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Conservation-Compatible Practices and Programs

Who Participates?

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Abstract

In recent years, the Federal Government has increased its emphasis on conservation programs that reward good stewardship on working farmland. This report examines the business, operator, and household characteristics of farms that have adopted certain conservation-compatible practices, with and without financial assistance from government conservation programs. The analysis finds that characteristics of the farm operator and household, in addition to the characteristics of the farm business, are associated with both the likelihood that a farmer will adopt certain conservation-compatible practices and the degree to which the farmer participates in different types of conservation programs. For example, operators of small farm operations and operators not primarily focused on farming are less likely to adopt conservation-compatible farming practices that are management-intensive and to participate in working-land conservation programs than operators of large enterprises whose primary occupation is farming.

Keywords: Conservation programs, conservation-compatible management practices, conservation structures, farm households, Conservation Reserve Program, Environmental Quality Incentives Program

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Summary

What Is the Issue?

Farm operators have a financial incentive to maintain the quality of their land by limiting soil erosion, avoiding excessive use of chemical inputs, and taking other steps to protect soil productivity. Because many farm operators live on or near their farms, they also have an incentive to reduce the onsite environmental degradation often associated with farm production. However, farm operators have little financial motivation to reduce offsite impacts, and farming remains a significant source of sedimentation and nutrient loading in some watersheds.

The Federal Government provides technical and financial support to farm operators for a wide range of conservation practices meant to reduce these offsite environmental impacts. Because these programs are voluntary, their effectiveness depends on the willingness of farm operators to participate. Operators' decisions can be influenced by considerations other than profits and the environment, such as off-farm work commitments and farm ownership status. By examining the characteristics of farms that have adopted conservation-compatible practices and participate in USDA conservation programs, we can better understand how potential participants might respond to market and program incentives.

What Did the Study Find?

The results of the analysis suggest that farm size, commodity mix, and operator motivation are all associated with decisions to use various types of conservation practices, but in different ways.

Conservation-Compatible Management Practices

Management practices that provide environmental benefits and profitability without large conversion costs (such as conservation tillage, crop rotation, and the use of insect-resistant or herbicide-tolerant plants) have been adopted by farms of all sizes, largely without direct financial assistance from conservation programs. However, operators of small enterprises focused on nonfarm occupations are less likely to adopt practices requiring extra time or expense (such as variable-rate application of inputs or integrated pest management) than operators of large enterprises whose primary occupation is farming. Higher education, the use of outside expertise, farm household reliance on farm income, and receipt of commodity program payments all affect the likelihood of a farmer's adopting conservation-compatible practices that are more management-intensive.

Structural and Vegetative Conservation Practices

Conservation structures like grass waterways and riparian buffers, and vegetative measures such as planting farmland to grasses and other conservation cover crops, come at a cost, both for installation and in forgone production. Younger operators who consider farming their primary occupation and who rely less on off-farm income are more likely to install grass waterways, contour strips, and other working-land structures compatible with agricultural production. Farmers who install these structures tend to receive only modest assis-

tance from conservation programs. More farm operators who plant conservation cover crops (either to retire cropland or as part of some other land-use change) consider themselves to be retired than those in the conservation structure group, and they receive more conservation program payments than other operators.

Working-Land Conservation Programs

Larger farms whose operators consider farming their primary occupation are more likely to seek participation in working-land conservation programs, such as the Environmental Quality Incentives Program (EQIP). Farmers who take advantage of conservation programs to install working-land practices typically enroll relatively little acreage in the programs, particularly if they are involved in the production of high-value crops.

Land Retirement Programs

Intensive use of land retirement programs is most common among smaller “retired” and “lifestyle” farms. Smaller farms whose operators are focused on nonfarm activities are also more likely to take land out of production. “Whole-farm” enrollees (those who effectively replace income from farm production with Conservation Reserve Program (CRP) payments) are generally older than other farm operators, are more reliant on nonfarm sources of income, and account for roughly half of the farms participating in the CRP. Most of the remaining participants use CRP to retire selected fields or portions of fields from production. These “partial-farm” enrollees tend to be operators of larger farms who consider farming their primary occupation.

Policy Implications

Because working-land and land retirement programs appeal to different types of farmers, both approaches may be needed to address the conservation needs of a diverse agricultural sector. Also, program incentives that assume that all farmers aim to maximize farm profits may not be as effective or efficient as flexible incentive structures that can accommodate other farm operator goals, such as timesaving and ease of use. Finally, policies other than direct subsidies can provide substantial environmental benefits. For example, conservation-compliance regulations, technical assistance, and research to improve standard farming practices (such as crop rotation) can all provide conservation payoffs.

How Was the Study Conducted?

This report analyzes the business, operator, and household characteristics of farms, focusing on those that have adopted one or more of a select group of conservation-compatible management practices or have installed one or more conservation structures, with and without the assistance of USDA's major conservation programs. Particular attention is focused on the Department’s farmland retirement programs, the largest of which is CRP, and its working-land programs, most notably EQIP and the working-land structures funded by CRP. Crop-specific data from the Agricultural Resource Management Surveys (ARMS) of farms growing corn (in 2001), soybeans (in 2002), and cotton (in 2003) allow us to examine the characteristics of farms that adopt conservation-management practices. A special section of the 2001 ARMS survey of all farms and ranches is used to examine the adoption of structural and vegetative conservation practices.

Introduction

Farm operators who own their land or who expect to lease it year after year have a profit motivation to ensure that its quality and productivity do not deteriorate over time. Further, many farm operators live near their farms, giving them an incentive to reduce farming-related environmental degradation such as air, noise, and groundwater pollution. Nonetheless, farming remains an important source of sedimentation and nutrient loading in our Nation's rivers and streams (Ribaudo, 2000; Claassen et al., 2001). Some conservation practices require costly investments that can reduce farm profitability, particularly in the short run. In addition, much of the unintended environmental damage caused by farm production is felt far downstream or only after a considerable time lag. If the farm operator will not benefit enough from adopting conservation practices, farming-related environmental problems are less likely to be addressed.

As an incentive to reduce both the onsite and offsite environmental impacts of farming, the Federal Government provides technical and financial support for farm conservation efforts. USDA's conservation programs share with farmers the cost of adopting conservation practices, but because these programs are voluntary, their cost and effectiveness depend on what farm operators demand in return for altering their farming practices. For the farmers, considerations other than profits and environmental outcomes, such as household budget constraints, farm structure and ownership, and personal goals, can affect the decision. This report examines farm operator adoption of selected conservation-compatible farming practices and participation in USDA's conservation programs. By identifying the characteristics of farm households that adopt conservation-friendly farming practices and participate in conservation programs, we can begin to understand how potential participants might respond to market and program incentives.

Why Is Farmer Behavior Important?

Farmland accounts for about half of the land area within the 48 contiguous States. Farming practices adopted by America's roughly 2 million farm operators have a major impact on the health of the ecosystem and on soil erosion, sedimentation levels in streams and rivers, nutrient and pesticide runoff, groundwater contamination, and air quality. National water quality assessments by the U.S. Geological Survey suggest that agriculture contributes toward water quality problems (Ribaudo, 2000). Agriculture has also been cited as a major contributor to declining levels of groundwater (Gollehon et al., 2003; Alley et al., 1999), pesticide contamination of groundwater (Barbash et al., 1999), nitrogen contamination in groundwater (USGS, 1999), nitrogen loads to the Gulf of Mexico, which contributes to hypoxia or oxygen-deficient waters (Goolsby et al., 1999), declining air quality near large confined animal feeding operations (NRC, 2003), and toxic *Pfiesteria* outbreaks (Staver and Brinsfield, 2001). Improved conservation practices can mitigate these unintended environmental consequences of agricultural production. For example, improved farming practices played a large role in reducing soil erosion from U.S. cropland by nearly 40 percent between 1982 and 1997 (Claassen et al., 2004). Variable-rate fertilizer application has decreased nutrient loadings into the environment in some cases

(Bongiovanni and Lowenberg-DeBoer, 2004). The establishment of permanent cover on farmland enrolled in land retirement programs has improved wildlife habitat and increased carbon sequestration (Claassen et al., 2001).

Economists typically assume that the decision to adopt a specific farming practice is based on profit-maximizing behavior, given the resources—including the type of farmland and the amount of time and management skills—of the farm operator. Indeed, research has shown that the operator's profit motive is often sufficient to elicit cost-cutting conservation efforts. For example, 75 percent of the reduction in soil erosion by corn producers between 1982 and 1997 can be attributed to the adoption of conservation tillage practices for business reasons (Hopkins and Johansson, 2004). But is profit the only motive behind the decision to practice good stewardship? Roughly 44 percent of farm operators are classified as "residential" by ERS, suggesting that the decision to pursue farming is based on quality-of-life factors in addition to the farm's ability to generate profits. Decisions based on enhancing the household's preferred lifestyle may result in different farming practices than those based on profit alone. An additional 19 percent of farm operators regard themselves as "retired." Concerns over succession, the desire to limit the time and energy spent farming, and the need for income stability can all affect decisions about farming practices and conservation program participation. These two types of farms, residential and retiree-operated, control over 24 percent of the Nation's farmland.[1] These farmers may weigh the importance of farm profits and quality of life differently than full-time commercial farmers, and their farming decisions can have a sizeable effect on the farm sector's environmental impacts.

[1]These data include retired and residential limited-resource farm operators (see box "Farm Typology") and so differ slightly from published data using the ERS farm typology, which includes such farms as a separate group. (www.ers.usda.gov/data/arms/app/Farm.aspx).

This report examines the economic and demographic profiles of farm operators who adopt conservation-compatible management practices, with and without Federal assistance. The factors driving the decision to adopt a conservation practice or participate in a conservation program are diverse, and they vary from household to household. Different types of farmers adopt different kinds of conservation practices. In designing conservation programs that maximize environmental benefits and rely on voluntary participation, it is critical to understand the motivating principles of various types of farmers.

Conservation-Compatible Practices

What are good conservation practices? USDA's Natural Resources Conservation Service (NRCS) lists 151 structural farming practices (e.g., the construction of riparian buffers, terraces, and sediment basins) and 16 management practices (e.g., conservation crop rotation, pest management, and nutrient management) that are eligible for Federal cost sharing under one or more of its conservation programs (NRCS, 2004). Each practice addresses one or more of the major concerns underlying USDA's conservation efforts: soil and land conservation, water quality and conservation, crop nutrient management, livestock manure management, wildlife habitat management, and air quality improvement (NRCS, 2003). Not all conservation practices have the same environmental impact, and their applicability depends on the situation. The conservation benefits from adopting a practice depend on the farmland's attributes, the farming practices in place, and a host of other factors, including the commodities grown, timing of the growing cycle, and input use. For example, conservation tillage can save on labor, machinery, and fuel costs while it reduces erosion and runoff. But farmers may need to increase their use of herbicide or other inputs to attain optimal yields, potentially reducing or eliminating conservation tillage's environmental benefits (Padgitt et al., 2000).

In assessing the extent to which farm operators practice conservation or use conservation-compatible practices, we have only limited information about the actual farming practices followed. (See box "Data Sources and Limitations," p. 5.) No attempt is made to assess the degree to which individual farmers are "good stewards of the land." Rather, we examine the household, operator, and farm characteristics of operations that have adopted one or more selected farming practices consistent with good stewardship, chosen for their broad applicability in different geographic locations and across different types of farming operations.

The practices we consider vary depending on the data source, and they are most relevant for farms engaged in crop production. For specific crops, we analyze three groups of conservation-compatible management practices.[2] The first group, which we term "standard practices," consists of farming practices that do not require highly specialized management skills:

- *Conservation tillage*. Mulch-till, ridge-till, and no-till practices can maintain or enhance soil quality while reducing soil erosion associated with conventional tillage practices.[3]
- *Crop rotation*. By interrupting the life cycles of some pests and reducing fertilizer needs, crop rotation can reduce the use of chemical inputs and soil erosion.[4]
- *Insect/herbicide-resistant plant cultivation.* Growing crops resistant to insects or tolerant of herbicides can reduce the need for chemical inputs.[5]

The second group, which we term "decision aids," provides the farm operator with information needed to pursue farming practices that moderate chemical input use:

- *Soil testing.* This is a first step toward targeted fertilizer application rates that can reduce nitrate leaching and phosphorous run-off.
- *Pest scouting.* As a first step for integrated pest management systems, pest scouting can lead to reduced pesticide applications.
- *Soil mapping.* Information on the soil characteristics enables strategic placement and timing of inputs.

The third group, "management-intensive practices," requires extra effort on the farm operator's part to manage inputs. Operators who make this effort can be identified by their use of data, gathered through decision aids, to apply nutrients and chemicals for maximum effect:

- *Input placement and timing.* Variable-rate application of fertilizers, herbicides, and pesticides may indicate that farm operators are using the results of soil tests and pest scouting to target input applications.

[2]This list of management practices builds on research reported in Caswell et al. (2001) and Quinby et al. (forthcoming).

[3]Mulch tillage allows at least 30 percent of crop residue to remain on the soil (Massey, 1997). Ridge tillage is a system in which ridges are formed during cultivation or after harvest, depending on which crops are planted. Crop residue accumulates between the ridges (Reeder et al., 1992). No-till systems leave the soil relatively undisturbed, with 60-95 percent of the field surface covered with crop residue (Hoette, 1997).

[4]Conservation crop rotation is used in about 80 percent of conservation-compliance plans (Claassen et al., 2004).

[5]Adoption of herbicide-tolerant plants can reduce the need for repeated applications of herbicides and can reduce the toxicity of herbicides that are applied (Fernandez-Cornejo et al., 2002).

- *Nutrient management.* Nitrogen applications based on the results of soil and plant-tissue tests are evidence of management-intensive farming.[6]
- *Pest management.* The use of written records on pest infestation, input applications based on university-developed infestation thresholds, or one or more recognized integrated pest management practices indicates a management-intensive approach.[7]

While these practices do not necessarily imply good stewardship, their use indicates that the farm operator is knowledgeable about the costs and benefits of altering farming practices to achieve conservation goals. The standard practices considered here characterize "embodied knowledge" technology (Griffin et al., 2004). That is, these technologies are self-contained, requiring little or no new equipment purchases, retrofitting of equipment, or additional cultivating skills.[8] Use of insect/herbicide-tolerant plants, conservation tillage, and crop rotation all involve practices with which farm operators are already familiar. At the other end of the spectrum, nutrient and pest management practices tend to be "knowledge intensive" in that they require the farmer to gather and process information and use farming techniques that may be new (Griffin et al., 2004).

In general, as one moves from standard practices to more management-intensive practices, management costs tend to rise. Management-intensive technologies are often scale-intensive.

For the producer willing to purchase a new combine, the extra charge of a global positioning system for the combine is negligible. But these technologies are human-capital intensive as well (Lowenberg-DeBoer, 2003). The extra time required may often be high enough to discourage producers from learning how to accumulate, store, process, and interpret laboratory results in the field or data generated electronically using office computers (Fountas et al., 2003). Being able to spread human capital costs and added equipment costs over more acres makes adoption of management-intensive technologies more likely.

The management-related practices discussed above were identified using data collected on specific crops. To supplement such data, we also looked at the use of a small number of conservation cover practices and structures (for example, grasses, trees, and riparian buffers) by all types of farmers and ranchers. These practices include:

- *Whole-field grasses and trees.* Native grasses, legumes, and trees planted on farmland retired from production can provide a wide array of environmental benefits.
- *Wildlife habitat enhancement and protection of rare or declining habitats.* Native wildlife habitats can be rejuvenated by installation of food stands, demarcation of sensitive wetland areas, and cessation of farming or grazing. Most benefits accrue off-farm or to the farmer in the form of nonfarm returns (for example, hunting or viewing fees).
- *Grass waterways, filter strips, contour strips, and riparian buffers.* Grass or vegetative strips and filters capture sediment and organic matter by slowing runoff. Riparian buffers along streams and waterways reduce

[6]All NRCS-approved nutrient management plans must balance nutrient inputs with nutrient outputs (NRCS, 2003).

[7]This definition follows that used by Fernandez-Cornejo and Jans (1999) to identify farms engaged in integrated pest management practices.

[8]Hybrid corn in the 1920s is an example of embodied knowledge technology. When it was introduced in the United States, hybrid corn was a new technology, but the knowledge needed to implement the technical package was already well-established. Two other examples of embodied knowledge technologies are Bt corn and Round-up Ready™ soybeans.

Data Sources and Limitations

Because this research focuses on the characteristics of farms, operators, and households that have adopted conservation-compatible practices and participate in conservation programs, we rely primarily on USDA's Agricultural Resource Management Survey (ARMS). ARMS is the only annual source of data on the finances and practices of a nationally representative sample of U.S. farms that includes information on the characteristics of farm operators and their households. ARMS is a collection of annual surveys, some of which focus on the farm enterprise and some on specific fields growing specific crops. This report uses data from the 2001 Phase III ARMS questionnaires for a representative sample of all farms in the United States, supplemented with 2001-2003 Phase II/III ARMS data on specific crops. Phase II data allowed for a closer look at the adoption of a consistent set of farming practices on farms growing corn (in 2001), soybeans (in 2002), and cotton (in 2003).[9]

Given our interest in farm operator and household characteristics associated with conservation-compatible practices and program participation, our focus is on family farm operations for which household information is available and meaningful. That is, we exclude nonfamily corporate and cooperative farms and other operations with a hired farm manager. Family farms operated 875 million acres of U.S. farm and ranchland in 2003 (94 percent of the total) and accounted for more than 98 percent of U.S. farms.

Note that ARMS is not designed to evaluate conservation practices or program use. While the questionnaires elicit information on a select group of management practices that are consistent with good stewardship, they make no attempt to collect information on all recognized conservation practices, or to tie the adoption of identified practices to a conservation need or, in most cases, conservation program funding. ARMS tells us if the farm has adopted one or more of a select group of reimbursable conservation practices and whether the farm received conservation funding, but we do not know if the funding was for the identified practices or for some other approved practice.[10] For farms that follow conservation practices during the year of the survey but do not report receiving conservation program funds, we cannot rule out the possibility that those practices were paid for with program funds received in previous years. With these caveats in mind, we know whether a farm has adopted some of the farming practices thought to have conservation benefits and whether it is currently receiving conservation program funding.

ARMS asks the respondents to specify the amount of conservation program funds received during the survey year and the number of acres enrolled in conservation programs.[11] In some years, the survey collects information for specific types of programs, but in other years, only combined information is collected for participation in the three major programs (the Conservation Reserve Program (CRP), the Wetland Reserve Program (WRP), and the Environmental Quality Incentives Program (EQIP)). Rather than restrict our analysis to a consistent (aggregated) set of programs, we exploit detailed program data when it exists and is of interest.

Finally, little information is available on the need for conservation practices on land farmed by the respondent or the eligibility of nonparticipating farms for conservation program assistance. For specific crops, information is available on highly erodible land and wetlands, but for all farms and ranches, only county-wide measures of erodibility are available using National Resource Inventory data. If the distribution of other or intracounty landscape characteristics requiring remedial action is correlated with business, operator, or household characteristics, the relationships identified with ARMS data can be misleading.

[9]For a description of ARMS, see "ARMS—what farmers tell us about their businesses and households" (www.ers.usda.gov/Briefing/ARMS/).

[10]We refer to any practice eligible for cost-share or rental payments under one of USDA's conservation programs as a reimbursable conservation practice.

[11]The ARMS data do not include information from USDA administrative files on program usage or payment receipts, but rely entirely on the respondent for program-related information. Because of differing concepts of what constitutes a farm among the program agencies and the National Agricultural Statistics Service (which administers the ARMS questionnaires), as well as confidentiality concerns, administrative data cannot readily be matched to ARMS respondents.

runoff and stabilize banks. They can have both onsite and offsite benefits and are often compatible with existing farm production practices.

By comparing farms that have chosen to adopt these conservation practices with farms that have chosen not to adopt them, we can identify the characteristics of farming operations that appear to follow practices consistent with good stewardship. Then, by focusing on the characteristics of farms that chose to participate in conservation programs, we can begin to understand how certain programs encourage good stewardship practices within the diverse group of farms operating across the country.

Conservation Programs

Efforts to mitigate unwanted environmental side effects from agriculture are not new. In 1894, the Federal Government established the Division of Agricultural Soils to curtail soil erosion caused by agriculture (NRCS, 2000). For most of its history, the Department's conservation efforts focused on the onsite benefits of reducing soil erosion. In recent decades, the Department has broadened its emphasis (although soil erosion reduction remains an important goal of conservation policy) to target water and air quality improvement and wildlife habitat protection. Together, these goals help define "good stewardship" of privately owned agricultural land.

Today, the NRCS and the Farm Service Agency manage several voluntary conservation programs for private land with the objective of fostering good stewardship practices. Funding for voluntary conservation programs was $3.8 billion in 2006. Federal programs providing conservation funding directly to farmers and ranchers focus largely on either: (1) retiring environmentally sensitive farmland from production or (2) improving conservation practices on working farmland. Examples of voluntary conservation programs include:

- **The Conservation Reserve Program (CRP)** was authorized by the Food Security Act of 1985 (the 1985 Act) to retire environmentally sensitive land from agricultural production for 10 to 15 years. In return for an annual rental payment and partial reimbursement for the cost of establishing and maintaining approved groundcover, participants agree to take enrolled land out of production and plant grasses, trees, and other conservation cover crops. Since 1996, producers have also had the option of enrolling land through a continuous signup program focused on developing riparian buffers and other working-land conservation structures. The program is limited mostly to cropland. In 1997, the Department began funding the Conservation Reserve Enhancement Program (CREP), a Federal-State partnership that targets farmland in specific geographic areas for retirement to further local conservation goals. Nearly 600,000 acres have been enrolled in the CREP, which is administered through CRP. In 2004, farmers and landowners were paid $1.8 billion in cost-share and rental payments on roughly 35 million acres of enrolled land (USDA, 2005a).
- **The Wetland Reserve Program (WRP)** was first implemented in the early 1990s to retire and restore wetlands that had been converted to cropland (Heimlich et al., 1998). The Farm Security and Rural Investment Act of 2002 (the 2002 Act) authorized enrolling slightly over 2 million acres in WRP. The WRP program restores and protects wetlands through cost-share assistance as well as 30-year and permanent easements.
- **The Environmental Quality Incentives Program (EQIP)** provides financial and technical assistance to help participants install or implement conservation practices on eligible agricultural land. EQIP is a working-land program designed to help farmers institute conservation practices and integrate conservation structures into their farming operations. For structural or vegetative practices, EQIP can reimburse up to 75 percent of the installation costs.[12] Producers can also receive incentive payments for adopting management practices. Since EQIP's inception in 1996, $720 million in EQIP funds has helped nearly 46,500 ranchers and farmers improve air, soil, and water quality on private working land (USDA, 2005a). At least 60

[12]With passage of the 2002 Act, most practices are now cost-shared at 50 percent, and incentive payments are fixed by practice and county.

percent of EQIP funds go to livestock producers, including large confined livestock operations.

- **The Conservation Security Program (CSP)** was authorized by the 2002 Act. It is a working-land program that rewards ongoing environmental stewardship and provides producers incentives to adopt additional conservation practices. But unlike EQIP, CSP can reimburse farmers for continuing conservation practices already in place. 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 (USDA, 2005a).

Other programs include the Farm and Ranch Lands Protection Program, the Grassland Reserve Program, the Wildlife Habitat Incentives Program, and Agricultural Management Assistance. The 2002 Act provided a $17 billion increase above the baseline spending for these programs over 10 years, with the major recipients being CRP, CREP, EQIP, and WRP (Lovejoy and Doering, 2002). This report focuses on these programs.

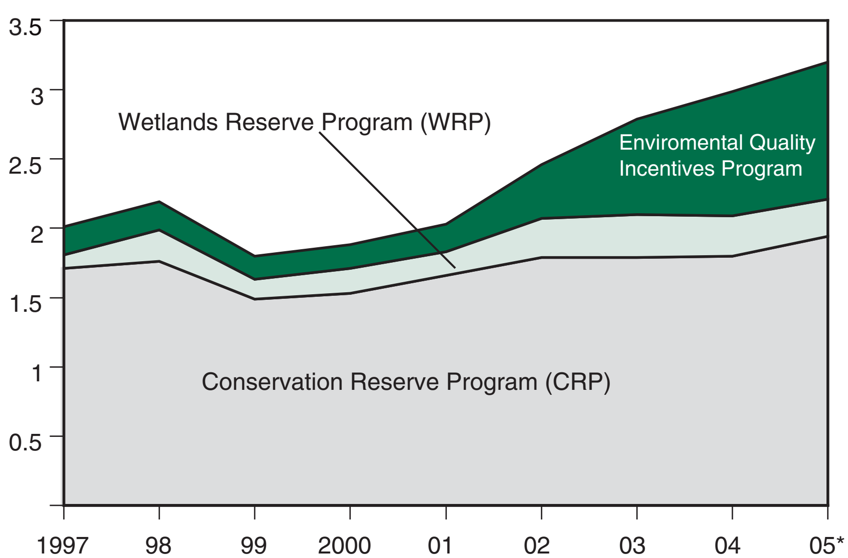
In the years following CRP's authorization in 1985, most conservation payments to farmers funded land retirement. But with the 2002 Act, funding for working-land programs has risen rapidly (fig.1). While land retirement and working-land practices are not mutually exclusive (several practices, such as riparian buffers, can be funded under either type of program), one would expect land retirement programs to appeal to a different segment of the farming population than working-land programs. Land retirement may appeal more to those who wish to curtail their farming activity, either because of retirement plans or to take advantage of more lucrative off-farm activities. Working-land programs may appeal more to those who see farming as their primary occupation and can afford to invest time and managerial skill to experiment with new farming practices. We focus on any differences between participants in these two general types of conservation programs.[13]

[13]To highlight the "land retirement" vs. "working-land" aspects of Federal program assistance, we treat some CRP assistance as a working-land program. Farmers who sign up whole fields are assumed to focus on the land retirement aspects of CRP. Those who enroll smaller tracts of land to meet specific conservation needs (i.e., to install riparian buffers, grass strips, grass waterways, or other conservation structures) consistent with working-land practices are assumed to use the program in conjunction with production on adjacent land.

Figure 1

USDA conservation expenditures for selected programs, 1997-2005

Billion $



*Estimated
Source: ERS analysis of Office of Budget and Policy Analysis data.

Who Has Adopted Conservation-Compatible Practices?

To anticipate the characteristics of farmers who have chosen to adopt conservation-compatible practices, it helps to consider why they might do so. We have already alluded to the most powerful argument for adopting many conservation-compatible practices: to reduce costs or increase revenue. For example, variable rate applications of inputs not only reduce the likelihood of excessive use of nutrients and chemicals, but they can also reduce the cost of growing a crop. However, variable rate applications may require new or retrofitted fertilizer application equipment and new management skills. Being able to spread these fixed costs over more acres makes conversion more appealing. Thus, the scale of the farming operation is likely to be a major determinant in many farming practice decisions. Similarly, the farmer's planning horizon can influence cost-effectiveness calculations; young farmers, or those who plan on farming for many years, may be more willing to retool than farmers looking forward to retirement.

But profits are not the only consideration in farm management decisions. Even practices that promise higher returns may not be appealing to some operators if they require lifestyle changes inconsistent with household goals. Off-farm employment and the relative importance of farm profits to farm household income and well-being may make it more important to minimize the amount of time the operator spends farming than to maximize farm profits.

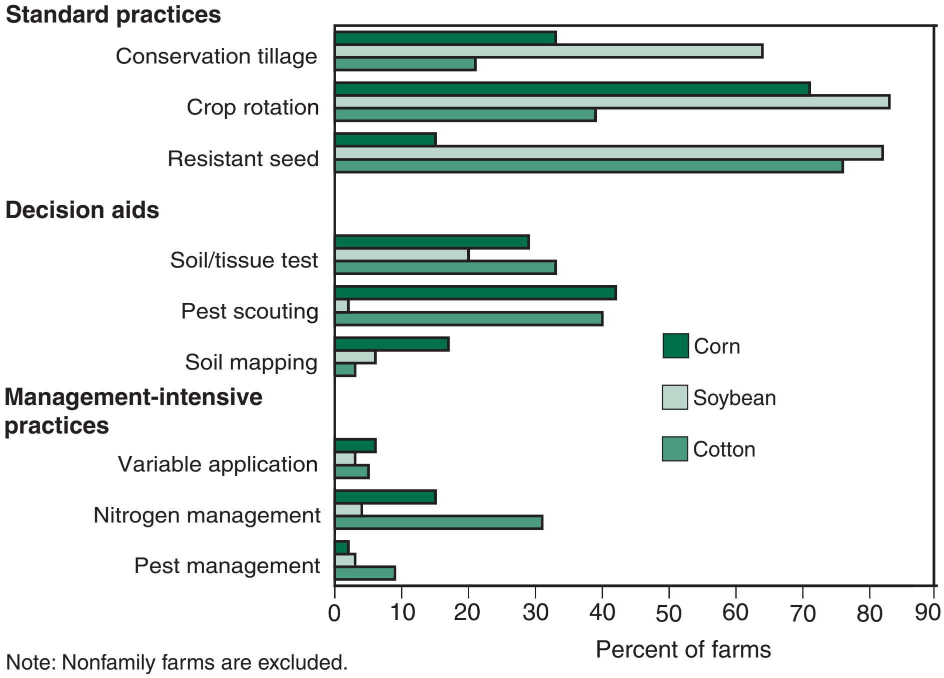
Not all conservation-compatible practices save time or reduce costs. When a conservation practice would cause a drop in production or require increased cost and management skills to hold production steady, what would motivate the farmer to adopt it? One motivation might be the need to satisfy conservation-compliance requirements to ensure continued receipt of Federal farm payments, especially for operators who receive large payments.[14] Further, commodity payments reduce the financial risk farmers face in changing farming practices, making adoption of conservation-compatible practices for business reasons less risky. Another consideration is the share of adoption costs borne by the farm operator; operators who participate in conservation programs may find the out-of-pocket expenses of conservation practices much reduced. Finally, farm operators can value land stewardship and the environment apart from any profit motive. While environmental sentiments are not the province of any particular type of farm, adoption of conservation practices may be more likely in environmentally sensitive areas and when the cost is relatively low.

[14]The 1985 Food Security Act required producers cropping highly erodible land to implement soil conservation plans or risk losing their Federal farm program benefits. More stringent conservation requirements were imposed on highly erodible land cropped for the first time (Claassen et al., 2004).

Figure 2 shows the percentages of corn, soybean, and cotton farms whose operators report that they are engaged in selected farming practices consistent with conservation behavior. While there are variations among crops, a high percentage of farm operators report using one or more "standard" conservation-compatible farming practices-conservation tillage, crop rotation, or insect/herbicide-tolerant plants. Fewer farm operators perform soil tests, systematically scout for pests, or develop soil maps to help them manage their input use. Still, fewer report using management-intensive conservation-compatible practices, such as variable-rate application of

Figure 2

Use of conservation-compatible management practices on selected fields from farms growing corn (2001), soybeans (2002), and cotton (2003)



Note: Nonfamily farms are excluded.
Source: 2001-2003 ARMS, Phase II/III.

inputs and nutrient and pest management systems. Because these are all working-land management practices, they are not reimbursable under any of the land retirement programs (CRP, CREP, or WRP). While many of these practices do qualify for reimbursement under EQIP, program funding was limited in 2001-2002. According to the ARMS data, only about 1 percent of corn and soybean farms were reimbursed for these or related conservation-compatible management practices.[15]

[15]EQIP funding was not tracked as a separate item for cotton farms in 2003.

Farm size and farm household characteristics that might influence farming practice decisions are summarized in the ERS farm typology (Hoppe et al., 2000). Retirement and residential farms are generally smaller and less engaged in farming as an occupation. Low-sales farm operators who consider farming their primary occupation may lack the resources to remain viable in the long run without significant off-farm income. Farms with higher sales are more focused on farming as an income source and have the scale needed to make farming investments pay off (see box "Farm Typology"). Figure 3 shows the distribution of corn, soybean, and cotton farms that have adopted one or more farming practices in each of our three classes of conservation-compatible management activities. Farm size and farm type do not appear to be related to the adoption of standard practices. However, the distribution of farms collecting field-level information to support production decisions and of farms using management-intensive practices suggests that scale and farm/off-farm work considerations may be factored into decisions about practices that require more operator skill or time.

Larger corn farms and farm households with relatively little off-farm income are more likely to employ decision aids and adopt management-intensive

Farm Typology (Family farms)

To highlight segments of the farming population, we modified the standard ERS farming typology (Hoppe et al., 2000) to focus on four groups of family farms, which differ depending on the data analyzed:

- ***Retired***. Small farms (those with sales under $250,000) whose operators report they are retired.

- ***Residential***. Small farms whose operators report a major occupation other than farming.

For corn, soybean, and cotton farms, which tend to be larger than many other family farms, we combine the retired and residential categories.

- ***Low-sales***. Farms with sales less than $100,000 whose operators report farming as their major occupation.

- ***High-sales***. Farms with sales of $100,000 or more whose operators report farming as their major occupation and farm with sales of $250, 00 or more, regardless of the operator's occupation.

For analyses of corn, soybean, and cotton farms, we separate the high-sales group into:

- ***Small/higher sales***. Farms with sales of $100,000 to $249,999 whose operators report farming as their major occupation.

- ***Commercial.*** Farms with sales of $250,000 or more.

Farms organized as nonfamily corporations and cooperatives, and farms operated by hired managers, are excluded from our analysis.

Key characteristics of each group are as follows:

Variable	Retired	Residential	Low sales	High sales: Small	High sales: Commercial
Farm operators (1,000s)	398	933	469	135	151
Average farm size (acres)	172	163	423	1,165	1,987
Average farm income ($)	4,885	642	7,905	41,486	155,969
Percent of HH* income nonfarm	102	106	99	51	27
Percent of U.S. farmland	7	16	21	17	32
Percent of U.S. cropland	6	12	17	21	41
Percent of U.S. farm production	2	5	8	12	59
Percent receiving govt. payments	33	27	44	84	75
Percent receiving conservation pmts.	17	11	10	18	19

Nonfamily farms are excluded, so the percentages of U.S. totals do not sum to 100.
Source: 2003 ARMS, all versions.

*HH=Household.

practices (table 1). Thus, the larger the farm and the more important its profitability to the farm household's income and well-being (as evidenced by the operator's primary occupation and the farm household's degree of reliance on off-farm income), the more receptive the operator will likely be to practices that may reduce costs or increase yields.[16] If these practices cut costs by reducing chemical input use or runoff, they can have broader environ-

[16]While we cannot infer cause and effect based on a comparison of means or from any of our econometric results, farms that practice more management-intensive farming practices have higher average yields.

Table 1

Farm, operator, and household characteristics of corn farms and conservation-compatible management practices adopted, 2001

Characteristic	Units	Standard practices[1]	Decision aids[2]	Management intensive[3]	No listed practice
Farm characteristics					
Average farm size	Acres	575 BCD	648 ACD	854 ABD	386 ABC
Average net farm income	Dollars	15,390 BC	23,753 A	32,981 AD	*17,327 C
Average commodity payments	Dollars	17,409 BCD	24,587 ACD	34,833 ABD	4,561 ABC
Average conservation payments	Dollars	548 D	764 D	*761	*243 AB
Acres owned that are operated	Percent	45 D	41 D	43 D	63 ABC
Farm with HEL/wetlands	Percent	20 D	24 CD	17 BD	*8 ABC
Irrigated land	Percent	*4 C	*10	15 AD	*3 C
Average corn yield	Bu/acre	119 BCD	135 AD	142 AD	60 ABC
Operator characteristics					
Average age	Years	53 BC	51 A	51 A	53
Average experience	Years	27	25	27	26
Major occupation:					
Farming	Percent	69 BC	81 A	84 AD	74 C
Nonfarm occupation	Percent	28 BCD	17 A	14 AD	21 AC
Retired	Percent	*3	**2	*3	**5
Education:					
High school	Percent	54	48	46	46
Some college	Percent	20	28	26	21
Completed college	Percent	13 C	14 C	20 ABD	*8 C
Used outside advice[4]	Percent	7 BCD	12 ACD	28 ABD	*2 ABC
Household (HH) characteristics					
Farm income shared with others	Percent	15	12 D	14	18 B
Off-farm work (operator)	Percent	44 CD	38	31 A	34 A
Off-farm work (spouse)	Percent	48	53 D	46	41 B
Average off-farm income	Dollars	33,176	31,52	30,494	27,582
Share of HH income off-farm	Percent	70	59	51	62
Number of observations		484	745	459	142
Number of corn farms		108,494	141,569	73,963	32,902
Share of all corn farms	Percent	30	40	21	9

[1] Farms using conservation tillage, crop rotation, or insect/herbicide-resistant plants, but not other listed practices.

[2] Farms that collect soil or plant tissue tests, systematically scout for pests, or map soil characteristics, but do not use any management-intensive practices.

[3] Farms that use variable rate application of fertilizers and pesticides, rely on soil tests for nitrogen application, or display evidence of integrated pest management practices.

[4] Farmers who rely on crop consultants or extension service personnel when deciding how much nitrogen to apply.

Notes: Nonfamily farms are excluded. Coefficient of variation = (standard error/estimate) x 100.* indicates that CV is greater than 25 and less than or equal to 50.** indicates that CV is above 50.

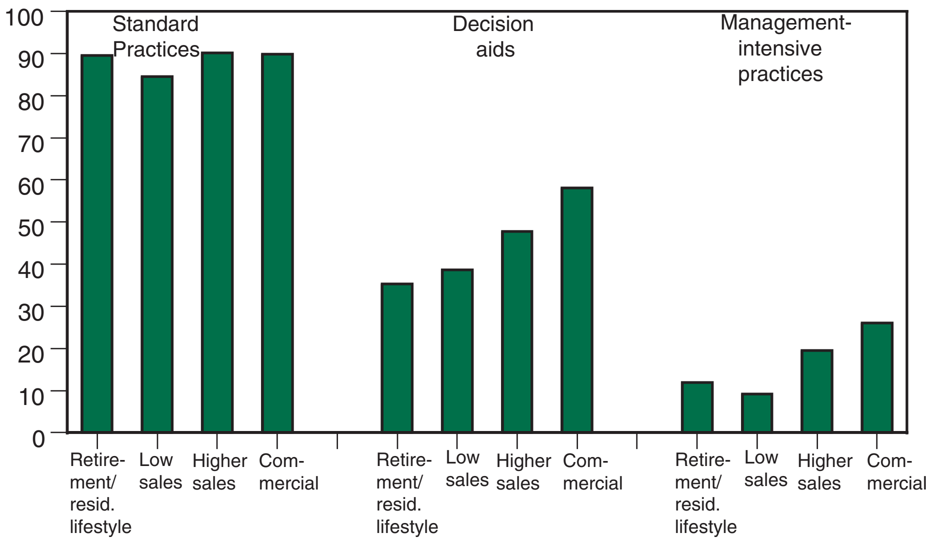
Letters A, B, C, and D indicate significant column differences based on pairwise two-tailed [Ho:B1=B2] delete-a-group Jackknife t-statistics at a 90-percent confidence level or higher with 15 replicates (Dubman, 2000). A = standard practices, B = decision aids, C = management-intensive practices, and D = no listed practice.

Source: 2001 ARMS, Phase II/III.

Figure 3

Conservation management practices used on corn, soybean, and cotton farms, by type of farm (2001, 2002, and 2003, respectively)

Percent of farms in each type



Note: Nonfamily farms are excluded.
Source: 2001-2003 ARMS, Phase II/III.

mental benefits. While farming practices vary depending on the commodity grown, a similar pattern emerges for soybean and cotton farms (not shown). Corn farm operations tend to be larger than many other family farm operations, averaging 644 acres, compared with 414 acres operated by the typical family farm in 2001. However, even with a distribution skewed toward full-time farming operations, the effect of scale on farming practice decisions is clear. As the management skill needed to make a farming practice profitable increases, so does the average size of farms adopting the practice (in terms of acres operated, net farm income, and commodity payments received). Increased use of management-intensive practices corresponds with higher education levels of farm operators and greater operator reliance on outside consultants, perhaps reflecting the human capital needed.

Many farm operations had adopted at least one of the standard conservation-compatible practices we examined, such as crop rotation. Those that had not adopted these practices were smaller than the adopting farms and had lower average yields. Farm operators who had not adopted any of the farming practices we examined also had fewer years of formal education, relied less on outside consultants, and had lower household income levels, on average.

We estimated an econometric model to explore how the likelihood of corn farmers' adoption of management-intensive conservation techniques varied with specific business, operator, and household characteristics.[17] (See appendix for details.)

[17]The analysis focuses on corn farms that completed Phases II and III of the 2001 ARMS. Therefore, conclusions should not be extrapolated to other farm operations.

From our analysis of corn operations that had adopted or not adopted conservation-compatible practices, we found that, holding other factors constant:

- Larger corn operations are more likely than small operations to use decision aids or management-intensive technologies.
- Farms that combine corn production with production of high-value crops (fruits, vegetables, and nursery products), poultry, or hogs are more likely to use decision aids or management-intensive technologies.
- Corn farm operators who receive commodity program payments are more likely to use decision aids or management-intensive technologies than operators who do not receive payments.
- Corn farm operators who seek advice from consulting services or extension agents are more likely to use decision aids or other management-intensive information systems.
- Operators of irrigated corn farms are more likely to use management decision aids or management-intensive technologies than operators who do not irrigate.
- Corn farm operators reporting higher levels of educational attainment (on a continuum from high school through graduate study) are more likely to use decision aids or management-intensive practices than operators with less education.
- Corn farm operations that classify themselves as family corporations are more likely to use decision aids and management-intensive technologies on their farms, but farms sharing income with other households are less likely to adopt these technologies.

We do not find a connection between conservation program payments and the decision to adopt conservation-compatible practices, perhaps because working-land program budgets were relatively small in 2001. However, as funding for working-land programs increases, more farmers may take advantage of these programs to adopt reimbursable conservation practices.

Our findings are generally consistent with those reported by Caswell et al. (2001) in an analysis of farming practices in the 1990s. That study found a correlation between farm size, receipt of government commodity program payments, use of expert advice, educational attainment, and use of irrigation systems and the decision to adopt “modern” farming practices (which loosely correspond to our “management-intensive” conservation-compatible practices).

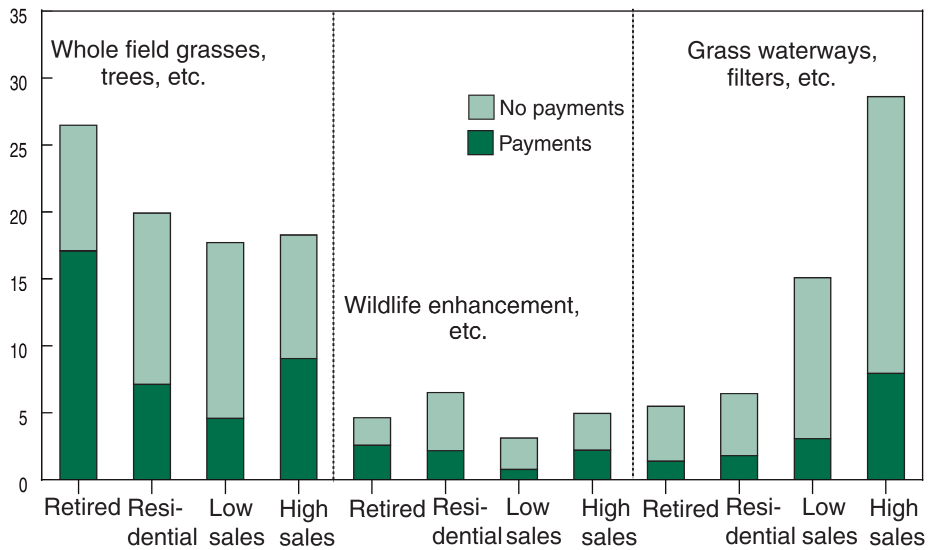
Farm operators can also install conservation structures on working and retired farmland. Figure 4 shows the share of all farm operations that had installed conservation structures or rotated fields out of production in 2001.[18] Scale seems to be important when the conservation structure is compatible with ongoing farming operations (for example, grass waterways or contour strips, which are used more frequently on large farms than on smaller ones), but appears less important when practices involve land retirement and wildlife enhancement. Furthermore, participation rates in a conservation program are higher among farms that planted whole fields to grasses, etc., and installed wildlife enhancements than among farms that installed

[18]The question on whole fields planted to grasses, etc., does not require the respondent to differentiate between cropland and pastureland or between "permanently" retired fields, fields left temporarily fallow, or planted to grasses/legumes as part of a planned crop rotation. For farms participating in CRP, CREP, or WRP, land is retired for a multiyear contract period and is managed for conservation purposes. But for other farms, land could come back into production at any time (or may currently be working pastureland) and so may have only limited environmental benefits.

Figure 4

Conservation structural and vegetative practices on all family farms with and without conservation program funding, by type of farm, 2001

Percent of farms in each type



Note: The darkest portion of each bar represents farms that have conservation structures in place and that received conservation funding in 2001. The program funding need not be for the specific practice highlighted. Whole fields planted to grasses, etc., that are obviously pastureland are excluded, but this category can still include land never intended for crop production or cropland left fallow on a temporary basis.
Source: 2001 Arms, Phase III, Cost and Returns Report, Version 1.

working-land-compatible conservation structures. Table 2 presents descriptive statistics on the business, operator, and household characteristics of farms that had installed conservation structures and those that had not. Most farms had none of the identified structures in place in 2001. Of the 25 percent that had one or more conservation structures, over half were in the form of whole fields planted to conservation cover (grasses, legumes, etc.), with working-land-compatible structures accounting for another one-third of "practicing" farms. Major differences between farms that had not installed conservation structures and those that had were largely restricted to the working-land structures. The only significant differences between farms that had not installed conservation structures and farms that had retired whole fields were the lower share of retired farm operators, the lower level of Federal conservation payments, and the higher share of production from high-value crops among noninstallers.[19]

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 conservation structures were generally larger grain farms that relied less on conservation payments. The farm operator who installed them was more likely to consider farming his/her primary occupation, was slightly younger, and relied less on off-farm income than the farm operator who participated in land retirement programs. These differences are consistent with our previous finding that farm operators who focused on farm production and relied on farm income were more likely to invest in costly and management-intensive, conservation-compatible practices.

[19]We do not include an exhaustive list of conservation structures eligible for reimbursement under CRP or EQIP. As a result, the "No listed practice" group includes farms that receive conservation payments for other activities.

Table 2

Farm, operator, and household characteristics of farms with selected conservation structures in place, 2001

Characteristic	Units	Whole field grasses, etc.		Wildlife enhancement		Working lands[1]		No listed practice	
Farm characteristics									
Average farm size	Acres	494		*705		*592		388	
Average net farm income	Dollars	***14,844		***7,308		*30,877	D	*12,033	C
Average commodity payments	Dollars	5,352	C	*6,648	C	19,427	ABD	5,689	C
Average conservation payments	Dollars	*3,043	CD	*3,258	CD	711	ABD	*189	ABC
Average share of production from:									
Grains	Percent	10	C	*14	C	47	ABD	12	C
High-value crops	Percent	***2	BD	*9	AC	***2	BD	*8	AC
Livestock	Percent	36		**24		36		43	
Other	Percent	17		**32		*9	D	22	C
Operator characteristics									
Average age	Years	58	C	54		53	A	54	
Average experience	Years	24		*22		26		22	
Major occupation:									
Farming	Percent	35	C	**29	C	68	ABD	40	C
Nonfarm occupation	Percent	41		*58		*26	D	50	C
Retired	Percent	25	CD	*12		*6	A	*10	A
Education:									
High school	Percent	42		*29		43		41	
Some college	Percent	21		***34		27		24	
Completed college	Percent	*14		***18		13		13	
Female operator	Percent	*17	C	***9		*3	AD	8	C
Household (HH) characteristics									
Average size of household	Number	2.6		2.9		3.1		2.7	
Farm income shared with others	Percent	***4		—		5	D	**2	C
Off-farm work (operator only)	Percent	*17		***21		19		*24	
Off-farm work (spouse only)	Percent	**15		*8	C	22	B	13	
Off-farm work (dual)	Percent	34		*48		31		32	
Average off-farm income	Dollars	52,811		*77,778		44,192	D	60,499	C
Share of HH income off-farm	Percent	83		88	C	74	BD	83	C
Observations	Number	546		223		488		4,090	
Farms	Number	263,553		82,322		166,863		1,499,219	
Share of all farms	Percent	13		4		8		75	

[1] Conservation structures consistent with farm production, such as grass waterways, filters, and riparian buffers.

Notes: Nonfamily farms are excluded. Coefficient of variation (CV) = (standard error/estimate) x 100.
* indicates that CV is greater than 25 and less than or equal to 50.
** indicates that CV is greater than 50 and less than or equal to 75.
*** indicates that CV is above 75.
Letters A, B, C, and D indicate significant column differences based on pairwise two-tailed [Ho:B1=B2] delete-a-group Jackknife t-statistics at a 90-percent confidence level or higher with 15 replicates (Dubman, 2000). A=whole field grasses, etc., B=wildlife enhancement, C=working-land practices (grass waterways, filter strips, etc.), and D=no listed practice.
— indicates legal disclosure problems.

Source: 2001 ARMS, CRR version 1.

To supplement table 2, we used an econometric model to determine the characteristics associated with the likelihood that an operation used working-land-compatible structures, installed wildlife enhancements, or planted whole-field conservation cover (see the appendix, particularly app. table 2). Holding all other factors constant, as the contribution of grain production to total production revenue increased, the likelihood of a farm operation planting whole fields to conservation cover crops lessened. On the other hand, farms specializing in grain production were more likely than farms that focused on other products to install working-land-oriented conservation structures. Conservation payments as a proportion of the total value of farm production had a positive influence on the likelihood that an operator participated in land retirement and wildlife enhancements. Farms operating on land susceptible to water erosion, or farms located near water sources (such as streams, rivers, or lakes), were also more likely to use working-land structures.

In summary, there are differences in the adoption of conservation-compatible practices that embody knowledge and skill within the technology itself (such as insect/herbicide-resistant plants) and the adoption of practices that require farm operator knowledge and skill (such as variable rate application of inputs). Conservation-compatible practices that require relatively little specialized management skill and cost the farm operator little in forgone profits or out-of-pocket expenses are widely dispersed among the farming population. Their adoption may have environmental benefits, but the farm operator's primary consideration is likely to be minimizing cost and time.[20] Farm practices that require more intensive management skills and a considerable investment in working and human capital, but that offer a sound investment return, may appeal more to farm operators concerned with maximizing farm profits. Large-scale farm operations can spread the cost of such practices over more acres, making it easier to justify the initial investment in equipment and management skill. For example, contour farming or strip cropping is easier using autoguidance systems. These navigating systems are relatively expensive, costing up to $35,000 (Griffin et al., 2005). However, large commercial operations can quickly recapture this capital outlay through input cost savings and soil productivity enhancement. Likewise, younger farmers may be more willing to make these investments because of their longer farming horizons.

[20]Nehring et al. (2002) argue that practices that do not add to farm profitability by cutting costs or increasing yields, such as herbicide-tolerant plants, are popular on soybean farms because they reduce the time and effort the farm operator needs to devote to the operation.

Conservation structures that encompass whole fields are likely to appeal to farm operators who: (1) have marginal land that cannot be profitably farmed year after year, (2) own pasture not intended for crop production, or (3) have a primary goal other than maximizing crop yields. This goal might be maximizing rental returns (in the form of CRP payments), finding time for other pursuits (such as retirement or an off-farm career), or increasing the value of farmland for nonfarm activities (such as hunting, fishing, and scenic enjoyment). Older, retired farm operators and those receiving significant conservation program payments are more likely than other farm operators to plant whole fields with grasses and other conservation cover. Structures compatible with continued crop production, such as filter strips, appeal to larger operations that receive more in Federal commodity payments than in conservation program payments. Thus, the role of conservation programs in influencing conservation practice decisions likely varies by the type of practice, the farm's cost structure, the operator's skill, and the household's goals.

Variables Examined

Tables 1 through 3 compare farm, operator, and household attributes, and each is supplemented with the results of a multivariate regression model. Details of these models are provided in the appendix. The model variables include (1) farm production characteristics, (2) government payments received by farm households, (3) farm household demographic variables, (4) environmental factors, and (5) regional variables.

Farm Production Characteristics

- ***Value of production shares.*** To measure effects of farm diversification, we include the value of production shares from high-value crops (e.g., revenue from fruits, nursery products, and vegetables), grain crops (such as corn, soybeans, rice, barley, sorghum, and wheat), and sales of cattle and dairy, hogs, and poultry.

- ***Tenure.*** The proportion of land owned to land operated reflects the effects of tenancy on the adoption of conservation-compatible practices and land enrollment in conservation programs. In general, we expect this ratio to be relatively small for larger farms engaged in agriculture for profit, as these farms tend to rent land for production purposes.

- ***Gross cash farm income less government payments.*** Scale effects may be important with respect to participation in conservation programs and adoption of conservation-compatible practices, particularly costly or management-intensive practices. We use gross cash farm income less government payments to measure farm size. We hypothesize this variable to be positively related with participation in working-land programs.

- ***Acreage expansion since 1996.*** For farms engaged in production agriculture, one strategy to increase revenue is expansion of operations. A binary variable (0,1) indicating whether the operator had expanded acres since 1996 is included to capture this effect. We hypothesize this variable to be negatively correlated with participation in land retirement programs and positively correlated with working-land conservation activities.

- ***Use of extension/consultant advice.*** A dummy variable indicates whether an operator used recommendations from an extension service or a hired consultant for nitrogen management. Many of the "high-tech" solutions to nutrient management problems are not single-component, "one-size fits all" technologies (Griffin et al., 2004). We use this variable to proxy an operator's willingness to seek outside advice. Producers who follow expert advice on nitrogen management are expected to be more likely to use advice on other farming practices as well.

- ***Cost/output ratio.*** The economic cost-to-output ratio is calculated as 100 x (total expenses + noncash expense paid to labor + depreciation expense + adjusted charge to management + estimated charge to operator + total contractor reimbursed operator expense)/(total value of production - total value of production to landlord + government payments) (Banker et al., 2001). This variable captures the effects of farm efficiency with respect to total costs and output.

- ***Asset turnover ratio.*** Because the cost-to-output ratio was not calculable for many farms in the 2001 ARMS III dataset, the asset turnover ratio (ATR) is used as a measure of farm efficiency. The ATR is calculated as the ratio of gross farm income to total assets (Banker et al., 2001). It is expected that this variable will be negatively associated with the decision to participate in land retirement practices and programs and positively associated with the decision to practice working-land conservation.

Government Assistance

Government payments, which can include fixed income, marketing loan, disaster, and conservation payments, may influence the adoption choice of some conservation-compatible practices or participation in conservation programs. In some models, we include the commodity payments as a separate variable from the conservation payments. Because government payments are highly correlated with farm scale, the sum of Agricultural Marketing Transition Act (AMTA) payments, disaster payments, and loan deficiency payments (LDPs) was normalized by the total value of production. Conservation payments were scaled to total farm acres operated.

Household Characteristics and Human Capital

- ***Off-farm income.*** Income from off-farm sources averaged 83 percent of total farm household income in 2001. The off-farm income share of total household income is included to measure the effect of nonfarm income sources on the decision to participate in a conservation program or adopt conservation-compatible practices. In addition, whether the farm operator,

Variables Examined (continued)

the farm operator's spouse, or both the operator and spouse work off-farm are included as binary variables. These variables are hypothesized to be positively related with the decision to engage in land retirement activities and negatively related with working-land conservation activities.

- ***Farming experience*.** Years of farming experience and the square of those years are used to measure the effect of human capital on decisions to engage in conservation practices. It is hypothesized that more experienced farmers are more likely to adopt working-land conservation practices. However, because the relationship between years of experience and the likelihood of adopting conservation practices is expected to be curvilinear, at some point in a farmer's career, land retirement opportunities may become increasingly attractive.

- ***Education experience***. Educational attainment is also used to measure the relationship between human capital and decisions to adopt conservation practices (Lynch et al., 2002). We used a Likert scale to represent the education of ARMS respondents, with "1" indicating less than a high school degree and a "5" indicating postgraduate education. It is generally thought that education is positively associated with the adoption of new technologies.

- ***Retirement***. Retirement and succession plans can play an important role in farming practice decisions. Whether the ARMS respondent was retired (but still farming) is included as a binary variable. In general, it is hypothesized that this variable will be positively correlated with land retirement activities and negatively correlated with adoption of working-land conservation practices.

- ***Spouse or operator raised on farm*.** This binary variable is included to capture the relationship between human capital/farm attachment and farm management decisions.

- ***Household size*.** This may be an indicator of the life stage of a farm household and a measure of the human resources available to the farm operation. It is expected to be positively related with working-land activities and negatively related with land retirement.

Environmental Characteristics

- ***Soil erodibility*.** Highly erodible land (HEL, land with erodibility indices > 8) for wind and water is used to proxy environmental sensitivity (Heimlich, 2003). These measures are county-level averages in analyses of conservation structures and program participation. They are only a rough approximation of the environmental sensitivity of individual farms. For our analysis of corn farms, ARMS respondents were asked directly whether any of their farmland was classified by NRCS as HEL or wetland. We expect these variables to positively correlate with the decision to use conservation-compatible practices.

- ***Humidity index*.** This variable is the average humidity recorded in July from 1941 to 1970. It is aggregated to the county level from the 2003 Area Resource Files (Centers for Disease Control and Prevention) and used to measure the effects of growing conditions and weather on the adoption decision.

- ***Farm proximity to water sources*.** A binary variable indicates whether the operator's farm is located next to water sources or water bodies. We expect this variable to be positively correlated with the decision to use conservation-compatible practices.

- ***Remoteness.*** The distance in miles to the nearest town with a population greater than 10,000 is used to measure the correlation between off-farm employment and land values on farming practice decisions.

Local/Regional Economy

The share of the county's workforce employed in manufacturing, the service sector, and wholesale/retail trade is used to control for local economic effects. Population density (10,000 persons/square mile) is included to measure the effects of population and land values on the farming practice decisions. Finally, in the model, the effects of weather, climate, and other phenomena characteristic of the ERS production regions are measured using binary (0,1) variables for each of these regions.

Who Participates in Conservation Programs?

While the decision to adopt a conservation-compatible practice is generally made by the operator or landowner, the decision to participate in a conservation program is less open-ended. Although these programs are voluntary, budget and acreage limitations preclude the enrollment of all producers who want to participate. In both CRP and EQIP, applicants are ranked using benefit-cost indices, and in most cases only some of the applicants are accepted.[21] In CRP, for example, an applicant's environmental benefit "score" is derived from land characteristics and the conservation practices to be applied. A cost "score" is determined by the level of payment requested in the landowner's and/or operator's bid. Together, these scores are used to rank all bids and determine which parcels of land will be accepted into the program.[22]

Given program budget constraints and enrollment caps, a farmer's likelihood of receiving conservation program funding is also influenced by each program's goals. EQIP was a relatively small program until the 2002 Act increased its funding level nearly fivefold. EQIP targets livestock producers for over 60 percent of its funds (fig. 5). Program funds for livestock producers primarily support conservation practices addressing livestock manure and water quality, while water quality and soil conservation practices are the main categories for other producers. Nevertheless, with funding averaging roughly $200 million per year over the period of this study, EQIP had little measurable impact on the farming practice decisions of most farmers in our sample.

As a land retirement program, CRP focuses on cropland. Based on the distribution of acreage enrolled in the program, it primarily supports planting land to grasses, largely through enrollment of whole fields (fig. 6). Nonetheless, while the acreage involved in working-land-compatible practices is small, such signups amounted to 20 percent of the CRP contracts outstanding in 2001, indicating that these conservation efforts are viewed as important, even within a land retirement program.[23] During the years we analyzed, CRP's much larger annual budget allowed it to finance more conservation activities pursued by working farms than EQIP did.

Given the relatively small number of farms participating in EQIP during the survey year we analyzed, a sample survey such as ARMS collects information on too few EQIP participants to allow a reliable estimate of the characteristics of the typical participant. However, although the majority of EQIP participants are livestock producers and CRP is generally oriented toward cropland, EQIP and the working-land portion of CRP both fund some common types of conservation structures (for example, riparian buffers, grass waterways, and filter strips). Furthermore, many CRP participants combine livestock and crop operations. We therefore combined these two groups of conservation program participants into a "working-land" group for further analysis. Table 3 provides descriptive statistics for 2001 on participants in working-land conservation programs, all other CRP/CREP/WRP program participants (differentiated by the extent to which

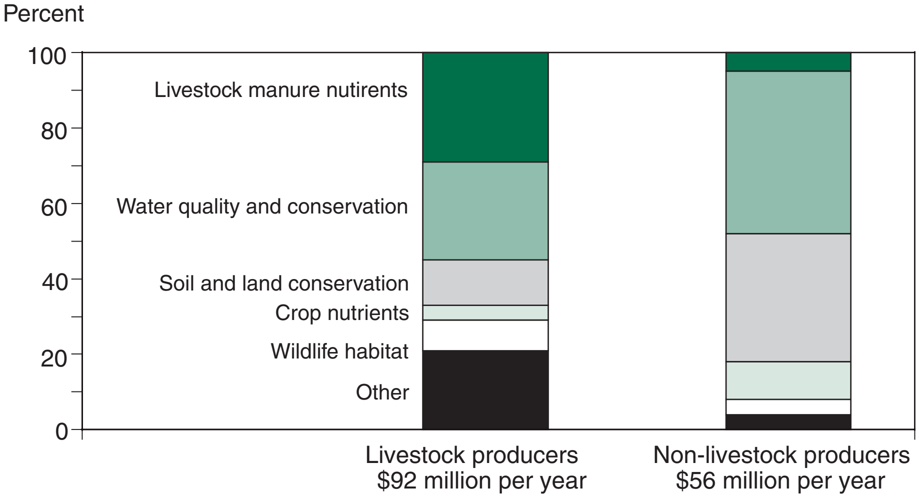
[21]Between 50 and 70 percent of CRP contract offers have been accepted into the program during general signups held since 1997.

[22]The 2002 Act eliminated the ability of an operator to reduce the cost share requested on EQIP bids, although cost can be considered in determining which EQIP contract offers to accept. See Cattaneo et al. (2005) for a discussion of the eligibility criteria and bid selection procedures of CRP, CSP, and EQIP.

[23]Many of the working-land-compatible practices covered by the CRP are eligible for continuous signup. Land offered through the continuous signup program does not go through a competitive bidding process and often receives rental and cost-share payments higher than those received under the program's general signups. Continuous signups accounted for over 40 percent of all CRP contracts in place and 18 percent of CRP payments in 2005.

Figure 5

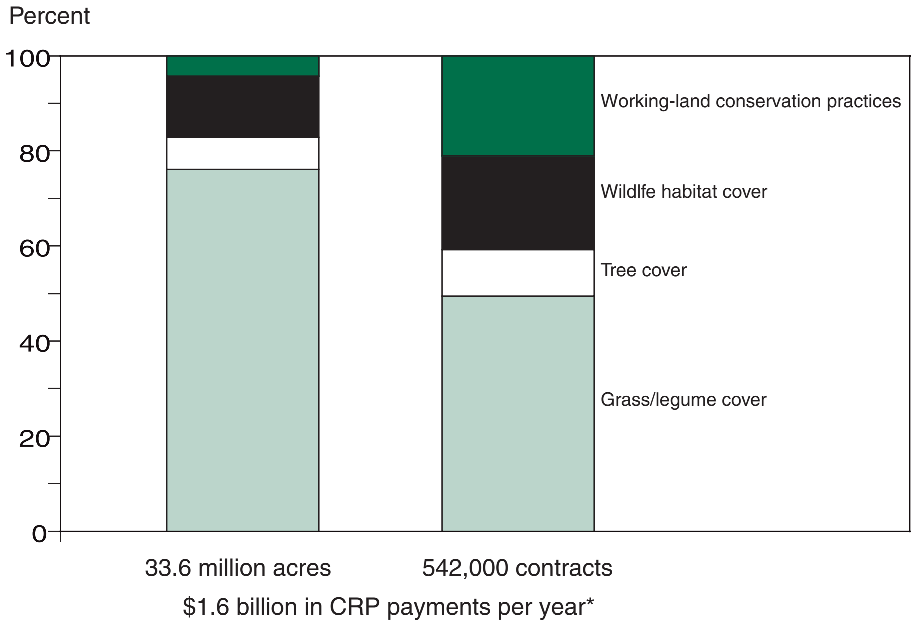
Distribution of EQIP funding among major environmental concerns, 1997-2000



Note: “Other” includes installation of fencing, which acounted for 11 percent of the obligated funds for livestock producers.
Source: NRCS, 2003.

Figure 6

Distribution of CRP-enrolled acreage and contracts by major conservation practice, 2001



*Based on rental and cost-share payments disbursed to program participants between 1997 and 2000.
Note: Distribution of acres enrolled in CRP/CREP and contracts as of November 2001.
Source: Barbarika (2001).

conservation payments displace production), and farms that did not participate in any Federal conservation program that year.[24]

Research on CRP participants has long shown that participants who cease farming following enrollment in the program have very different characteristics than CRP participants who continue farming (Sullivan et al., 2004). Table 3

[24]The 2001 ARMS is unique in collecting conservation structure information for all farms. More recent surveys have not requested information on the practices implemented on CRP-enrolled acreage.

Table 3

Farm, operator, and household characteristics of farms participating in one or more conservation programs, by type of participation, 2001

Characteristic	Units	EQIP & CRP working land[1]		Land retirement[2] Partial-farm		Land retirement[2] Whole-farm		Non-participants	
Farm characteristics									
Average farm size	Acres	*1,089	CD	1,127	CD	267	AB	374	AB
Average net farm income	Dollars	*47,382	CD	**27,686		7,812	A	12,444	A
Average commodity payments	Dollars	26,571	BCD	12,698	ACD	**634	ABD	4,430	ABC
Average conservation payments	Dollars	4,044	D	6,441	D	6,682	D	0	ABC
Farms in HEL areas	Percent	*5		*11		12	D	6	C
Irrigated farms	Percent	**7		*2	D	—		9	BC
Average ratio of owned/operated	Percent	57	BCD	99	AC	141	ABD	93	AC
Average share of production from:									
Livestock	Percent	28	BCD	40	AC	0	ABD	50	AC
Crops	Percent	71	BCD	60	ACD	0	ABD	35	ABC
Operator characteristics:									
Average age	Years	57	C	56	C	63	ABD	54	C
Average experience	Years	31	D	28	D	26		22	AB
Major occupation:									
Farming	Percent	85	CD	62	CD	**5	ABD	40	ABC
Nonfarm occupation	Percent	**14	CD	25	CD	51	AB	50	AB
Retired	Percent	**2	BCD	*12	AC	44	ABD	10	AC
Education:									
High school	Percent	*39		39		46		42	
Some college	Percent	*25	C	23	C	*11	ABD	25	C
Completed college	Percent	*21		*15		*17		13	
Female operator	Percent	**4	C	**2	CD	*34	ABD	8	BC
Household (HH) characteristics									
Average size of household	Number	3.0	C	2.7	C	2.1	ABD	2.8	C
Farm income shared with others	Percent	*9	C	**5		**2	A	*5	
Off-farm work (operator)	Percent	47		43	D	52		57	B
Off-farm work (spouse)	Percent	61	BD	41	A	*46		45	A
Average off-farm income	Dollars	50,288		45,097	D	63,081		58,786	B
Share of HH income off-farm	Percent	65	CD	73	CD	87	AB	83	AB
Observations	Number	228		388		122		4,701	
Farms	Number	*47,456		101,390		118,168		1,824,902	
Share of all farms	Percent	2		5		6		87	

[1]Farms participating in EQIP or using CRP funds to install conservation structures consistent with farm production, such as grass waterways, filters, and riparian buffers

[2]Farms installing all other CRP/CREP/WRP-funded conservation practices, such as whole or partial-field grasses, wildlife habitat enhancements, etc. Farms are separated into two groups based on the value of farm production in 2001: partial-farm participants continued producing, while whole-farm participants produced no farm commodities.

Notes: Nonfamily farms are excluded. Coefficient of variation (CV) = (standard error/estimate) x 100. * indicates that CV is greater than 25 and less than or equal to 50. ** indicates that CV is greater than 50. Letters A, B, C, and D indicate significant column differences based on pairwise two-tailed [Ho:B1=B2] delete-a-group Jackknife t-statistics at a 90-percent confidence level or higher with 15 replicates (Dubman, 2000). A=working lands, B=partial-farm CRP, C=whole-farm CRP, and D=nonparticipant. — indicates legal disclosure problems.

Source: 2001 ARMS, CRR version 1.

refers to CRP participants who are not currently producing agricultural commodities as whole-farm participants. CRP participants who continue to grow crops or raise livestock are considered "partial-farm" participants. The distinction does not necessarily reflect the amount of land enrolled (i.e., whole-farm participants often cannot enroll all of their land in the program); rather, it highlights whether conservation program payments have replaced commodity receipts or supplemented them.[25]

Roughly half of the participants in conservation programs in 2001 did not produce farm commodities, while the other half integrated their conservation and farming activities to varying degrees. As expected, farms taking advantage of conservation programs to help finance working-land-compatible practices were typically larger operations whose operators considered farming their primary occupation. Despite EQIP's emphasis on livestock producers, this group was primarily focused on crop production.[26] At the other extreme, whole-farm participants had smaller operations and were generally older, retired farm operators whose household income depended more on off-farm sources. A relatively high percentage of whole-farm participants was comprised of female-headed operations. However, partial-farm means reported in table 3 were generally closer to working-land means than whole-farm means. This suggests that the role conservation programs play in decisions about adopting conservation practices may be similar for farms that continue producing farm commodities.

We use an econometric model to associate farm structure, household, and environmental variables with the program participation choice (see appendix). Two possibilities are considered for households reporting zero value of production: they either enroll as much farmland as possible into a land retirement program or they do not enroll any land. We consider three alternatives for households reporting production of crops or livestock. First, the households enroll farmland in a land retirement program. Second, the households participate in a working-land program. Finally, they do not participate in either type of program.[27] For farms participating in working-land programs, factors associated with the number of conservation activities practiced on the farm are examined.[28] For working farms participating in a land retirement program, the proportion of the land enrolled is modeled.[29]

A farm can produce no commodity and still be considered a farming operation under two circumstances: (1) if it normally produces a crop or raises livestock but conditions temporarily prevent it from doing so, or (2) if the farm participates in a land retirement program and the operator has chosen not to farm. In 2001, about 35 percent of the farms that reported zero production were enrolled in the CRP. The rest, typically, were small farms whose operator could not plant or harvest a crop because of, possibly, health problems, trouble finding hired labor, weather conditions, or insect/disease infestation. In modeling the zero-production decision, we found that receipt of conservation payments was the only factor significantly associated with the decision not to produce crops or livestock (table 4 and app. table 3). We found no significant factors associated with enrollment in a land retirement program conditional on zero production of crops and livestock, most likely due to the relatively small sample of the zero-production farms (app. table 3).

[25] In this usage, whole-farm CRP participants are no longer working farms. However, it is not clear that partial-farm CRP participants necessarily fit the common view of working farms, since they can have very low levels of production, given their resource base.

[26] The number of large crop farms participating in CRP overwhelmed the number of livestock producers who received EQIP funding. In contrast, many of the smaller operations that took advantage of CRP to retire land or to focus on wildlife enhancements were mixed crop-livestock operations.

[27] Households can participate in both a land retirement and a working-land program. However, few farms surveyed in 2001 did so.

[28] The number of practices adopted is only a proxy for intensity of conservation activity. Because of data limitations, it was the only one available for working-land practices.

[29] The proportion of land enrolled in a land retirement program by zero-production farms was not modeled because it was assumed that if their reservation rent was met, their operators would enroll as much land as possible.

Table 4

Associations between farm business characteristics, household attributes, and environmental characteristics and farm production and program participation

	Probability of a farm's "deciding" to:		
		Participate in a:	
Variable	Cease production[1]	Land retirement program[2]	Working-land program[3]
Farm characteristics			
High value crops	na	–	no association
Tenure (owned/operated acres)	no association	+	no association
Gross cash farm income less govt. payments	no association	no association	+
Government payments			
Conservation payments	+	na	na
Farm household characteristics			
Off-farm income/total household income	no association	no association	–
Environmental characteristics			
Highly erodible land index	no association	+	no association
Farm next to stream, etc.	no association	no association	+

[1]Probability that a farm reports zero value of production.

[2]Probability that a farm reporting crop and/or livestock sales participates in a land retirement program.

[3]Probability that a farm reporting crop and/or livestock sales participates in a working-land program.

Notes: + or – indicate a positive or negative association; na = variable not included in the model. See appendix for details.

Source: Marginal effects for "Cease production" are in appendix table 3.
Marginal effects for "Land retirement program" and "Working land program" are in appendix table 4.

For farms reporting production of crops and/or livestock, as the share of the total value of production attributed to high-value crops increased, the likelihood that the operator participated in a land retirement program decreased. Land ownership was positively associated with the likelihood that production farms participated in land retirement program (table 4 and app. tables 3 and 4). But farm size (as measured by gross farm income less government payments) was positively related with the likelihood of participating in a working-land program.

With respect to farm household characteristics, off-farm income as a proportion of total farm household income was negatively associated with the likelihood that an operator participated in a working-land program. Variables measuring local environmental sensitivity were positive and significant for farms enrolling part of their farmland in a land retirement program. This effect was not evident for farm households choosing to participate in working-land programs. However, farmsteads next to a body of water (e.g., a stream, river, or lake) were more likely to participate in a working-land program.

For farms reporting production and participating in a land retirement program, a question arises: Which factors are associated with the land enrollment decision, as a proportion of total acres that could be farmed? An acreage supply function was constructed to measure this relationship (see the appendix for details). Farms where government payments (including commodity and conservation payments) were large relative to the total value of farm production generally enroll more land as a proportion of total operated acres into land retirement programs. As the programs existed in 2001, operations focusing on grain production enrolled less land, on average, in land retirement programs (table 5 and app. table 3). Farms operated by females tended to enroll a larger proportion of land into a land retirement program. Tenure, measured as total acres owned divided by acres operated, was positively related to the amount of acreage enrolled into a land retirement program.

A second measure of conservation "intensity" that we considered was the total number of conservation activities practiced by program participants reporting revenue from crops or livestock. Ten conservation activities were considered in the 2001 ARMS Phase III: planting a whole field to grasses or legumes, planting a whole field to trees, installing grass filter strips, installing grass contours, planting riparian buffers, planting grass waterways, improving wildlife habitat, constructing wildlife food stands, establishing rare or endangered habitats, and restoring wetlands. The number of conservation activities practiced was positively associated with land ownership (table 5), which is consistent with previous research on conservation technology adoption by corn farmers (Soule et al., 2000). However, farms focusing on production of high-value crops appeared to have fewer conservation activities. Larger farm households and operators who were raised on a farm also tended to practice a wider array of conservation practices. Farm proximity to a water body and location on environmentally sensitive land was also positively correlated with the number of conservation activities practiced by a farm (table 5 and app. table 3).

In summary, the variety of conservation programs complements the diversity of farm households. Farms located on marginal land or near waterways have the option to receive Federal support on a cost-share basis to integrate conservation activities into their production plans or to retire land to

Table 5

Association between selected variables and the proportion of farm acreage enrolled in land retirement programs and the number of working-land structures installed, 2001

Variable	Percent of land enrolled in CRP/ CREP/WRP	Number of conservation structures
Farm characteristics		
High-value crops	no association	–
Grain crops	–	no association
Tenure	+	+
Govt. payments/value of production	+	no association
Household characteristics		
Household size	no association	+
Operator raised on farm	no association	+
Female operator	+	no association
Environmental characteristics		
Highly erodible land index	no association	+
Farm next to water source	no association	+

Notes: + and – denote a positive or negative association.
Source: Appendix table 3.

enhance natural landscapes and wildlife populations. The choices are largely associated with the point at which the decisionmakers find themselves in their life cycle, and the degree of dependence on farming as a source of income. The relationship between farm scale, tenure, and the choice to participate in a conservation program appears to be important, too.

Conclusions, Policy Implications, and Data Constraints

With the impending expiration of 80 percent of the contracts on 35 million acres currently enrolled in CRP and the growth of working-land conservation program budgets, policymakers and program managers face important decisions about the future direction of USDA's conservation efforts. By taking a close look at the characteristics of farms, operators, and households that have adopted conservation practices, with and without Federal program support, this report offers some basic insights into the role of conservation programs in the agricultural sector's conservation efforts.

Because farm households are not identical, their decisions to adopt a particular conservation practice and to seek conservation program support (if they are eligible) vary and depend on many factors. Based on the level of adoption evident in 2001-2003, there are likely to be farmers who could benefit from undertaking one or more conservation practices but who have not chosen to do so. For some of these farmers, the initial investment for putting the practices in place is a deterrent, despite the longrun profits such investments might garner. Conservation programs can help eligible farmers overcome short-term funding constraints. But programs based on the assumption that long-term profit is the driving force behind farm practice decisions will not appeal to all farmers. And in many cases, offsite environmental concerns may not be adequately addressed by the conservation practices capable of bolstering long-term farm profits.

It is important to recognize that there are varying degrees of environmental benefits that can accrue from the adoption of specific conservation practices, depending on the physical characteristics of the farmland. For example, the marginal environmental benefit of adopting conservation tillage on a farm with low soil erodibility is likely to be low, providing little onsite erosion reduction for the farmer or offsite benefit to society.[30] If conservation is the primary goal of conservation programs, then whether 30 or 50 percent of farmers participate is not important; the environmental payoff is the program's measure of success.

[30]There may still be business reasons why these farmers would find it profitable to adopt conservation tillage practices even though the environmental benefits are negligible.

Conservation-compatible practices that reduce the operator's time or out-of-pocket labor and input costs for producing a commodity without requiring specialized knowledge have been widely adopted, without direct financial assistance from the government. Because of their widespread appeal, practices such as conservation tillage, crop rotation, and use of insect/herbicide-tolerant plants have been extensively adopted. This suggests that development of environmentally friendly plant varieties, farming practices, and inputs, coupled with extension services and education, could have broad environmental benefits if they make good stewardship of farmland easier, more profitable, and less risky than current farming practices.

Conservation-compatible practices that require a sizeable investment of management time or heightened skill are less likely to be adopted by farm operators who focus primarily on nonfarm activities. While financial assistance can reduce the initial out-of-pocket costs of conservation-compatible practices that are management-intensive, unless the farm has the scale or the operator has the time to make such investments pay off on their own, financial inducements would likely need to be high. But for full-time commercial farm operations, such practices as variable-input application rates and integrated pest management can be both profitable and environmentally beneficial.

Our research suggests that the availability of expert advice may help induce the adoption of specialized conservation-compatible practices. By providing information about the costs and benefits of alternative options, extension agents can help reduce the risks associated with new farming practices and increase the number of farm operators willing to consider change. However, in response to fiscal constraints, State funds marked for extension are becoming scarce (McDowell, 2004). As a result, many traditional roles played by extension agents are now met by experts hired as crop consultants. As information-intensive technologies that aid crop input management decisions become increasingly complex, technical assistance becomes all the more challenging. EQIP currently budgets 23 percent of its funds for technical assistance, part of which goes to nongovernment technical experts to assist farm operators with conservation-practice decisions (NRCS, 2003). Our results suggest that technical assistance will remain important if farmers are to make the best use, in terms of both onsite and offsite benefits, of working-land programs such as EQIP.[31]

[31]In 2007, EQIP's base funding will be $1.36 billion per year, more than quintupling its original funding allocation (NRCS, 2003). If technical assistance funds increased proportionally, they would amount to more than $300 million in the coming years.

Our research also suggests that farm payments may influence the conservation behavior of farmers. By reducing the financial risks of changing farming practices, commodity program payments may make it easier for eligible farmers to introduce such changes. The relationship between farm payments and conservation-compatible innovations appears to go beyond satisfying compliance requirements—many farms adopting conservation-compatible practices do not have highly erodible land or wetland that is subject to compliance. While farm commodity programs have been accused of worsening environmental damage by encouraging more intensive farming, farm payment recipients are more likely to have adopted conservation-compatible farming practices than farms growing nonprogram crops and livestock.

For conservation practices and structures that do not pay for themselves in reduced costs or increased yields, some form of incentive (positive or negative) would be necessary to encourage adoption. Voluntary working-land programs can be effective for larger and commercial-scale farms, especially when combined with technical assistance and conservation-compliance regulations. By rewarding good conservation behavior, working-land programs can reduce the initial costs of altering farming practices. For farm households that depend on farming as their primary source of income and well-being, working-land programs can make many of the practices recognized as good conservation behavior affordable. But our research also suggests that the cost-share needed to make a practice affordable is a function of farm size and the farm operator's goals. A sliding scale of payments that accounts for the higher cost of conservation-practice adoption by smaller farm operations could increase participation and adoption.

While working-land programs are likely to reach more farms than the traditional land retirement programs, they are unlikely to appeal to all farm operators and may not provide all of the environmental benefits (particularly for wildlife) attributed to USDA's land retirement programs. Smaller farms, particularly those whose operators consider themselves retired or whose primary occupation is something other than farming, are less likely to adopt management-intensive farming practices. They are likely to adopt conservation practices that save time and effort and do not require major changes in established practices. But their primary motivation may be maximizing something other than farm profits; small farms are less likely to adopt conservation practices that bolster returns at the cost of added complexity, with or without conservation program financial or technical assistance. Land retirement is attractive to retirement and residential/lifestyle farm households that spend less time and effort on agricultural operations than full-time, occupational farms. CRP payments may also stabilize farm income for retired farmers and farmers planning on retiring in the near future, whether or not they want to maintain the farmstead. In addition, retiring contiguous fields from production can provide a broader array of environmental benefits than is easily accomplished through working-land conservation structures. Wildlife populations, in particular, may require more undisturbed land than is possible through working-land programs (Haufler, 2005). While smaller farms are not major producers of agricultural commodities, they control a sizeable amount of farmland and their numbers have been increasing.

Land retirement need not signal a retrenchment from production agriculture. Many larger farms participate in the CRP to retire whole fields.[32] Whether to take marginal land out of production, diversify the operation to include hunting or scenic viewing, address conservation-compliance concerns, or reduce variability in farm returns, enrolling one or more fields in CRP may be a logical part of a profit-maximizing farm operation. Roughly half of the participants in the CRP produce commodities, so land retirement can be an integral part of a working-land approach to conservation.

[32]Many large farms also use CRP to retire parts of fields, but it is easy to envision these enrollments as being part of a working-land operation. Parts of fields that are not irrigated, are awkward to farm because of terrain, or have poor soil are often left fallow. Farm returns could easily rise if these partial fields were enrolled in the CRP and earned an annual rental payment.

With EQIP and CSP augmenting voluntary land retirement programs, USDA offers farm operators financial assistance from a wide range of conservation programs. In general, working-land and land retirement programs play complementary roles in efforts to reduce the unintended environmental consequences of agricultural production for farmers and the rest of society. Our research and that of others suggests that, while there is overlap, land retirement and working-land practices are often used by different types of farms.

Finally, our research has made it clear that our understanding of the linkage between farming practices and the characteristics and goals of the decision-makers could be improved with more information. The advantage of using ARMS is that it provides a detailed snapshot of the structural and household characteristics of the Nation's family farms. A disadvantage of the survey is that it presents only a cross-sectional picture of family farms in a given year. As a result, decisions made in the past about conservation practices in particular, and production decisions in general, may not reflect what the operator would have preferred given current-day conditions. Therefore, it is difficult to draw conclusions about who is likely to adopt practices or participate in programs in the future. Our findings cannot be used for predicting future behavior, but are only meant to shed light on the present associations between farm/operator/household characteristics and conservation-compatible practices adopted in the recent or not-so-recent past. Indeed, ARMS is not designed to capture specific details about conservation practices, but it is the only annual survey of farm activities that captures household characteristics.

An alternative nationwide survey, the Conservation Effects Assessment Project (CEAP) conducted by NRCS, collects detailed information on a myriad of conservation practices. While this survey may be useful for determining the onsite and offsite benefits these practices bestow, it is not designed to assess how the practices affect the well-being of farm households that adopt them or to identify the socioeconomic factors influencing participation. As an extension to CEAP, in 2004 a hybrid version of ARMS and CEAP was developed and administered to wheat producers. Designed to integrate the strength of these two survey approaches, the CEAP-ARMS pilot survey aims to provide a more complete dataset to answer future questions about adoption of conservation practices and the motivations behind conservation program participation.

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Appendix: Modeling Approach and Explanatory Variables

In addition to the comparison of means reported in tables 1-3 in the main text, each table is supplemented with the results of a multivariate regression model designed to correlate the factors associated with the adoption of conservation-compatible practices and participation in conservation programs (holding all other factors constant), using an expanded list of explanatory variables.

Table 1 is supplemented with a cumulative probit model (app. table 1) (Allison, 2003; Maddala, 1983) to estimate the correlation between farm structure, household demographics, environmental factors, regional economy indicators, and the level of conservation-compatible management practices used by farms. By assuming that these practices can be ordered to represent a progression in intensity from low to high management activities, and that such a progression would go from nonusers, to users of "standard practices" only, to users of "decision aids" but not "information-intensive" practices, to users of "management-intensive" practices, the marginal effects can be interpreted as the effect a variable has on the probability of an individual using the next, or higher, level of technology. The ordered response model assumes an underlying response function, $Y_i = \beta' x_i + u_i (i=1,\ldots,n)$, where Y is an unobserved latent response variable, x is a matrix of explanatory variables, β is a mean response vector, and u is a disturbance term. The latent response is not observed, but it is known to which of j categories it belongs (in our case, 'Standard Practices', 'Decision Aids', etc.). Specifically, Y belongs to the jth category is stated as $\alpha_{j-1} < Y < \alpha_j (j = 1,\ldots, m)$ (Maddala, 1983, p. 47). The ordinal variables are defined as:

$$
\begin{aligned}
&Z_{ij} = 1 \text{ if } Y_i \text{ belongs to the } j\text{th category} \\
&Z_{ij} = 0 \text{ otherwise} \qquad (i = 1,\ldots,n, j = 1,\ldots,m) \\
&\Pr(Z_{ij} = 1) = \Phi(\alpha_j - \beta' x_i) - \Phi(\alpha_{j-1} - \beta' x_i)
\end{aligned}
$$

where Φ is the cumulative standard normal. The marginal effects are calculated as, $\frac{\partial \Pr(Z_{ij} = 1)}{\partial x_{ik}} = [\phi(\alpha_j - \beta' x_i) - \phi(\alpha_{j-1} - \beta' x_i)]\beta_k$, where ϕ is the normal probability density function (Greene, 2003, p. 738). The system is estimated by maximizing the log likelihood function, $\ell = \sum_{i=1}^{n} \sum_{j-1}^{m} Z_{ij} \, \text{Ln}[\Phi(\alpha_j - \beta' x_i) - \Phi(\alpha_{j-1} - \beta' x_i)]$ (Maddala, 1983, p. 48). The cumulative probit results are presented in appendix table 1.

Table 2 is supplemented with a multinomial logit model (Allison, 2003; Greene, 2003) to estimate the correlation (holding all other factors constant) between farm structure, household demographics, environmental factors, and regional economy indicators and the use of conservation covers and structures. Because there is no apparent hierarchy among the conservation structures of interest, the analysis attempts to determine if different factors are associated with the use of different categories of conservation structures (working-land structures, wildlife enhancements, or whole-field land retirements) and the

Appendix table 1

Cumulative probit results (supplement to table 1)*

	Estimate	T-test+	Marginal effects: Standard	Marginal effects: Standard + Decision Aids	Marginal effects: Standard + Decision Aids + Mgt. Intensive
Farm structure and production characteristics:					
High value crops	**0.714**	1.87	0.0749	0.0957	0.0001
Grain crops	**0.842**	3.43	0.0883	0.1128	0.0001
Hogs	**0.901**	2.27	0.0945	0.1207	0.0001
Cattle/dairy	-0.051	-0.20	-0.0053	-0.0068	-5.68E-06
Poultry	**0.564**	1.67	0.0592	0.0756	0.0001
Cost/output ratio	-2.0E-04	-1.47	-2.30E-05	-2.90E-05	-2.44E-08
Gross cash income from farming less govt. payments	**0.003**	2.34	0.0003	0.0004	3.19E-07
Tenure	-0.045	-0.34	-0.0047	-0.0060	-5.06E-06
Irrigation	**0.584**	2.89	0.0613	0.0783	0.0001
Extension/consulting advice	**0.581**	4.64	0.0610	0.0779	0.0001
Family corporation	**0.361**	1.93	0.0378	0.0483	4.05E-05
Government assistance:					
Conservation payments	0.008	0.65	0.0008	0.0010	8.44E-07
AMTA, LDP, Disaster payments	**0.002**	1.83	0.0002	0.0003	2.22E-07
Household (HH) characteristics:					
Share of off-farm income to total HH Income	-0.142	-1.14	-0.0149	-0.0191	-1.60E-05
Education experience	**0.116**	2.45	0.0122	0.0156	1.30E-05
Farming experience	0.003	0.23	0.0003	0.0004	3.21E-07
Square of farming	-3.0E-05	-0.15			
Retired	-0.256	-0.95	-0.0268	-0.0343	-2.90E-05
Operator works off-farm	0.040	0.28	0.0042	0.0054	4.53E-06
Spouse works off-farm	0.100	0.80	0.0105	0.0134	1.12E-05
Dual off-farm income	-0.076	-0.59	-0.0080	-0.0102	-8.56E-06
Share income with other households	**-0.260**	-2.08	-0.0273	-0.0349	-2.90E-05
Environmental variables:					
Highly erodible land	0.153	1.60	0.0161	0.0205	1.72E-05
Wetland	-0.211	-0.71	-0.0221	-0.0283	-2.40E-05
Population density	2.260	0.69	0.2371	0.3028	0.0003
Humidity	0.002	0.23	0.0002	0.0003	2.27E-07
Manufacturing share	-0.772	-1.41	-0.0810	-0.1035	-0.0001
Services share	0.240	0.32	0.0252	0.0322	2.70E-05
Wholesale/retail share	1.387	1.26	0.1456	0.1859	0.0002
Regional variables:					
Heartland	0.205	0.65	0.0215	0.0274	2.29E-05
Northern Crescent	-0.088	-0.28	-0.0092	-0.0117	-9.81E-06
Northern Plains	0.218	0.62	0.0229	0.0292	2.44E-05
Prairie Gateway	0.023	0.07	0.0025	0.0031	2.63E-06
Eastern Uplands	0.240	0.69	0.0252	0.0322	2.69E-05
Southern Seaboard	0.413	1.18	0.0434	0.0554	4.64E-05
Dependent variable:	Sample size	Expanded			
No practice	139	32,285			
Standard	600	115,151			
Standard + Decision	477	107,536			
Standard + Decision + Intensive	364	58,734			
All farms	1,580	313,707			
Log likelihood	-355,986				
Test for endogeneity*	Wald = 7.69				

*See Wooldridge, 2000, p. 483. $\chi^2_{crit,\ 10\%} = 7.78$, $\chi^2_{crit,\ 5\%} = 9.49$, df = 4. Instrumental variables were: the 2000 county-level unemployment rate from the Bureau of Economic Analysis, whether the county was classified as metropolitan or nonmetropolitan, or poverty-persistent, whether the economy of the county was dependent on farming, whether there had been significant population loss in the county between 1990 and 2000, and whether the county was considered a 'low-education' county. The previous five variables are from the ERS county typology codes available at http://www.ers.usda.gov/briefing/rurality/Typology/index.htm#start. An environmental amenity index was also included in the set of instrumental variables (http://www.ers.usda.gov/Data/NaturalAmenities/). +=calculated using the delete-a-group Jackknife (Dubman, 2000).

Note: **Bold** entries are significant at the 10% level or lower.
Source: 2001 ARMS, Phase II/III.

total absence of such structures. The probability (p_{ij}) that the *i*th (i=1,…,n) individual practices the *j*th conservation activity (j = 1,…,m, in our case, the operator plants whole fields to grasses or trees, enhances wildlife, or practices working-land activities), can be represented as

$$\mathrm{Ln}\left(\frac{P_{ij}}{P_{iJ}}\right)=\boldsymbol{\beta}_j\mathbf{x}_i\left(j=1,\dots k\right)$$

where $\mathbf{x}_i$ is a column vector of explanatory variables describing the *i*th individual and $\boldsymbol{\beta}_j$ is a row vector of coefficients associated with the *j*th category. The equation system solves to yield

$$P_{ij}=\frac{\exp(\boldsymbol{\beta}_j\mathbf{x}_i)}{1+\sum_{k=1}^{J-1}\exp(\boldsymbol{\beta}_j\mathbf{x}_i)}\left(j=1\dots,k\right)$$

The marginal effects on the probability that an operator will choose the *j*th conservation practice with respect to the *k*th explanatory variable is (Greene, 2003, p. 722)

$$\frac{\partial\,\Pr(J=j)}{\partial x_{ik}}=\Pr(J=j)\left[\boldsymbol{\beta}_j-\sum_{k=0}^{J}\Pr\left(J=k\right)\boldsymbol{\beta}_k\right].$$

The multinomial results are presented in appendix table 2.

Table 3 is supplemented with a more complicated modeling structure. A multistage approach explains the decision to participate in conservation programs, and the participation intensity (app. fig.1; app. table 3). The first stage entails logit regression to determine the factors associated with the choice to produce nothing (value of production is zero), or to produce crops and/or livestock for sale. The second stage estimates two additional logit models. In the first model, the factors associated with the decision to participate in a land retirement program for farms that report zero value of production are examined. In the second model, a multinomial logit regression models the decision to participate in a working-land program, or to enroll some farmland into a land retirement program. Finally, "participation intensity" is measured in two ways. First, the proportion of acres enrolled in CRP, CREP, or WRP to the entire number of acres operated is estimated using an acreage supply function. Because of the possibility of sample selection bias, the supply function is estimated using Heckman's two-step method (Maddala, 1983). The two-step procedure originally suggested by Heckman adjusts estimates for the bias in the acreage supply equation introduced by individuals (i.e., operators) choosing to participate in the CRP. In this sense, the sample we choose to analyze is not random, and the usual statistics applied to estimate the means of this 'self-selected' population are biased and inconsistent (Greene, 2003, p. 781). There is a rich literature on sample selection bias in econometrics. The interested reader may consult Maddala (1983) or Greene (2003) for thorough introductions to this topic. The second measure of intensity uses a negative binomial regression to estimate which factors are associated with the

(text resumes on p. 43)

Appendix table 2

Marginal effects for conservation practices multinomial logit regression (supplement to table 2)*

	WF grasses, trees, etc	Wildlife enhancement	Working lands
Farm production characteristics:			
High-value crops	-0.045	0.006	-0.006
Grain crops	**-0.030**	0.000	**0.009**
Hogs	-0.016	-0.027	0.004
Cattle	0.002	**-0.004**	0.003
Poultry	0.006	-0.009	-0.003
Asset turnover ratio	-0.008	-0.009	0.000
Acreage expansion since 1996 (1=yes)	0.003	-0.002	0.000
Tenure (owned/operated acres)	0.014	0.005	0.001
Gross cash farm income less govt. payments	0.000	0.000	0.000
Government assistance:			
Commodity payment/Value of production	-0.002	0.002	-0.001
Conservation paymnt/Acres operated	**0.006**	**0.001**	0.001
Farm household characteristics:			
Household size	0.001	0.000	0.001
Farming experience	0.080	0.004	0.013
Square of farming experience	-0.160	-0.011	-0.009
Education experience	0.008	0.003	0.001
Off-farm income/total household income	0.002	0.002	-0.002
Female operator (1=yes)	0.010	-0.006	-0.004
Operator works off-farm (1=yes)	-0.017	0.002	0.001
Spouse works off-farm(1=yes)	-0.001	-0.002	0.002
Dual off-farm income (1=yes)	-0.008	0.005	0.000
Retired (1=yes)	-0.014	0.000	0.002
Spouse raised on farm (1=yes)	-0.001	-0.002	0.002
Operator raised on farm (1=yes)	0.029	0.003	0.001
Environmental characteristics:			
HEL (water erosion)	0.041	-0.017	**0.018**
HEL (wind erosion)	0.065	-0.017	-0.008
Humidity index	0.001	0.000	0.000
Farm next to stream, river, lake (1=yes)	0.023	**0.015**	**0.006**
Distance from nearest town>10,000	0.000	0.000	0.000
Local/Regional economy:			
Manufacturing	-0.046	-0.028	**0.013**
Service trade	0.033	0.035	0.021
Wholesale/Retail trade	0.005	**-0.042**	0.000
Population density (persons/sq. mile)	0.138	-0.072	-0.054

See notes at end of table.

-Continued

Appendix table 2

Marginal effects for conservation practices multinomial logit regression (supplement to table 2)*—Continued

		WF grasses, trees, etc	Wildlife enhancement	Working Lands
Regional variables:				
Heartland		**0.022**	**0.009**	**0.010**
Northern Crescent		0.017	0.012	0.000
Northern Plains		0.022	0.006	**0.006**
Prairie Gateway		0.019	-0.004	**0.005**
Eastern Uplands		-0.011	-0.006	-0.003
Southern Seaboard		-0.019	0.000	0.000
Fruitful Rim		-0.017	-0.001	**-0.005**
Basin and Range		-0.021	-0.010	-0.005
Test for endogeneity‡	Wald =		15.60†	
Log likelihood	-1,638,676			
Sample size (N)		541	221	483
Expanded N*		261,866	81,256	165,379

*Reference group is nonpracticing farms (N = 4,025, expanded N = 1,488,190).

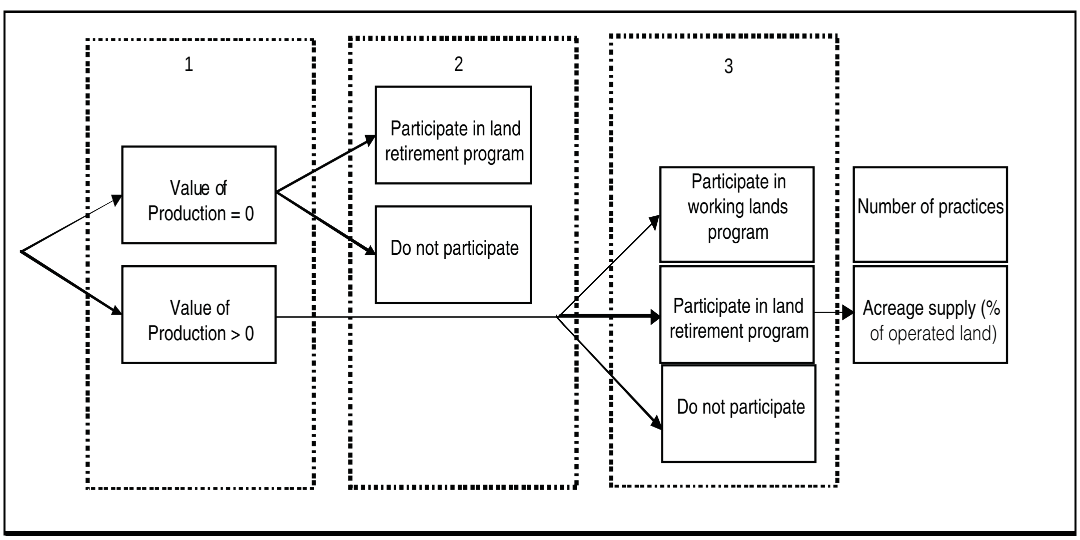
†global test across equations, $\chi^2_{crit,\ 10\%} = 18.55$, df = 12.

‡See Wooldridge, 2000, p. 483. $\chi^2_{crit,\ 10\%} = 7.78$, $\chi^2_{crit,\ 5\%} = 9.49$, df = 4. Instrumental variables were the 2000 county-level unemployment rate from the Bureau of Economic Analysis, whether the county was classified as metropolitan or nonmetropolitan, whether the county was classified as a poverty-persistent county, whether the economy of the county was dependent on farming, and whether there had been significant population loss in the county between 1990 and 2000, and if the county was considered a 'low-education' county. The previous five variables are from the ERS county typology codes available at http://www.ers.usda.gov/briefing/rurality/Typology/index.htm#start. An environmental amenity index was also included in the set of instrumental variables (http://www.ers.usda.gov/Data/NaturalAmenities/).

Note: **Bold** entries are significant at the 10% level. Standard errors were estimated using the delete-a-group Jackknife (Dubman, 2000).

Source: ARMS Phase 3, Version 1, 2001.

Figure A-1. Multistage approach and measurement of program participation and conservation Intensity



Note: The decisions in boxes 1 and 2 are modeled using a logit regression. The decisions in box 3 are modeled using multinomial logit regression. Acreage supply is modeled using Heckman's two-step procedure, while the number of practices used on a farm is modeled using negative binomial regression.

Appendix table 3

Results of the logit and acreage supply models (supplement to table 3)

			VP>0			
	Pr[VP=0][1]	Pr[Land retirement, VP=0][1]	Pr[Partial farm enrollment][2]	Pr[Working lands][2]	Acreage supply[3]	Number of practices[4]
Farm production characteristics:						
High-value crops	-	-	**-3.09**	-1.18	0.01	**-0.37**
Grain crops	-	-	0.51	1.40	**-0.05**	0.16
Hogs	-	-	-0.02	-1.19	0.04	-0.25
Cattle	-	-	-0.32	-0.09	-0.01	-0.11
Poultry	-	-	0.06	0.19	0.12	-0.50
Asset turnover ratio	-20.17	1.55	0.01	-0.22	-0.16	-0.04
Acreage expansion since 1996 (1=yes)	0.22	-	0.02	0.54	-0.31	0.05
Tenure (owned/operated acres)	0.98	3.96	**1.02**	-0.48	**0.19**	**0.19**
Gross cash farm income less govt. payments	-0.0001	-0.00003	4.6E-08[5]	**1.8E-07**	0.01	0.00
Government assistance:						
Conservation payments	**0.22**	2.49	-	-	-	-
Commodity payments	0.69	0.93	0.19[6]	-0.39[6]	-	-
(Cons. paymts. + Comm. paymts.) /tot. value of production	-	-	-	-	**0.47**	-0.06
Farm household characteristics:						
Household size	-0.03	-0.63	0.004	0.14	0.05	**0.06**
Farming experience	-2.17	-0.14	3.36	4.37	0.02	1.97
Square of farming experience	1.84	4.75	-3.32	2.46	-	-2.03
Education experience	0.14	0.41	0.15	**0.33**	-0.28	0.09
Off-farm income/total household income	-0.15	0.18	-0.41	**-1.52**	0.02	0.04
Female operator (1=yes)	1.14	0.24	-1.14	0.14	**0.65**	0.11
Operator works off-farm (1=yes)	0.43	0.71	-0.0003[5]	0.52	0.03	0.04
Spouse works off-farm (1=yes)	0.04	0.39	-0.003[5]	**0.81**	-0.43	0.14
Dual off-farm income (1=yes)	0.24	2.57	-0.11[5]	1.19	0.04	0.06
Retired (1=yes)	0.29	1.82	-	-	-	0.00
Spouse raised on farm (1=yes)	0.86	1.13	0.16	0.18	0.17	0.14
Operator raised on farm (1=yes)	-0.20	1.57	0.08	-0.19	-0.06	**0.06**
Environmental characteristics:						
Highly erodible land (water erosion)	0.20	8.98	**2.58**	-0.12	2.E-03	**1.79**
Highly erodible land (wind erosion)	-0.72	15.05	**2.19**	0.17	0.05	0.09
Humidity index	-0.02	0.07	**0.02**	-0.01	0.77	0.00
Farm next to stream, river, lake (1=yes)	-0.20	0.44	0.22	**1.03**	0.03	**0.74**
Distance from nearest town>10,000 persons	0.003	0.03	2.92E-03	3.77E-03	0.02	0.00

See notes at end of table.

-Continued

Appendix table 3

Results of the logit and acreage supply models (supplement to table 3)—Continued

			VP>0			
	Pr[VP=0][1]	Pr[Land retirement, VP=0][1]	Pr[Partial farm enrollment][2]	Pr[Working lands][2]	Acreage supply[3]	Number of practices[4]
Local/Regional economy:						
Manufacturing	-1.82	11.75	-1.01	0.42	0.01	-0.25
Service trade	1.19	-1.37	0.95	3.55	0.03	-0.84
Wholesale/Retail trade	-0.25	-3.98	-2.39	-3.12	-0.01	-0.72
Population density (persons/sq. mile)	4.72	19.54	-27.38	-6.77	-0.10	0.18
Regional variables:[7]						
Heartland	-0.43	5.70	**0.51**	1.36	-0.22	0.43
Northern Crescent	0.90	3.64	-0.24	-0.18	0.57	**0.58**
Northern Plains	0.17	6.80	**1.11**	0.23	-0.77	**0.48**
Prairie Gateway	-0.34	5.66	**0.64**	-0.16	-0.36	**0.23**
Eastern Uplands	-0.40	3.91	**-0.52**	0.49	0.33	**-0.75**
Southern Seaboard	-0.10	3.67	-0.67	-0.40	0.05	-0.06
Fruitful Rim	-0.15	-6.31	0.20	-0.51	0.63	0.05
Basin and Range	-0.48	-27.31	-0.21	0.01	-0.70	-0.03
Constant	-0.60	-21.84	**-5.43**	**-6.82**	-0.36	-2.48
Inverse Mill's Ratio					-0.36	
R^2					0.46	
Test for endogeneity [8] (Wald test)	1.02	0.0003	**13.56**[9]	3.62[9]	6.78	
Log likelihood	-539,844	-20,643	-578,009			-3,067
Sample size (N)	5,270	328	373 10	220	395	4,957
Expanded N	2,087,099	333,720	97,524	45,665	104,002	1,665,306

[1]Logit model.

[2]Multinomial logit.

[3]Heckman two-step model. Dependent variable is an extreme value transformation of the percent of total operated acres enrolled in CRP. Therefore, the conservation acreage supply equation is $P(x, \beta) = 1 - \exp(-\mathbf{Z})$, where **Z** is a Cobb-Douglas function with the arguments x and β, and P is the percent of acres operated enrolled.

[4]Negative binomial count model.

[5]Expected value of the variable.

[6]Normalized by total value of production.

[7]Regional coefficients are constrained to sum to zero.

[8]See Wooldridge, 2000, p. 483. $\chi^2_{crit, 10\%} = 7.78$, $\chi^2_{crit, 5\%} = 9.49$, df = 4. Instrumental variables were the 2000 county-level unemployment rate from the Bureau of Economic Analysis, whether the county was classified as metropolitan or nonmetropolitan, whether the county was classified as a poverty-persistent county, whether the economy of the county was dependent on farming, if there had been significant population loss in the county between 1990 and 2000, and if the county was considered a 'low-education' county. The previous five variables are from the ERS county typology codes available at www.ers.usda.gov/briefing/rurality/Typology/index.htm#start. An environmental amenity index was also included in the set of instrumental variables (www.ers.usda.gov/Data/NaturalAmenities).

[9]The endogeneity statistic was 16.81, $\chi^2_{crit, 10\%} = 13.36$, df = 8; 10. Reference group is nonparticipants (N = 4,349, expanded N = 1,519,782).

BOLD is significant at the 10% level (delete-a-group Jackknife standard errors, Dubman (2000)).

Source: ARMS Phase III, 2001, version 1.

Appendix table 4

Multinomial logit marginal effects for key variables in conservation participation model: Partial land retirement and working-land participants

	Partial farmland retirement	Working-land participant
Farm production characteristics:		
High-value crops	**-0.096**	-0.008
Grain crops	0.015	0.010
Hogs	-3.E-04	-0.009
Cattle	-0.010	-0.001
Poultry	0.002	0.001
Asset turnover ratio	4.E-04	-0.002
Acreage expansion since 1996 (1=yes)	0.001	0.004
Tenure (owned/operated acres)	**0.032**	-0.004
Gross cash farm income less govt. payments ($10,000)	1.4.E-04	**1.3.E-04**
Government assistance:		
Commodity payments/total value of production	0.006	-0.003
Farm household characteristics:		
Household size	0.000	0.001
Farming experience	0.104	0.032
Education experience	0.005	0.002
Off-farm income/total household income	-0.012	**-0.011**
Female operator (1=yes)	-0.036	0.001
Operator works off-farm (1=yes)	-1.E-04	0.004
Spouse works off-farm (1=yes)	-3.E-04	0.006
Dual off-farm income (1=yes)	-0.004	0.009
Spouse raised on farm (1=yes)	0.005	0.001
Operator raised on farm (1=yes)	0.002	-0.001
Environmental characteristics:		
Highly erodible land (water erosion)	**0.080**	-0.002
Highly erodible land (wind erosion)	**0.068**	0.001
Humidity index	0.001	-6.E-05
Farm next to stream, river, lake (1=yes)	0.007	**0.008**
Distance from nearest town>10,000 persons	9.E-05	3.E-05

Note: **Bold** entries are significant at the 10-percent level or lower.

Source: ARMS Phase III, 2001, version 1.

adoption of one or more conservation practices (app. table 4). In this regression, all farms (program and nonprogram) producing crops or livestock for revenue are considered together because of the limited sample size of working-land program participants.

In the cases of the limited dependent variable models, a likelihood ratio test was used to determine the overall acceptability of the model. The null hypothesis that all of the coefficients associated with the explanatory variables were zero was rejected at the 1-percent level for the limited dependent variable models and the negative binomial count model. The coefficient of determination was 0.46 for the acreage supply model.

We tested whether our farm-size proxy (gross cash income from farm sales less government payments) and the decision to work off-farm (operator, spouse, or dual income earners) were endogenous using a regression-based test outlined in Wooldridge (2000, pp. 483-84). For the multinomial models, testing whether these variables were endogenous involved a two-step process. In the first step, the joint hypothesis that these variables were exogenous was tested across equations. If the null hypothesis was rejected, then each vector of coefficients corresponding with each choice was tested separately. When it was determined which equation contained the endogenous variables, these variables were replaced with their expected values. The results are included in the appendix tables. Empirically, the decision to work off-farm and farm scale were not endogenous in the cumulative probit model (app. table 1) or the multinomial logit model estimating the factors influencing participation in working-land or land retirement programs. For the two-stage decision model, the joint hypothesis of exogeneity was rejected in the negative binomial count model and the multinomial discrete choice model estimating the factors influencing the decision to enroll part of a farm into a land retirement program.