissions by putting a cover on lagoons that trap gaseous emissions or by injecting wet waste (slurry) into soil rather than spreading it on top. The right edge of the graph shows the situation when farmers emit 50 percent more ammonia than the best possible situations (all farmers cover their lagoons or inject slurry). At this point, farmers emit about 300,000 tons of ammonia-nitrogen, and apply about 200,000 tons of nitrogen to fields. As the amount of ammonia is reduced (moving from right to left), the amount of nitrogen applied to fields increases.

Source: USDA, Economic Research Service.

mal waste to the surface of fields without incorporating it into the soil. Those practices reduce the nitrogen content of manure spread on fields by volatilizing nitrogen to the atmosphere. In so doing, however, nitrogen that otherwise would be available for runoff to water bodies is transformed into atmospheric ammonia emissions to the possible detriment of air quality.

According to a 2003 National Academy of Sciences study, animal feeding operations are the primary source of ammonia emissions in the U.S., and ammonia emissions are already a cause for concern in some rural communities. Ammonia emissions are regulated in parts of California. Current Federal air quality rules (e.g., Clean Air Act's PM 2.5 standards and CERCLA) might force more States to consider regulating ammonia emissions from animal operations.

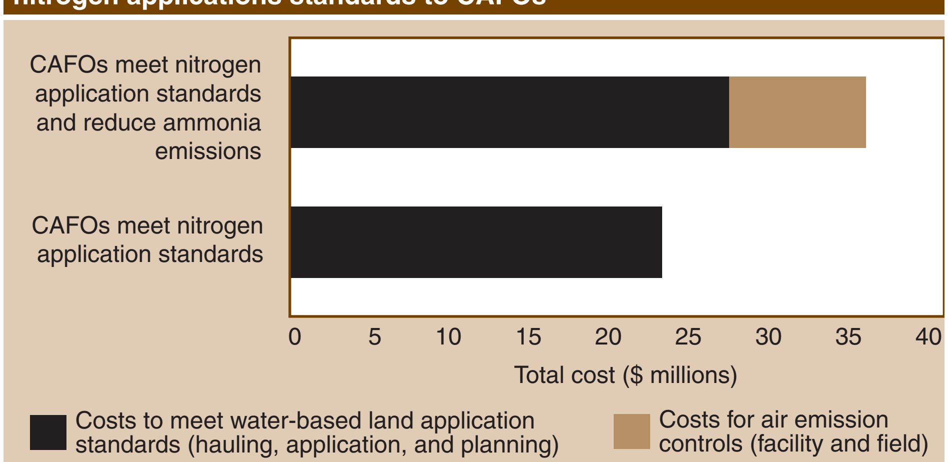
An ERS study estimates that farmers would respond to hypothetical ammonia emission standards by adopting manure management practices that reduce nitrogen emissions to the air but increase the nutrient content of animal waste spread on fields. Depending on how the air quality regulations were applied, this could have two impacts on CAFOs and water quality. First, CAFOs might need to further increase the amount of land on which they spread manure in order to continue to meet nutrient application standards. This increase could be particularly costly in a region where animal concentrations are high and cropland available for spreading manure is relatively scarce. For example, in the Chesapeake Bay watershed, ERS found that requiring CAFOs to adopt practices that reduce ammonia emissions would increase the nitrogen content of manure and thus the CAFOs' cost of applying manure to land to meet water quality requirements.

Information on environmental emissions from production practices would improve coordination of environmental policies.

An uncoordinated approach between air and water policies could also reduce water quality. The Clean Water Act's manure regulations apply only to CAFOs. If ammonia reductions are required on farms other than CAFOs, the water quality benefits of the CAFO regulations are potentially reduced by increased nutrient applications on these other farms. In the Chesapeake Bay watershed, for example, ERS research estimates that the nutrient content of manure produced on farms not covered by current regulations would more than double if ammonia restrictions were applied to all animal feeding operations. This would increase the risk of nitrogen runoff that eventually reaches the Chesapeake Bay.

USDA has long recognized the impacts of conservation practices on multiple environmental resources (soil, water, and air). Yet, when a set of conservation practices is recommended to improve water quality, full consideration is not always given for accompanying air quality benefits. In the Conservation Reserve Program, for example, the Environmental Benefits Index used to rank applications for enrollment includes wind erosion benefits but not benefits for reduced ammonia, odor, fine particulates, oxides of nitrogen, or pesticide volatilization. A fuller accounting of the multimedia benefits in the implementation of conservation programs could result in a redirection of resources to producers who could provide a higher level of overall environmental quality for a given cost.

Reducing ammonia emissions would increase costs of meeting nitrogen applications standards to CAFOs*



*CAFOs are concentrated animal feeding operations, or those operations regulated by EPA under the Clean Water Act.

Source: USDA, Economic Research Service.


Jeff Vanuga, USDA/NRCS

Better Data for Better Coordination

Information on environmental emissions from production practices would improve coordination of environmental policies. The National Academy of Sciences review of air emissions from animal feeding operations found that, while pressure to regulate air emissions from animal operations has mounted, the basic scientific information needed for effective regulation and management of emissions is lacking. The study was requested jointly by EPA and USDA to assess the state of knowledge and to recommend steps for bridging the information gap that is hindering the development of effective regulations and management measures. Existing data are insufficient to establish thresholds for emissions from livestock operations that would trigger compliance with air quality requirements.

This need for better data about air emissions from animal feeding operations has led to an innovative agreement between EPA and some sectors of the animal industry to monitor air quality on farms. The Air Emissions Consent agreement and National Monitoring Study between pork and egg producers and EPA calls for a 2-year national air monitoring study on animal feeding operations that agree to participate in the study. The study will use state-of-the-art technologies and standardized procedures to monitor emissions from barns and lagoons. These data will help State and Federal regulators and farmers identify farm sizes and manure handling systems that exceed thresholds for regulated pollutants. For farms that participate, EPA has agreed to provide certain legal protections for past and current emissions violations. EPA has invited other sectors of the animal industry (broilers, dairy, and fed beef) to participate.

The information gathered during the study will be valuable for both farmers and regulators. Many producers are not aware of their operation's contribution to emissions or whether they are subject to existing air quality regulations. Knowing the legal and financial risks for different types of operations would help farmers make decisions about reducing emissions to protect them from possible lawsuits or enforcement actions and still remain profitable.

Information on atmospheric emissions from agriculture can help regulators identify the emission thresholds that meet air quality goals at minimum cost to the sector and develop coordinated incentives to help farmers simultaneously protect air and water quality. This would reduce unintentional harm to the environment because of unconsidered cross-media effects and minimize the cost to producers who change their production practices to comply with emerging environmental regulations. AW

This article is drawn from . . .

Managing Manure To Improve Air and Water: Coordination Works Better, by Marcel Aillery, Noel Gollehon, Robert Johansson, Jonathan Kaplan, Nigel Key, and Marc Ribaudo, ERR-9, USDA, Economic Research Service, September 2005, available at: www.ers.usda.gov/publications/err9/

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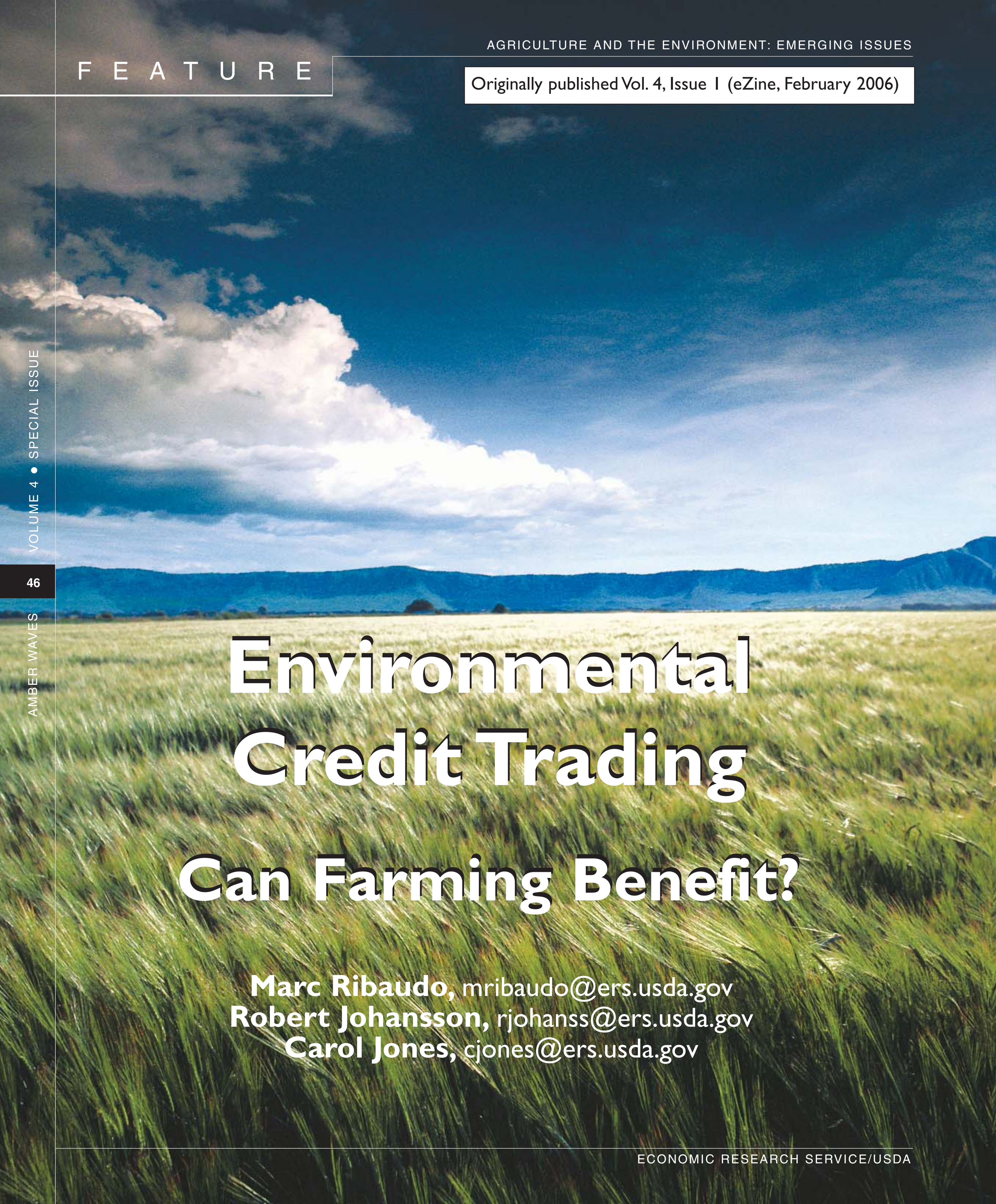

Environmental Credit Trading

Can Farming Benefit?

Marc Ribaudo, mribaudo@ers.usda.gov
Robert Johansson, rjohanss@ers.usda.gov
Carol Jones, cjones@ers.usda.gov

Corbis

Environmental regulations often require firms that emit pollutants to limit emissions to a set level or to install specific emission-reducing technologies. While fairly straightforward, this command-and-control approach can be costly both to the firms and to society. Firms with high costs of pollution reduction and those with low costs are required to meet the same requirements, which may waste resources. Environmental credit trading, an alternative to command-and-control regulations, is a market-based approach to comply with regulations that could achieve pollution abatement goals at lower costs to society. Environmental credit trading allows regulated firms to meet their obligations by purchasing pollution abatement services (credits) from lower-cost providers. For example, the 1990 Clean Air Act amendments established a trading program between power plants to cut sulfur dioxide (SO2) emissions by 50 percent from 1980 levels to control acid rain. The trading program has been a success, with emissions reductions exceeding the goal by 30 percent and annual cost savings estimated at $1 billion.

Trading programs have been created for environmental issues other than air quality, such as water quality, wetlands protection, and greenhouse gas emissions. Even though agriculture per se is not subject to most environmental regulations, farmers can participate in these credit trading programs by generating pollution-reduction credits and selling them to regulated firms. Farmers can benefit if the cost of generating credits is less than the price they command. Farmer participation in trading programs has been limited to date, but USDA has recently committed to promoting farmers' participation in trading programs. The success of these programs will rest on several key design elements and their ability to generate the economic incentives needed to encourage both the regulated firms and farmers to participate.

What Does It Take For Credit Trading To Succeed?

For a credit trading program to be successful, there needs to be a demand for credits as well as a supply of credits. Demand is generally created by a regulation or other cap on emissions or other activity that degrades the environment. In the case of water quality, the Total Maximum Daily Load provisions of the Clean Water Act set a discharge cap for point sources in impaired watersheds, creating a demand for pollution-reduction credits. Firms required to meet a discharge cap will be willing to pay for credits from other sources as long as the credits are less expensive than their own abatement costs. Forty trading programs have been established across the country for such pollutants as nitrogen, phosphorus, selenium, dissolved solids, and heavy metals.

In the case of carbon and other greenhouse gases, demand for credits in the U.S. originates with some local, State, and regional regulations (there are no Federal regulatory limits). Oregon was among the first States to impose a performance standard for power plants. Companies can either meet the standard with new technology and increased efficiency, or pay $0.85 per ton of excess carbon dioxide emissions, which the Oregon Climate Trust then pools to buy credits from emission reduction projects in the U.S. and abroad. Though demand for credits generally originates in regulations (rather than voluntary programs), some exceptions exist. The Chicago Climate Exchange (CCX), for example, is an experimental, voluntary cap-and-trade system in which over 40 firms participate (including Dupont, Ford, IBM, Dow Corning). The price on CCX in April 2006 was $2.75 per ton carbon dioxide (or $10 per ton carbon).

Wetland conversion is governed by a Federal "no-net-loss" policy that essentially functions like a cap. The policy requires that wetlands converted to other uses be offset by the creation or enhancement of other wetlands that "possess the physical, chemical and biological characteristics to support establishment of the desired aquatic resources and functions," according to Section 404 of the Clean Water Act. This policy effectively caps the supply of land for development in certain areas (e.g., in the construction of roads, housing developments, shopping malls). Wetland mitigation banks have been set up in many States to allow private developers to purchase wetland conversion rights (credits) from farmers, who have established or restored wetlands on their farms. Current values of wetlands banked can depend on their location and/or expected environmental benefits. For example, in Minnesota, the value of wetland credits to public transportation authorities ranged from $4,000 to $35,000 per acre, depending on proximity to the Twin Cities metro area.

The supply of credits comes from those who can produce credits at a cost lower than the expected market price for credits. Suppliers can be regulated sources that can produce credits at a lower cost than other regulated sources, or unregulated sources that by design are allowed to participate. Farmers can supply environmental credits by, for example, reducing the runoff of regulated pollutants, reducing greenhouse gases, or restoring wetlands (see box, "Farmers as Suppliers of Environmental Credits"). These actions are conditional on farmers providing environmental services at a lower cost than that of regulated firms in meeting pollution regulations. In addition to lowering the overall costs of meeting environmental goals, subsequent credit trading could provide financial opportunities for farmers and leverage private sector funds for conservation.

Once a market has been established, the price for environmental credits could be determined by market-style trading

Farmers as Suppliers of Environmental Credits

By adopting certain types of conservation practices, farmers can become suppliers of environmental credits while reducing the negative environmental impacts of farming. Specifically, farmers can generate credits by undertaking measures to reduce pollutant runoff into water bodies, reduce greenhouse gas emissions, or restore wetland functions.

Reduce pollutant runoff—Point sources regulated by the Clean Water Act (CWA) discharge directly into water bodies from an identifiable location (e.g., end of pipe). Nonpoint sources, such as agricultural fields, generally do not discharge directly into water bodies from an identifiable location; runoff occurs in a more disperse manner above and below ground. Water quality trading allows a point-source discharger to meet CWA obligations by acquiring "credits" from other sources (point or nonpoint) that take measures to reduce the regulated pollutant. The Total Maximum Daily Load (TMDL) provision of the CWA prompted a recent surge in interest in point/nonpoint trading. Nutrients (nitrogen and phosphorus) are the predominant pollutants in point/nonpoint markets, since both point and nonpoint sources are major sources. Forty water quality trading programs have been started in the United States to date. Twenty-two allow trades with agricultural nonpoint sources. Most of these trading programs are for nutrient reductions, but others address selenium discharge, sedimentation, and water flow.

Reduce greenhouse gas emissions—Most proposed strategies to mitigate global climate change focus on reducing the dominant source of greenhouse gas (GHG) emissions to the atmosphere—combustion of fossil fuels, which releases carbon dioxide (about 80 percent of U.S. GHG emissions in 2001). But the agricultural and forestry sectors can provide low-cost alternatives to energy emission reductions by shifting land use to forestry or wetlands, or adopting best management practices such as conservation tillage. At this point, GHG trading is limited because the Federal regulatory program does not impose mandatory restrictions on GHG emissions.

Restore wetland functions—Wetlands are complex ecosystems, providing ecological, biological, and hydrologic goods and services. In the U.S., an estimated 100 million acres of wetlands (45 percent of the initial base) were converted between 1780 and 1990, mostly for agricultural production. Farmers can contribute to the "no-net-loss" goal by restoring some chemical and biological wetland functions on agricultural land.

Lynn Betts, USDA/NRCS

similar to a commodities exchange, if there are sufficient numbers of buyers and sellers. However, even with only a few buyers/sellers and prices set by a managing agency, program participants can still benefit, because the costs to comply with environmental regulations are allocated more efficiently. In Minnesota, the Rahr Malting Co. has achieved its discharge requirements through trades with only four farmers. Rahr purchased water quality credits for its new wastewater treatment plant by funding upstream reductions in nonpoint-source phosphorus discharges. The annualized cost of the trades was $2.10 per pound of phosphorus, but without the trade, it would have cost Rahr as much as $4-18 per pound of phosphorus to achieve its requirements.

For a successful trading program, the environmental equivalence between the location where a pollutant reduction is made and the location where that reduction is purchased or used must be established. For example, drained wetlands must be replaced with wetlands with equivalent wetland functions in order to comply with Section 404 of the Clean Water Act; otherwise, there will be a net loss in environmental quality. This is also the case with water quality trading. Credits produced by farmers implementing conservation practices should be assessed where a point source discharges (e.g., into a stream), not at the edge of the field. An exception is global pollutants. For example, the atmospheric concentration of greenhouse gases affects climate change, not the location of emissions or withdrawals of greenhouse gases (through carbon sequestration).

Willingness to participate is crucial. Those obligated to comply with an environmental restriction or cap must see an economic opportunity to reduce compliance costs by purchasing credits from others. Those offering credits must believe that they can produce credits at a cost less than the expected market price for credits. Environmental credit trading will be more likely when the economic opportunities are clear to all participants.

Some Obstacles Could Hinder Trading

Though opportunities to trade credits exist, very few farmers have taken advantage of them. Demand for credits from agricultural sources may be low because of uncertainty over the credits it can produce. Water quality is a good example. Much of agricultural pollution is considered nonpoint in nature. That is, many agricultural pollutants arrive via dispersed and unobservable transport mechanisms, whether through runoff, groundwater leaching, or the atmosphere. Therefore, it is difficult to predict with certainty the amount of discharge reduction (or production of credits) the implementation of management practices will produce at the point in the watershed where credits are measured. This may discourage demand for agricultural credits by regulated firms that are legally responsible for meeting discharge limits. Uncertainty could be reduced by more intensive monitoring, but that may be expensive. Such transaction costs could negate the benefits of trading. One reason why the SO2 trading program is so successful is that the cost of measuring emissions is low.

Uncertainty over the production of credits affects the supply side as well. Because of the nature of pollution from agriculture, and the need to assess credits at the point where regulated sources actually discharge, farmers may be unaware of the number of credits they can actually produce, or what price they should ask for them.

Farmers may also be reluctant to participate in a program that is partly regulatory, even with compensation. Some have suggested that farmers are afraid that information about their contributions to water quality and costs of pollution abatement on farms could eventually be used to develop regulations for agricultural pollution. In addition to farmer reluctance to participate in a regulatory program, uncertainty over the number of credits farmers produce and lack of enforcement of the environmental regulation have proved to be deterrents to trades.

Another supply-side issue is the treatment of credits generated on farms through publicly funded conservation programs such as the Conservation Reserve Program (CRP) and Environmental Quality Incentives Program (EQIP). Since credits from conservation programs are already partly or fully funded, some trading programs do not allow them to be traded. A farmer participating in a conservation program would have to implement additional conservation measures to participate in a trading program. This would raise the cost of credits, making them less attractive to those wishing to purchase credits.

USDA Can Facilitate Market-Based Stewardship

Under its new policy on market-based stewardship, USDA has committed to encourage participation by farmers in environmental credit markets. USDA has outlined three sets of actions that can help overcome some of the demand and supply side problems facing farmers' participation in trading programs. One action is to develop and evaluate the necessary tools and methods for estimating the environmental credits a farmer can produce. Accounting procedures for quantifying the environmental benefits of conservation practices are necessary in order to establish the environmental equivalence of credits and to reduce uncertainty.

USDA recently implemented the Conservation Effects Assessment Program to quantify the impact of conservation practices on water quality and other resources at the watershed scale. This pro-

Lynn Betts, USDA/NRCS

gram will standardize approaches for estimating the value of environmental goods and services generated by conservation systems. In addition, USDA's Agricultural Research Service has implemented a national program on global climate change and is conducting research on carbon sequestration of different cropping systems. USDA has also developed new accounting rules and guidelines for reporting greenhouse gas emissions and carbon sequestration as part of the U.S. Department of Energy Section 1605(b) Voluntary Greenhouse Gas Reporting Registry. The revised program enables agricultural and forest landowners to quantify and maintain records of actions that reduce greenhouse gas.

Another action is to educate farmers on the potential benefits of participating in trading programs. USDA's promotion of trading could alleviate farmer uneasiness about dealing with regulatory agencies. USDA's Conservation Innovation Grants were initiated as a component of the 2002 Farm Act provisions for the Environmental Quality Incentives Program. In 2004 and 2005, seven different projects received over $4.1 million to establish credit trading programs to improve water quality, establish wildlife habitat, and sequester carbon. Information developed by these programs could help USDA provide outreach, education, technology transfer, and partnership-building activities to facilitate credit markets. This information, coupled with education of farmers about the economic opportunities of selling credits and technical/financial assistance for establishing credit generating activities, could reduce farmer concerns about trading with regulated sources and alleviate some of agriculture's own environmental impacts.

USDA's credit trading policy also calls for cooperation with other agencies to remove programmatic barriers to farmer participation. One such barrier is the treatment of credits produced through conservation programs such as EQIP, CRP, or the Grassland Reserve Program. Creating synergies between program-generated credits and newly tradable credits could benefit both agriculture and regulated sources.

This article is drawn from . . .

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ERS Briefing Room on Conservation and Environmental Policy, www.ers.usda.gov/briefing/conservationand-environment/

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ARMS data highlight trends in cropping practices

Since 1996, U.S. farmers have responded to a number of industry-altering changes, including lower crop prices, the availability of genetically engineered seed, and environmental incentives embodied in farm legislation. How have these changes affected production and conservation practices used by farmers? USDA's Agricultural Resource Management Survey (ARMS) provides a source of information about practices on sample fields in major field-crop-producing states. Data from 1996 to 2002 show significant trends beginning to emerge, which may have implications for environmental quality.

C.S. Kim, ckim@ers.usda.gov

William Quinby

Tim Payne, jpayne@ers.usda.gov

This article is drawn from . . .

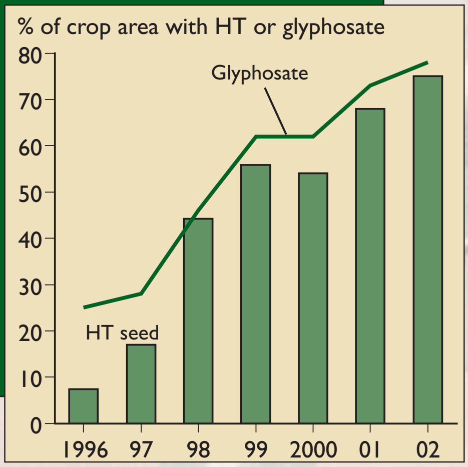
ARMS Data on Crop Production Practices, available at: www.ers.usda.gov/data/arms/cropoverview.htm

All chart sources: USDA Agricultural Resource Management Survey.

Genetically Engineered Soybeans

HT seed and glyphosate herbicide use soared...

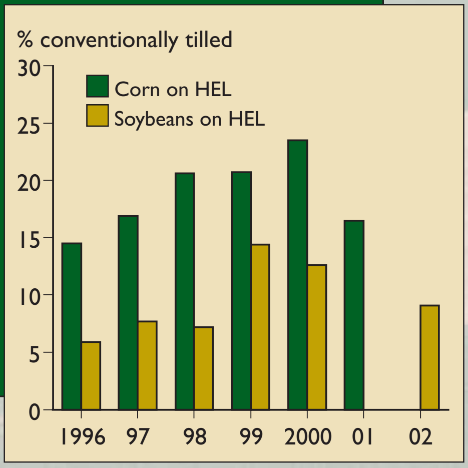
Use of herbicide-tolerant (HT) soybean seed has enabled farmers to use glyphosate herbicides that are effective in controlling weeds during crop growth.



Tillage

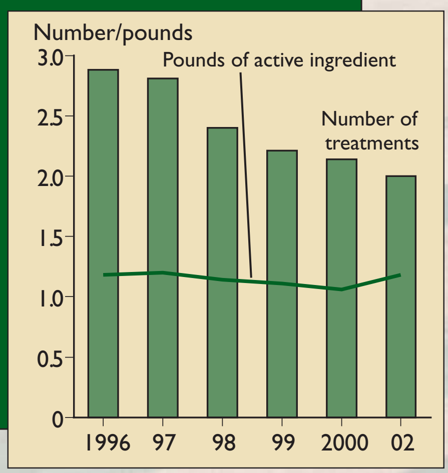
Conventional tillage trend reversed on highly erodible land

The recent decline in conventional tillage on highly erodible land reverses a previous trend toward greater potential for soil erosion. Soil-conserving tillage is compatible with HT seed and improved herbicides for effective weed control.



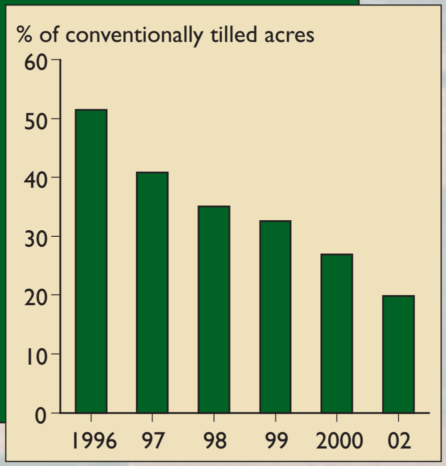
...while overall herbicide use decreased on soybeans...

With soybean producers relying more on glyphosate herbicides, the number of herbicide treatments has declined. The annual per-acre average of all herbicide active ingredients also declined. Adopting HT soybean varieties has allowed producers to switch to herbicides that are more effective at lower rates of use per acre.



...and cultivation for soybean weed control dropped.

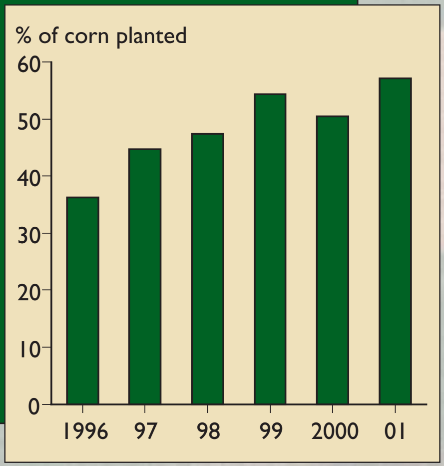
The use of glyphosate herbicides during soybean growth allowed farmers to reduce cultivation for weed control, especially on conventionally tilled soybeans (i.e., soybeans planted on land plowed or tilled so as to leave little or no crop residue, one-fifth of planted acreage in 2002).



Crop Rotation

More corn/soybean rotation in the Northern Plains and Lake States

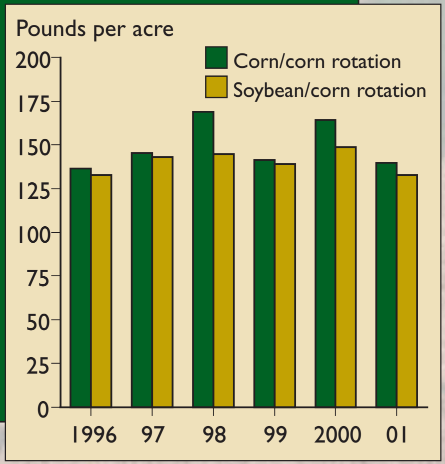
Rotating corn with soybeans increased in regions where continuous corn production had been the norm. Adding soybeans to the rotation may reduce use of nitrogen fertilizers and insecticides.



Nutrient Management

Nitrogen fertilizer application rates on corn in rotation after soybeans are lower

When nitrogen is applied on corn in rotation following soybeans, the application rates are lower due to the "carryover effect" from the increased soil nitrogen provided by the soybean crop during the previous growing season. This trend lowers the amount of nitrogen fertilizer required for the corn crop and reduces the risk of nitrogen runoff to surface waters.



Behind the Data Originally published Vol. 2, Issue 5 (November 2004)

Estimating U.S. Cropland Area

Measuring cropland area is essential for assessing the economic and environmental performance of U.S. agriculture. ERS tracks cropland in its annual "cropland used for crops" data series, which began in 1910. Cropland used for crops is the sum of cropland harvested, crop failure, and summer fallow. (Total cropland is part of the ERS Major Land Use series, started in 1945, that accounts for all land use in the 50 States.)

The data behind the ERS cropland series come from the *Crop Production Annual Summary* published by USDA's National Agricultural Statistics Service (NASS). This survey includes harvested acres of principal crops, the predominant field crops in U.S. agriculture. In 2005, 21 principal crops accounted for almost 98 percent of all harvested crop acreage in the United States, but just four crops—corn, soybeans, wheat, and hay—accounted for about 82 percent of all cropland harvested acreage.

The acreages of other crops (fruits and nuts, vegetables, and minor crops), which are published every 5 years by the U.S. Census of Agriculture and change little from one census year to the next, are added to the acres of principal crops to derive total crops harvested. In 2002, "other crops" comprised over 40 other crops plus nursery and greenhouse products. While these crops take up relatively little acreage, they can account for large market value shares of sales.

The *Crop Production Annual Summary* report counts all acres harvested, including double cropping. However, each cropland acre can only be counted once; thus, double cropping is subtracted from total crops harvested because cropland used for crops becomes part of the ERS *Major Land Use* series, which must sum to total U.S. land area. The result is total cropland harvested. Most double cropping occurs when soybeans are planted after the harvest of small grains (mainly wheat) in the same year, and these estimates are from the annual NASS acreage report published in June. Smaller acreages of other crops are also double cropped, and these estimates are from the Census of Agriculture.

Crop failure is the difference between cropland planted and cropland harvested. However, some cropland planted is not intended to be harvested. Thus, adjustments are made to account for cover crops, crops grazed, and crops cut for hay. Data for these adjustments are from the *Crop Production Annual Summary* and the Census.

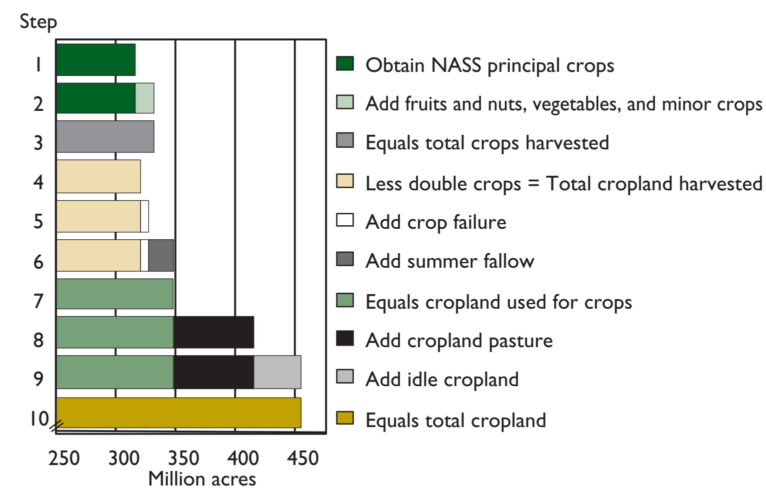
Cultivated summer fallow occurs predominantly in the Great Plains where it is a practice used to conserve moisture and control weeds. Fields are typically planted and harvested one year and summer fallowed the next. Acreage estimates are obtained from NASS, the Census of Agriculture, or the Conservation Technology Information Center. When no data are available, ERS estimates the area of cultivated summer fallow based on the acreage of wheat in the major summer-fallow States. The use of summer fallow has slowly declined over the last 30 years, due mostly to the increased adoption of conservation tillage and herbicides, which reduce the need for summer fallow to conserve moisture and control weeds.

Marlow Vesterby
Kenneth S. Krupa
Ruben N. Lubowski,rlubowski@ers.usda.gov

For more information, see the Major Uses of Land chapter of the ERS Briefing Room on Land, Use, Value and Management, available at: ww.ers.usda.gov/briefing/landuse/majorlandusechapter.htm

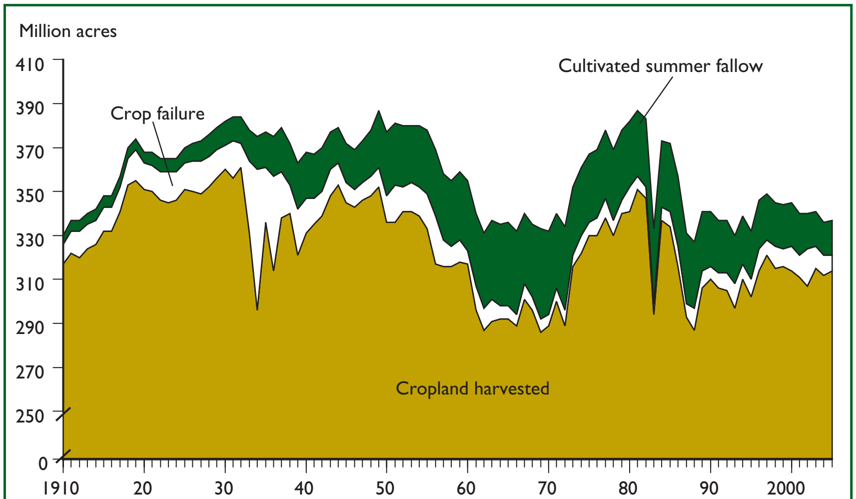
The ERS Major Land Uses data set is available at: www.ers.usda.gov/data/majorlanduses/

Estimating U.S. cropland area, 1997



Major Uses of Land in the United States, 1997, by Marlow Vesterby and Kenneth S. Krupa, SB-973, USDA/ERS, August 2001, available at: www.ers.usda.gov/publications/sb973/

Cropland used for crops was about the same in 2005 as it was in 1910, though it varied by as much as 13 percent from year to year



Source: USDA, Economic Research Service, *Major Land Uses in the United States, 2002* (EIB-14). Data available at www.ers.usda.gov/data/majorlanduses/

In the Long Run

Originally published Vol. 2, Issue 3 (June 2004)

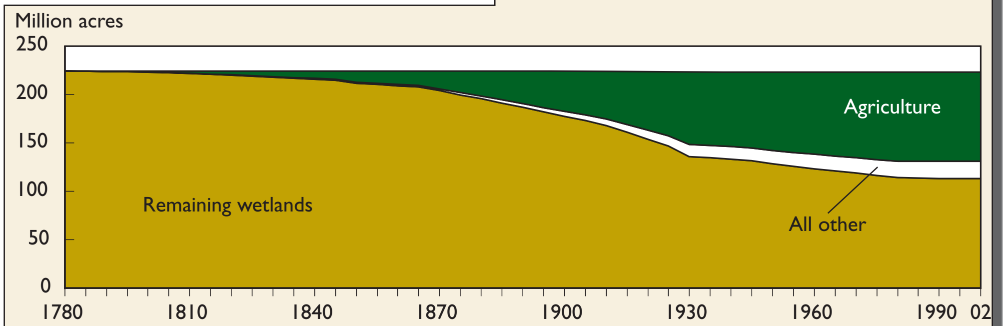
Wetland losses. Until well into the 20th century, conversion of wetlands to agricultural and other uses was encouraged by policy incentives for drainage and westward expansion. Starting in the 1930s, conservation laws began to slow wetland conversion, and this momentum was reinforced by other measures over the last 30 years. Today, about half of the original wetlands area in the 48 contiguous States has been converted to other uses, mostly agriculture, but urbanization and other uses now account for most wetland conversion. Currently, the rate of net wetland loss from agriculture has been reduced to almost zero.

Roger Claassen,
claassen@ers.usda.gov

The current inventory of U.S. wetlands has been influenced by key legal and economic milestones.

- The Swamp Land Acts of 1849 and 1850
- The Homestead Act of 1862
- The Migratory Bird Hunting Stamp Act of 1934
- The Water Bank Program, 1970
- The Clean Water Act of 1972 plus later amendments
- Swampbuster provisions, 1985
- Reduced tax incentives for wetland drainage, 1986
- Wetland Reserve Program, 1990

Wetland losses, 1780-2002



Source: ERS analysis of data from "Status and Trends of Wetlands in the Conterminous United States: 1986-1997" (U.S. Department of the Interior's Fish and Wildlife Service) and from 2002 National Resources Inventory (USDA's Natural Resources Conservation Service).

On the Map

Originally published Vol. 4, Issue 2 (April 2006)

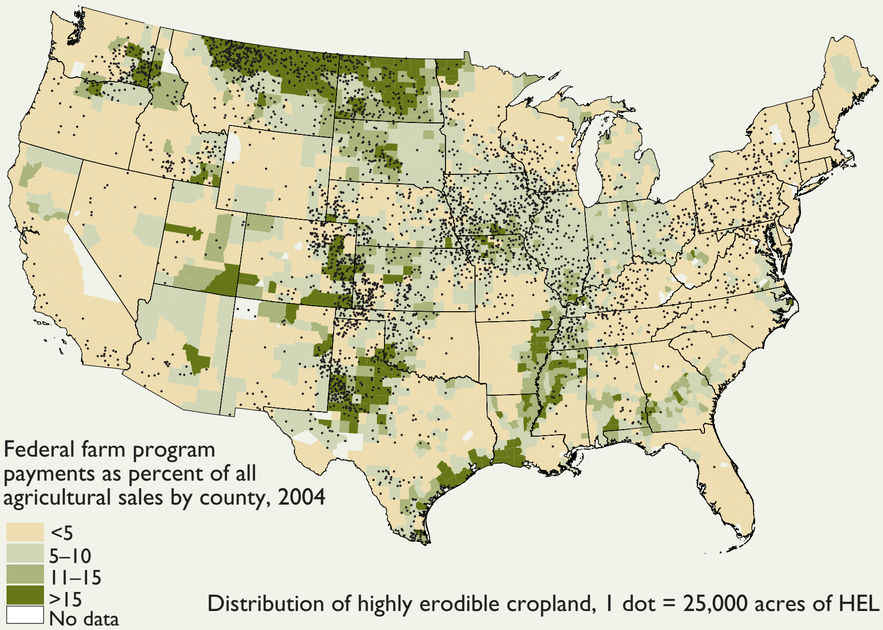
Conservation compliance effectiveness depends on where the money goes

USDA's Conservation Compliance Program was designed to ensure that Federal farm programs did not encourage crop production on highly erodible land (HEL) in the absence of measures to protect against soil erosion. Under this program, farmers who grow crops on HEL must apply an approved soil conservation system or risk losing eligibility for Federal income support, conservation, and other payments.

The effectiveness of conservation compliance in enhancing soil conservation depends, in part, on the extent to which farms that crop HEL also receive Federal farm program payments. Overall, 86 percent of all cropland and about 83 percent of highly erodible cropland is located on farms that receive farm program payments.

Roger Claassen
claassen@ers.usda.gov

Most farms with highly erodible cropland receive Federal farm program payments

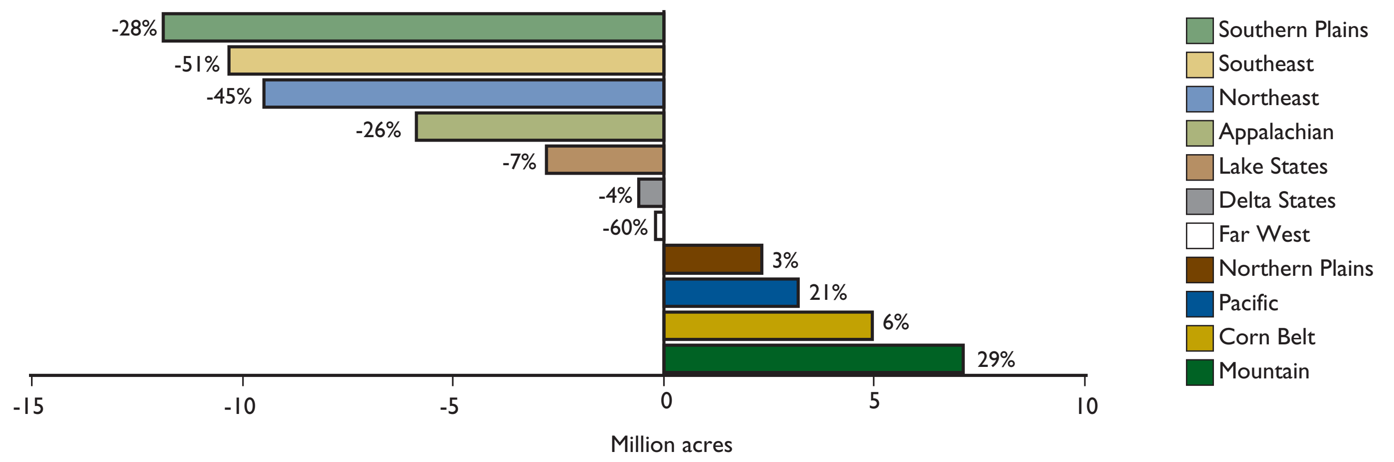


Source: USDA, Economic Research Service using data from USDA, Natural Resources Conservation Service's National Resources Inventory, the Commodity Credit Corporation, and the Census of Agriculture.

Natural Resources and Environment

July 2006

While cropland used for crops decreased by 6 percent nationally between 1945 and 2002, some regions exhibited much larger percentage changes



Notes: Changes for the Far West are for 1949-2002.

Source: USDA, Economic Research Service, *Major Land Uses in the United States, 2002* (EIB-14). Data available at www.ers.usda.gov/data/majorlanduses/

On the Map

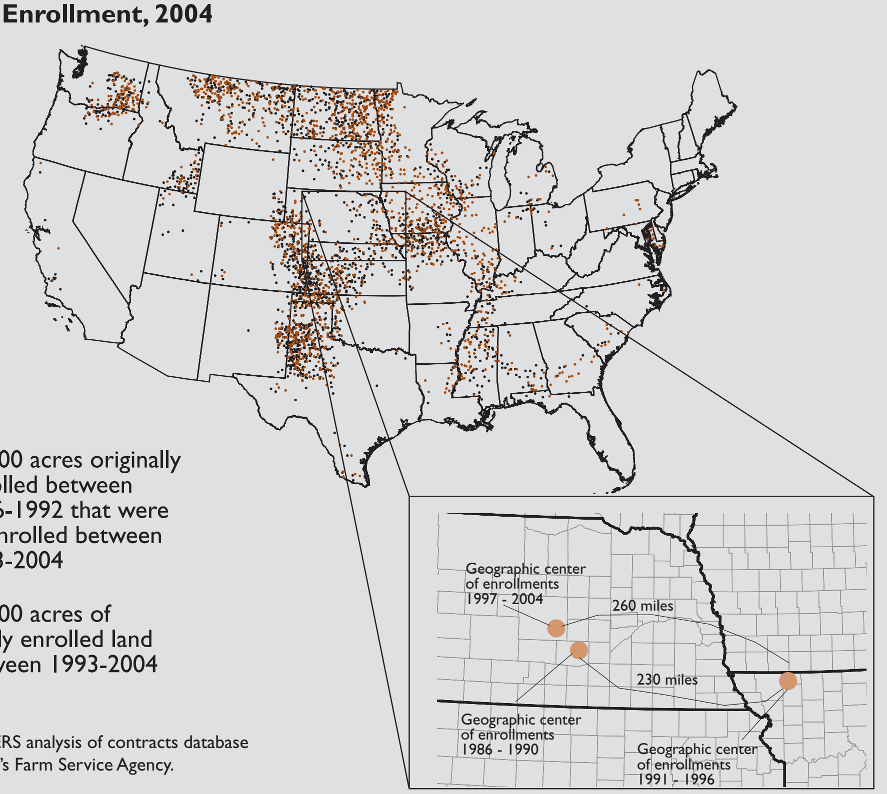
Originally published Vol. 2, Issue 5 (November 2004)

Geographic distribution of acres enrolled in the Conservation Reserve Program (CRP) is stable

Today, nearly 35 million acres of environmentally sensitive cropland are enrolled in the CRP. Although the total acreage enrolled in the CRP hasn't changed much since 1990, the actual land enrolled has. Nearly half of CRP acres enrolled between 1986-1992 have been replaced by new enrollments. Despite this turnover, the regional distribution of CRP acres has been stable. Within regions, however, changes are more substantial, with the Northern Great Plains showing the greatest shifts. These shifts may be due to changes in bid selection procedures; all contracts accepted after 1996 were ranked using a selection index that considers both cost and environmental benefits.

Shawn Bucholtz
sbucholtz@ers.usda.gov

CRP Enrollment, 2004



Source: ERS analysis of contracts database of USDA's Farm Service Agency.