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# Working Farm Participation and Acreage Enrollment in the Conservation Reserve Program

**Dayton M. Lambert, Patrick Sullivan, and Roger Claassen**

Among Conservation Reserve Program (CRP) participants, there is a distinction between farm households using the program to ease out of farming and those using the program to augment production receipts. We find evidence that factors other than crop or livestock revenue and environmental factors are associated with program participation and acreage enrollment among farmers who continue agricultural production. Program payments and farm size are positively associated with the amount of land enrolled in the CRP, and characteristics of participants in land retirement and working-lands CRP components are similar.

*Key Words:* acreage enrollment, Conservation Reserve Program, land retirement, program participation, working farms, working-land conservation

**JEL Classifications:** Q24, Q28

The Conservation Reserve Program (CRP) was authorized by the Food Security Act of 1985 to retire environmentally sensitive land from agricultural production. In return for an annual rental payment and partial reimbursement for the cost of establishing and maintaining approved groundcover, participants agree to take cropland out of production for 10 to 15 years and plant grasses, trees, and other conservation cover. Since its inception, the CRP has been the largest conservation program administered by the U.S. Department of Agriculture (USDA). In 2004, farmers and landowners were paid $1.8 billion in cost-share and rental payments on roughly 35 million acres of land enrolled in the CRP. Contracts for nearly 80% of the acres currently enrolled in the CRP are due to expire before 2010, leaving policymakers and program managers with important decisions about the future direction of the USDA's conservation efforts. But the ultimate impact of any conservation program depends upon the voluntary participation of farm operators and land owners. Current CRP participants will be deciding whether to renegotiate their expiring contracts, and other eligible operators will be deciding whether or not to offer any of their cropland for enrollment into the program. How these decisions are made will affect not only who participates in the CRP, but how they participate, and with what environmental consequences.

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While the CRP is designed to retire land from farm production and is therefore not commonly thought of as a working-land conservation program, about 40% of the program participants continue producing farm commodities for sale after enrolling in the CRP. A small group of high-priority conservation practices, including riparian buffers, grass filter strips, and contour strips, is eligible for assistance under the CRP as well as other working-land conservation programs supported by the USDA.[1] This article focuses on the factors associated with working farm operators participating in the CRP and the types of conservation practices they implement.[2] Interest in, and budget outlays and expenditures for, the USDA's other working-land programs have increased in recent years. Knowledge about the attributes associated with operators participating in the working-land component of the CRP may provide some insight about future participation in the Environmental Quality Incentives Program and the Conservation Security Program.

The criteria we use to distinguish working-land and land retirement components of the CRP are based on definitions used in the 2001 Agricultural and Resource Management Survey (ARMS). Ten reimbursable conservation activities were considered in the 2001 ARMS: (1) improving wildlife habitat, (2) planting entire fields to grasses or legumes, (3) planting entire fields to trees, (4) installing wildlife food stands or feeding areas, (5) establishing rare or endangered habitats, (6) restoring wetlands, (7) installing grass filter strips, (8) installing grass contours, (9) planting riparian buffers, and (10) planting grass waterways. We classified the first six practices into those that are consistent with the land retirement component of the CRP. The remaining practices are consistent with working-land practices and are typically associated with the continuous signup portion of the program.[3] Any of these practices may be reimbursable under the program, but in general, larger parcels not involving high-priority conservation structures are less likely to qualify for the continuous signup program.

This article has two research objectives. The first objective is to compare the farm structure, household characteristics, and operator attributes of farms that participate in the CRP and continue producing agricultural commodities with farms not participating in the program. We test the hypothesis that farm structure and operator attributes of households participating in the working-land and land retirement components of the CRP are different from nonparticipants using means separation procedures. We then focus on the attributes of CRP participants that have used the program to retire farmland from production versus those that use CRP to adopt practices consistent with working farmland.

The second research objective is to supplement our univariate comparisons by correlating farm structure and household attributes with participation and the acres enrolled by participants. Participation in working-land and land retirement components is modeled using a bivariate probit. We expect that participation in the working-land or land retirement components is associated with revenue maximizing objectives as well as personal attributes, family structure, farming experience, and environmental factors. But we hypothesize that factors correlated with the

[1] The Environmental Quality Incentives Program (EQIP), authorized in 1996, and the Conservation Security Program (CSP), authorized in 2002, are the USDA's primary working-land conservation programs. EQIP provides partial reimbursement for a wide range of conservation practices and structures on crop and livestock farm operations. CSP can reimburse farmers for continuing conservation practices already in place, as well as support newly adopted conservation practices.

[2] Working farms, as the idea is used here, are those farms that produce crops or livestock for sale. To contrast, we consider a nonworking farm to be one that does not produce agricultural commodities for sale (i.e. the value of production receipts is zero).

[3] Most of the acreage enrolled in the CRP enters the program during one of the general signups held periodically to elicit bids from interested farm operators/land owners with environmentally sensitive cropland. As the name implies, continuous signups are available anytime a farm operator/landowner wants to adopt high-priority conservation practices on eligible parcels.

decision to participate in the land retirement component of the CRP are different from those associated with the decision to participate in working-land projects. Because operators can choose to enroll cropland into both program components, we anticipate that land retirement and working-land participation decisions are significantly correlated. Acreage allocation equations are estimated using a bivariate censored regression, because operators may participate in both the land retirement and working-land program components. We hypothesize that program payments per acre are positively correlated with acreage enrolled in each component. We also expect that farm size is positively associated with the acres supplied to both components of the program but that tenure (acres owned/total acres operated) and operator age (as measured by years making farming decisions) are more likely to be positively correlated with acres supplied to CRP's land retirement component.

By focusing only on working farms (i.e., farms that report revenue generated from crop or livestock sales), this analysis attempts to isolate differences that may be important should conservation funding shift toward working-land programs. We can begin to understand how potential participants in either component might respond to market and program incentives by identifying the characteristics of farm households participating in CRP working-land and land retirement components and the factors associated with participation effort.[6] This is the first study to look at the CRP this way using a nationally representative sample of farm households.

[6] Because we are working with cross-sectional survey data, and because we cannot discern when a respondent enrolled in the CRP, or whether they had previously enrolled but their contracts had since expired, we cannot expect the decision to participate in the CRP to be coterminous with other farming decisions. Therefore, our results only imply correlations, and do not establish causality. To emphasize this point, we discuss our regression results in terms of "correlations," "relationships," and "associations," rather than "effects," "determinants," or "impacts." Nonetheless, the correlations we do present are *ceteris paribus*.

The remainder of the paper is organized as follows. First, the CRP is reviewed, along with the basis for distinguishing between working-land and land retirement components. Second, the ARMS data used in the study are described, followed by a comparison of farm structure, operator attributes, and household characteristics of CRP participants with nonparticipants. Third, an empirical model is specified to analyze factors hypothesized to be associated with participation in CRP working-land and land retirement components, holding other factors constant. Fourth, the conservation acreage allocation models are described, followed by results of the hypotheses tested. The empirical models are used to supplement our univariate comparisons by associating farm structure and household attributes with the participation decision and acreage supply while holding other factors constant. The final section concludes.

## Land Retirement and Working Land in the Conservation Reserve Program

Reducing soil erosion through the retirement of highly erodible farmland was the primary focus of CRP between 1985 and 1990. But, in the early 1990s, the focus of the CRP was broadened to address other objectives, such as reducing sedimentation, improving water quality, and fostering wildlife habitat. At the same time, additional high-priority conservation practices became eligible for assistance, providing potential participants and program planners with increased flexibility in dealing with environmental concerns. And, as pressure to enroll more acres increased, the bid process was changed to ensure that CRP rental rates reflected each parcel's market value and that the environmental benefits from enrolled land were commensurate with program outlays. After 1998, enrollment in the CRP became more competitive as benefit-cost indices were used to rank offers from eligible landowners and as legislatively imposed CRP acreage caps were approached (Sullivan et al.).

In 1996, the USDA began offering a continuous signup program to augment its periodic general signups. The continuous

signup component of the CRP allows nonoperator landowners and farm operators to use the program to install conservation structures such as riparian buffers, filter strips, windbreaks, grass-lined waterways, and other vegetative structures that provide large environmental benefits on relatively smaller parcels of farmland (Smith).

The conservation structures covered by the continuous signup portion of CRP are often compatible with existing farm production practices. Indeed, these high-priority structures are eligible for the USDA's working-land conservation programs as well.[5] Land offered through the continuous signup program is not subject to a competitive bidding process, and participants often receive rental and cost-share payments higher than those received under the program's general signups. Continuous signup enrollees received an average of $96 per acre in rental and cost-share payments in 2004, while the average rental payment per acre for general signup enrollees was $43 (USDA). The CRP acreage enrolled in working-land practices was only 8% of program acres in 2004, but such signups accounted for 18% of CRP payments and 40% of the CRP contracts, indicating that these conservation efforts are viewed as important—by participants and the USDA—even within a program typically regarded as a land retirement program (USDA).

## Data

The USDA's 2001 Agricultural Resource Management Survey (ARMS) was used to characterize farm households that participate in the CRP ($n$ = 5,439 respondents, expanded population = 2,091,919 farms). ARMS is a collection of annual surveys that focus on the farm enterprise and on specific crops, and it 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. Respondents are asked each year how much land they have enrolled in the CRP and how much payment they received for participation. While many of the same questions appear each year, in some years the survey includes sections that focus on special topics. The 2001 ARMS included a special group of questions on CRP-eligible conservation structures and whether support was provided through the continuous or general signup portions of the program. Additionally, the 2001 survey focused on which practices were implemented on the acres enrolled (e.g., planting entire fields to grasses, legumes, or trees, or installing vegetative structures such as contour strips, riparian buffers, or grass filters).

Because of the complex survey design of ARMS, variances are calculated based on standards established by the National Agricultural Statistical Service, using the delete-a-group jackknife variance estimator (Dubman; Kott). Details and implementation of this procedure are outlined in El-Osta, Mishra, and Ahearn. The delete-a-group jackknife procedure was used to make inferences about means of the groups analyzed in the paired $t$-tests and the probit and censored regressions.

## Factors Hypothesized to Be Correlated with CRP Participation and Conservation Acreage Allocation

Profitability drives many farming decisions, including practices that are eligible for conservation program support (Hopkins and Johansson). But farm household attributes and operator personal characteristics are also likely to correlate with farm management decisions (Smith and Weinberg). For example, retirement and residential farms are generally smaller in size, and their operators are typically less engaged in farming as an occupation (Figure 1). These operators may prefer land retirement over working-land conservation practices. Low sales farm operators consider farming their primary occupation but may lack

[5] While a working-land practice may be eligible for several programs, financial assistance can only be received from one program. For the working-land practices eligible for CRP assistance, the continuous signup CRP generally offers the highest remuneration rates of USDA's conservation programs.

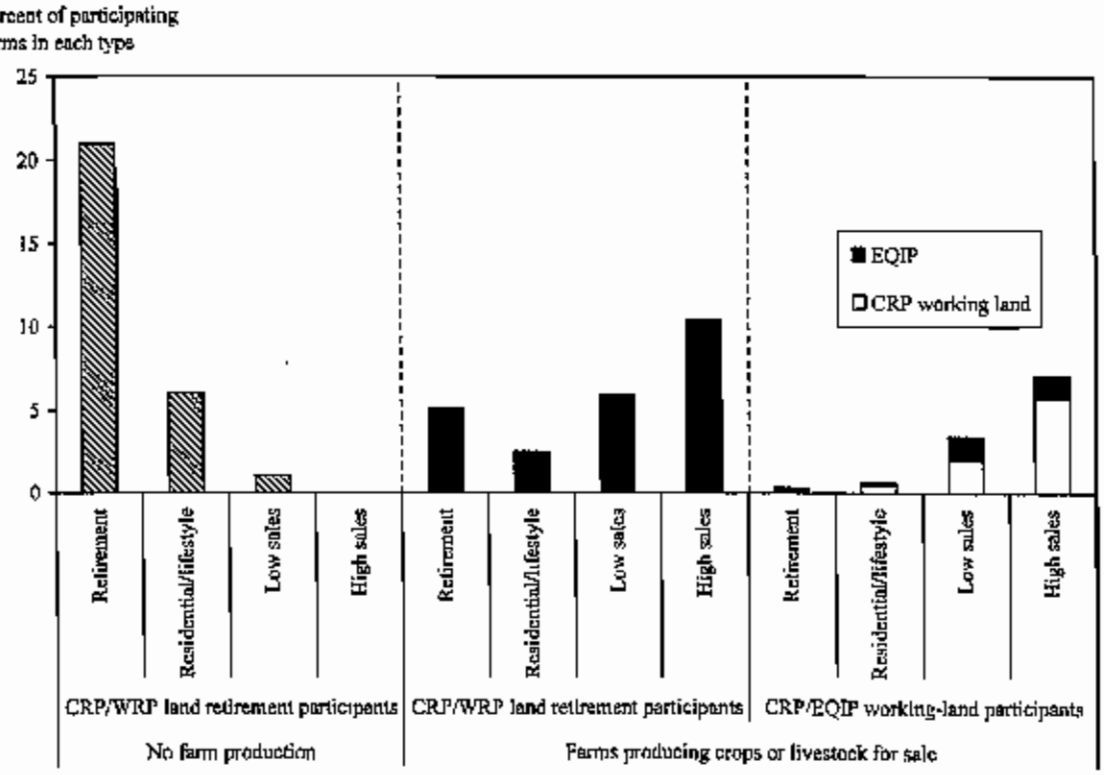


**Figure 1.** Distribution of Program Participants, by Production Status, Type of Program, and Type of Farm, 2001. Notes: Land retirement participants refer to farms that retired cropland from production for conservation purposes. Working-land participants had installed one or more vegetative working-land structures, such as grass filter strips, grassed waterways, contour strips, and riparian buffers. Farm types are retirement farms (small family farms—those with sales less than $250,000/year—whose operator is retired), residential-lifestyle farms (small family farms whose operator reports a nonfarm business as the primary occupation), low sales farms (family farms whose operators report farming as primary occupation, with sales less than $100,000/year), high sales farms (family farms whose operators report farming as primary occupation, with farm sales between $100,000 and $250,000/year, and all family farms with sales exceeding $250,000). Nonfamily farms are excluded. The percentage of farms on the *y*-axis is the percentage out of the retirement farm type, the residential/lifestyle farm type, etc. Source: 2001 ARMS, phase III, version 1.

the resources needed to remain viable in the long run without significant off-farm income, making conservation structural practices of all kinds less attractive. Higher sales farms are more focused on farming as an income source, perhaps making working-land conservation practices a more likely choice because these practices are compatible with crop operations. In an attempt to capture the attributes of a wide range of factors that may be associated with the participation decision, we examine farm business, operator, and household characteristics in our models, as well as environmental proxies.

*Farm Structural Variables*

Total cropland acres operated (*CROPLAND*) was used to measure the relationship between farm size and the decision to enroll land in the CRP (Chang and Boisvert; Lynch, Hardie, and Parker). Cropland acres operated are hypothesized to be positively correlated with the acres supplied to the land retirement and working-

land components of CRP because larger farms are likely to control more eligible land and enjoy a wider array of land-use options. The number of acres enrolled in the land retirement component of the CRP by larger working farms and smaller farms that had ceased production was not significantly different (Table 1). Nor were the per-acre rental payments they received

**Table 1.** Mean Comparisons for Farm Households Participating in CRP Land Retirement and Working-Land Programs with Nonparticipants

| | Working Farms in CRP[1] | | | | |
|---|---|---|---|---|---|
| | Land Retirement Participants[2] | Working-Land Participants[2] | Land Retirement and Working-Land Participants | Nonworking Farm Participants[1] | All Other Farms |
| Variable | A | B | C | D | E |
| Observations | 230 | 84 | 75 | 253 | 4,797 |
| Farms | 56,104 | 25,187 | 19,448 | 151,898 | 1,839,282 |
| Horizontal percentage | 2.7 | 1.2 | 0.90 | 7.3 | 87.9 |
| Cropland acres | 704 DE | 668 DE | *865 DE | *276 ABC | 155 ABC |
| % Tenure (owned/ operated acre) | 74 BD | 62 AD | 67 D | 90 ABCE | 73 D |
| % Revenue from crops | 57 BDE | 85 ADE | *66 D | *12 ABCE | 36 ABD |
| Govt. pmts./acre | 26 BDE | 54 ACDE | *28 D | *12 AB | 15 AB |
| CRP acres enrolled | 159 BE | 25 ACDE | 145 BE | *177 BE | 0 ABCD |
| CRP pmts./acre | 64 BE | 113 ACDE | 65 BE | 53 BE | 0 ABCD |
| % *HEL* | 12 E | *9 | *9 | 10 E | 6 AD |
| % Next to water | 50 E | *46 | *56 | 41 | 35 A |
| Experience (years) | 29 E | 32 E | 27 | 26 | 21 AB |
| Operator age | 57 D | 56 | 55 | 61 AE | 54 D |
| % Attended college | 27 | *22 | *21 | 26 | 19 |
| % With persons less than 18 years | 38 D | *24 | *38 | 16 AE | 32 D |
| % Off-farm income/ total household income | 73 DE | 60 DE | *60 | 85 AB | 83 AB |
| Heartland | 43 BDE | *88 ACDE | 44 BDE | 22 ABC | 16 ABC |
| Northern crescent | a 5 | a 2 | a 10 | a 17 | *16 |
| Northern plains | *9 E | a 4 D | *29 E | *17 BE | 4 ACD |
| Prairie gateway | 25 BCDE | a 2 ADE | a 9 A | *13 AB | 14 AB |
| Mississippi portal | *10 DE | a 3 DE | a 5 DE | *29 ABC | 34 ABC |
| Fruitful rim and basin | *7 BE | L | a 4 BE | *2 BE | 16 ABCD |
| % Farms, metro counties | 29 CDE | a 28 | a 9 AE | *11 AE | 44 ACD |

[1] Working farms are farms that reported sales from crop or livestock. Nonworking farms reported zero value of production in 2001.

[2] Working land refers to farms enrolled in CRP that had installed one or more of the following vegetative structures: grass filter strips, grass waterways, riparian buffers, contour strips. Land retirement refers to farms enrolled in CRP that had planted entire fields to grasses, legumes, or trees, or had set aside land for the reestablishment of wetlands or to rehabilitate wildlife. Based on 5,439 households. Asterisk indicates that coefficient of variation is greater than 25 and less than or equal to 50; a indicates that CV is above 50; letters A, B, C, D, and E indicate significant column difference tests based on pairwise two-tailed *t*-statistics at a 90% confidence level or higher; L is legal disclosure issue.

Source: 2001 ARMS, phase III, version 1.

different. But at the margin, it may make sense for smaller, eligible farms to enroll all of their eligible land into the CRP if revenue from production is not their primary goal. On the other hand, it may be reasonable to expect that larger farms more focused on production for revenue have less incentive to maximize potential rent from land retirement. Nonetheless, there may be circumstances when it is good business to cease production on relatively larger portions of marginal, fragile, or difficult-to-farm cropland operated by working farms if doing so allows the farm operation to diversify income flows. By enrolling such land in the CRP (if eligible), the operator can replace potentially variable crop receipts with a stable CRP rental payment.

The proportion of land owned to total farm acres operated (*TENURE*) was used to measure the relationship between tenure and the land enrollment decision. In 2001, CRP participants who no longer produced crops or livestock for revenue owned 90% of the land they operated. This ratio tends to be lower for working farms, particularly larger, higher sales farms that tend to rent land for production purposes. For working farms choosing to retire larger parcels of cropland into the CRP, tenure may be important for at least two reasons. First, it may be easier for the land owner to make the decision to take land out of production for 10 to 15 years. Second, the decision to forego production on relatively large tracts of land that could otherwise be used to produce crop receipts may coincide with retirement plans, or efforts to ease out of production. If so, farm operators easing into retirement might be expected to reduce their use of rented land as they decrease production (Wu).

Tenure may not be too important with respect to the decision to enroll smaller parcels of land into the working-land component of the CRP because these conservation measures are usually compatible with ongoing crop production objectives. Enrollment of noncontiguous, perhaps oddly shaped, hard-to-manage parts of fields that can be modified by installing corrective or preventative conservation measures should not have a large effect on production (e.g., center-pivot irrigated field perimeters). The working-land participation decision is expected to correlate with production objectives, but not with other factors that may signal that an operator's goals are less oriented toward generating revenue from production. Therefore, tenure is not expected to be associated with the decision to participate in the working-land CRP program. But, for reasons above, tenure is hypothesized to be positively correlated with the quantity of cropland retired into the CRP. Relatively little leased land is enrolled in the CRP.

The revenue from crop production as a proportion of total production revenue (including livestock receipts) measures the effect of farm diversification on the participation decision, acres set aside, or acres allocated to vegetative structures (*REVCROP*) (Lohr and Park; Soule, Tegene, and Wiebe). It is hypothesized that the share of total revenue from crops will be positively related with the decision to participate in the land retirement and working-land components of the CRP, since to be eligible, land offered must have been previously cropped. It is hypothesized that the revenue share from crop production will have a positive relationship with the acres supplied to the working-land CRP component because installation of these vegetative structures is usually consistent with production objectives of crop farms. Operators who consider revenue from crops to be important with respect to income are also more likely to have more eligible cropland that they can enroll, all else being equal. But retiring larger parcels of land that could otherwise produce a crop is an unlikely management strategy for working farms that depend more on crop revenue, so the crop revenue share of total production revenue is not expected to correlate with the supply of acres in the land retirement component of the CRP.

Nonconservation government payments may also correlate with the decision to participate in conservation programs (Chang and Boisvert; Lynch, Hardie, and Parker). Receipt of commodity payments may be correlated with the decision to participate in farm programs that promote good stewardship practices. To test this hypothesis, per-acre

receipts of nonconservation government payments, which include Agricultural Marketing Transition Act, disaster payments, and loan deficiency payments are included in the participation and acreage supply models (*GOVT*).[6]

*Farm Household Characteristics and Human Capital Variables*

The off-farm income share of total household income was included in the empirical models to measure the relationship between nonfarm income sources and the decision to participate in the working-land or land retirement components of CRP (*OFFINC*). The expected sign of this variable is ambiguous for working farms participating in either CRP component. On the one hand, for farms focused on agricultural receipts for income, it would be reasonable to anticipate that off-farm income would be negatively associated with the decision to participate in a working-land CRP program, assuming that the provisions associated with this program appeal more to persons engaged in production agriculture. On the other hand, for operators easing out of production, off-farm income may supplement, and eventually substitute for, income earned from farming. In this case, off-farm income may be positively correlated with the decision to participate in the CRP land retirement component even if operators are still actively engaged in production agriculture. Similar expectations hold with respect to acres supplied to land retirement and to working-land structures.[7]

Years of farming experience (*EXPERIENCE*) was used to measure the effect of human capital and operator age on decisions to participate in the CRP. Experience—the number of years the operator had made farm management decisions—was used rather than operator age because this variable is also a proxy for operator skill and human capital. It is hypothesized that more experienced farmers are more likely to adopt working-land conservation practices. The effect of operator age on the participation decision is also measured using farming experience because age and experience were significantly correlated (Pearson's $r = 0.67$). Previous research on CRP participation has found that operators approaching retirement may perceive land retirement as a viable strategy to keep the farmstead while receiving some compensation for retired land (Sullivan et al.). Therefore, it is hypothesized that farming experience might also positively relate to the decision to participate in the land retirement component of the CRP.

Educational attainment was used to measure the relationship between human capital and decisions to adopt conservation practices (Lynch, Hardie, and Parker). Previous studies found that education is positively associated with participation in conservation programs (Soule, Tegene, and Wiebe). A dummy variable was included in the participation and acreage allocation models indicating whether the operator had some college education (*COLLEGE*). It is expected that educational attainment will be positively correlated with the decision to participate in both the land retirement and working-land components of the CRP, as well as the quantity of acres supplied.

Household structure may be an indicator of the life stage of a farm household or operation or a measure of the human resources available to the farm operation. There were no significant differences between the numbers of households with persons less than 18 years old (*HH18*) living with operators of working farms participating in the working-land and land retirement components of the CRP. However, working farms, as a group, more frequently had persons under the age of 18 living in the household than did CRP participants that had ceased growing crops and livestock. If this variable is negatively correlated with the decision to partici-

[6] Because government payments are highly correlated with farm size, the sum of government payments is normalized by the total cropland acres operated.

[7] We refer to working-land structures as vegetative structures with the dual objective of enhancing soil productivity and increasing environmental benefits. These structures are usually compatible with ongoing crop production. That is, they are typically installed along the margins of fields or in other difficult-to-farm areas. Such structures include windbreak hedgerows, riparian buffers flanking streams, contour strips, grass filters or waterways, etc.

pate in the land retirement component of the CRP, then it may imply that older households without children perceive the CRP land retirement program as a way to position the farmstead for retirement, *ceteris paribus*. On the other hand, a significant positive relationship might suggest that the land retirement participation decision may be more related to a farm management strategy (i.e., retiring marginal cropland to save input costs) than positioning the farm in anticipation of retirement (i.e., easing out of production).

*Environmental Characteristics*

A highly erodible land index (*HEL*, land with erodibility indices ≥8) was used to proxy environmental sensitivity (Heimlich). This is a countywide measure rather than one specific to the field or parcel enrolled in the CRP. The measure is only an approximation of the environmental sensitivity of land operated by individual growers, but inclusion of this proxy controls for the fact that participants in the land retirement component of the CRP must have eligible land, as measured by its Environmental Benefit Index (EBI) score, to participate.[8] We expect this variable to be positively correlated with participation in the land retirement component of CRP. However, because working-land conservation structures service a wide array of environmental needs, the expected sign for the working-land participation decision is ambiguous.

A binary variable indicating whether the operator's farm was located next to water sources or water bodies is also included in the regressions (*NEXTH2O*). We expect this variable to be positively correlated with the decision to participate in both the land retirement and working-land components of the CRP.

The effects of farm location were measured using a set of dummy variables associated with the Economic Research Service's production regions.[9] The Heartland (a region encompassing Iowa, Illinois, Indiana, western Ohio, and northern Missouri) is used as the reference region. The regional variables control for differences in land prices, access to farm services, climate, and growing seasons (Khanna). Effects of proximity to metropolitan areas and potential access to off-farm employment opportunities are measured using a variable indicating whether the farm was located in a county categorized as metropolitan (*METRO*).

## Empirical Model for Working Farm Conservation Program Participation

We use a bivariate probit regression to test—holding other factors constant—the hypothesized relationships between farm structure, household and operator characteristics, and CRP participation. We assume that the producer considers farm output an important revenue source such that the utility gained from farming is greater than ceasing all production. Operators are assumed to be rational agents that face a discrete choice to participate in the CRP. The operator maximizes expected benefits from crop and/or livestock production over a time horizon. Therefore, the operator must weigh the costs of foregoing potential returns from cropland in return for a guaranteed payment over a contractual period. The operator may choose to participate in the land retirement component, the working-land component, both components, or neither component of the CRP. Because of data limitations, we do not observe the operators who would have participated in the CRP had their land been eligible or had their bids been accepted. To conduct this type of analysis would require matching the CRP administrative files with ARMS respondents. Thus, the participation

[8] Like other recent studies looking at the CRP participation choice (Chang and Boisvert; Jaroszewski, Poe, and Boisvert; Lambert et al.), we use a county aggregate because it was the only available proxy for environmental sensitivity. The ideal measure would be the environmental benefit scores of each respondent for each field. But because of technical problems and confidentiality concerns, CRP contract data are not currently available for ARMS respondents

[9] A description of the ERS resource regions is available at www.ers.usda.gov/Emphases/Harmony/issues/resourceregions/resourceregions.htm.

choice we observe is conditional upon the operator already having succeeded in negotiating a contract.[10]

If an operator successfully negotiates a contract to retire cropland, he is partially compensated for establishing grasses, legumes, trees, or other native vegetation on the parcel and receives a per-acre rental payment for the acreage enrolled. If an operator chooses to participate in the working-land program component, then he is compensated for the installation of vegetative or other conservation-compatible structures and receives an annual per-acre rental payment. An operator may also participate in both program components and receive program benefits accordingly.

We follow Khanna's notation used in her study of technology adoption as the framework for our conceptual model. Let $U_O$ be the expected utility of producing crops and/or livestock for revenue but not participating in the CRP, or ceasing all agricultural production after enrolling farmland into the CRP land retirement program. The operator participates in the CRP working-land (WL) component of the program if $U^*_{WL} = U_{WL} - U_O > 0$. The operator participates in the CRP land retirement (LR) component of the program if $U^*_{WL} = U_{LR} - U_O > 0$. The net benefits from participating in the CRP working-land ($U^*_{WL}$) or land retirement ($U^*_{LR}$) components are latent variables assumed to be stochastic functions of vectors of observed exogenous variables, $\mathbf{Z}_{WL}$ and $\mathbf{Z}_{LR}$.

$$(1)\quad U^*_{WL} = \mathbf{Z}_{WL}\gamma_{WL} + \varepsilon_{WL} \text{ and}$$
$$U^*_{LR} = \mathbf{Z}_{LR}\gamma_{LR} + \varepsilon_{LR}$$

where $\gamma_{WL}$ and $\gamma_{LR}$ are unknown vectors of coefficients and $\varepsilon_{WL}$ and $\varepsilon_{LR}$ are normally distributed random disturbances with mean zero and variance one. The observable choices ($C$) of the operator are $C_{WL} = 1$ if $U^*_{WL} > 0$; otherwise $C_{WL} = 0$, and $C_{LR} = 1$ if $U^*_{WL} > 0$; otherwise $C_{LR} = 0$.

When the random factors influencing both participation decisions are not independent because of unobserved factors that could be correlated with both decisions, then the disturbances in Equation (1) have a bivariate normal distribution with a mean vector of zero and a covariance matrix,

$$\Sigma = \begin{pmatrix} 1 & \rho \\ \rho & 1 \end{pmatrix}.$$

This system of equations is estimated maximizing the bivariate probit log likelihood function (Greene).

## Empirical Model for Conservation Acreage Allocation

Acreage allocation models were estimated to test, holding other factors constant, hypotheses relating farm structure, household characteristics, and operator attributes with cropland acres enrolled in the CRP working-land and land retirement components. The variables hypothesized to be associated with the working-land and land retirement participation decisions are included in both acreage supply functions. The rental payment received per acre was also included as an explanatory variable. The working-land and land retirement acreage allocation functions are first-order linear expansion around an arbitrary function linking farm structure and operator characteristics to acreage supply decisions, $A_{WL(LR)} = \mathbf{X}_{WL(LR)}\boldsymbol{\beta}_{WL(LR)} + \xi_{WL(LR)}$, where $\mathbf{X}$ is a matrix of exogenous variables including farm, operator, and environmental characteristics, and $\xi$ is a random disturbance with an unconditional distribution of mean zero. If the acreage allocation decisions are correlated with the same unobserved attributes of the operator as the participation decisions, the covariance between the $\varepsilon$'s and $\xi$'s is not zero. This implies the subgroups are not randomly drawn from the population of respondents. Double-selectivity, or Heckman-type treatment effect models have been used to attend to the selectivity bias resulting from such

[10] Nonetheless, we can partially control for eligibility with respect to EBI scores by including variables that measure soil erodibility or other physical features of the farm, such as proximity to streams, rivers, or other water bodies. Bid offer instruments are more challenging to imagine.

interactions (Fishe, Trost, and Lurie; Khanna; Tunali). We employed these techniques, but found that variance estimation of the subgroups was suspect because of the reduced sample size of the working-land, land retirement, and dual-component participants. This effect is not uncommon when delete-a-group jackknife estimators are used to estimate variances in complex survey subsamples. Delete-a-group jackknife variance estimators for subgroups based on survey sample weights calibrated to larger populations may perform poorly (Kott). Therefore, we used a bivariate censored regression (Lee) to estimate the working-land and land retirement acreage supply equations simultaneously. This allowed us to (1) use the full sample in our regressions and (2) test whether the acreage allocation decisions to land retirement and working-land structures were correlated.

## Results and Discussion

### *Univariate Comparisons of CRP Participants and Nonparticipants*

Previous research on CRP participants has shown that applicants who cease farming following enrollment in the program have very different characteristics than participants who continue farming (Sullivan et al.). The distinction does not necessarily reflect the amount of land enrolled (i.e., participants enrolling cropland into the program often cannot enroll all or even most of their farmland because of its environmental benefits ranking). Rather, it highlights whether conservation program payments have replaced commodity receipts or supplement revenue from crop and livestock sales. We used univariate *t*-tests to compare farm structure, household characteristics, and operator attributes of CRP participants who reported no revenue from crop or livestock production, working farm CRP participants with cropland enrolled in the land retirement or working-land components, and farm households that cannot or chose not to participate in CRP (Table 1).

In 2001, of the roughly 2 million farm households, 12% were enrolled in the CRP. Most of these participants (60%) reported no production of crops or livestock for sale. These respondents were typically older than those operating working farms and participating in the CRP and less frequently had children under the age of 18 in the household. Tenure (the ratio of owned land to operated acres) was also highest for CRP participants that had ceased production. The share of household income from off-farm sources was also somewhat higher for this group relative to other CRP participants. On average, working farms participating in either the land retirement or the working-land components of CRP relied less on off-farm income sources (73% and 60% of income, respectively) than did nonparticipants (83% of income), or CRP participants that had chosen to cease production (85% of income).

Crop sales as a proportion of total farm revenue were higher for CRP participants with land enrolled in the working-land component of the program. On average, working farms enrolled in either component of the CRP were larger than nonparticipant farms, and CRP participants reporting no farm production. While many CRP participants may use the program to ease into retirement, enrolling land into the CRP might be a reasonable land-use strategy for larger farm operations that are presumably more focused on farm profitability concerns. Farms participating in the working-land component of the CRP received, on average, more government payments per cropland acre (including Agricultural Marketing Transition Payments, Loan Deficiency Payments, and disaster payments) than all other farms. CRP per-acre rental payments for farms installing working-land structures were also higher (at $113 per acre) than they were for other CRP participants, reflecting the advantageous provisions of the continuous signup CRP with respect to the installation and maintenance of high-priority conservation structures.

### *Participation Model*

There is reason to suspect that cropland acres, or measure of farm size, and tenure may not be exogenous variables in these equations.

Revenue from crop production may not be exogenous as well, since it is tied to cropland acres. Chang and Boisvert also found that the decision to participate in CRP by farms (focusing on crop producers only) is made jointly with the decision to work off farm. The variable we use to control for program eligibility, *HEL*, could be endogenous if it is tied to how much land is cultivated in a county. Lastly, government payments are potentially endogenous since many of the payments received are dependent upon base acres enrolled.

We used the Rivers-Vuong method to test whether these variables were exogenous (Wooldridge). The (joint) null hypothesis is that these variables are exogenous. The Type I error rate of the multiple tests for exogeneity were adjusted using Bonferroni's procedure (Mittelhammer, Judge, and Miller). At $\alpha$ = 10%, with five restrictions in each equation, the corrected significance level for the variables hypothesized to be exogenous is $P$ = 0.02. For the land retirement participation equation, the coefficients associated with tenure, cropland acres, crop revenue, government payments, *HEL*, and the share of off-farm income as a proportion of total household income were not significantly different from zero ($P$ = 0.98, 0.58, 0.52, 0.67, 0.83, and 0.75, respectively). For the working-land participation equation, the coefficients associated with cropland acres, tenure, crop revenue, government payments, *HEL*, the off-farm income/total household income ratio, and tenure were not significant ($P$ = 0.69, 0.39, 0.41, 0.05, and 0.49, respectively). Therefore, we fail to reject the null hypothesis that these variables are exogenous.[11]

[11] The instruments included all exogenous variables in the participation equations, along with additional, county-level instruments: the share of the workforce employed in manufacturing in 2000, the share of the workforce employed in the service sector in 2000, population density, a binary variable indicating whether the county experienced a population loss between 1990 and 2000, and a natural amenity index (McGranahan) as a proxy for scenic attributes and recreational potential associated with the county. Economic sector information was obtained from the Bureau of Economic Analysis.

Estimates of the participation model are presented in Table 2. We focus our discussion on the factors that were significantly correlated with the working-land and land retirement participation decisions. The positive sign of the disturbance term ($\rho$) suggests that other omitted farm characteristics or personal attributes were positively correlated with the decision to participate in both program components ($\rho$ = 0.66, Wald test = 20.7, df = 1). That is, holding other factors constant, the decision by working farm operators to participate in the CRP land retirement component appears to be positively related to that of participating in the working-land component. For the working farms participating in the CRP, this seems plausible for two reasons. First, working farms participating in the CRP tend to operate, on average, more cropland than the typical farm. Because of their size, they are more likely to operate farmland suitable for both components of the CRP. Operators who enjoy the benefits of one component of the program may also be more inclined to enroll land in the other component of the program. Second, the premiums paid on land enrolled through the continuous signup CRP could encourage profit maximizing operations to split their enrollment. Reimbursement for eligible working-land practices that make good business sense could be maximized through the continuous signup program, while other marginal (but environmentally sensitive) cropland that is not eligible for continuous signup could be retired through the general signup program.

The hypothesis that crop revenue (*REVCROP*) was positively associated with the decision to participate in the CRP working-land component was tenable, but crop revenue had no relation with the land retirement participation decision. This suggests that farms relying on crop revenue as an income source may find installation of working-land structures more compatible with their conservation and farm operation objectives than retiring cropland from production. It may also be inferred that farms more oriented toward crop production are more likely to participate in the working-land CRP component (i.e.,

**Table 2.** Bivariate Probit Results of the CRP Land Retirement and Working-Land Participation Equations

| | Land Retirement CRP Participants | | Working-Land CRP Participants | |
|---|---|---|---|---|
| Variable | Estimate ($t$-test)[1] | Elasticity[2] | Estimate ($t$-test) | Elasticity |
| *REVCROP* | 0.423 (1.60) | 3.58 | 0.700 (2.55) | 0.82 |
| *TENURE* | 0.588 (3.73) | 17.17 | 0.337 (0.99) | 0.28 |
| *CROPLAND*[3] | 0.325 (3.64) | 1.46 | 0.261 (1.17) | 0.14 |
| *HEL* | 1.646 (2.73) | 4.00 | −0.917 (−0.44) | −0.08 |
| *COLLEGE* | 0.171 (1.22) | 1.48 | 0.042 (0.20) | 0.01 |
| *HH18* | 0.301 (3.04) | 3.94 | −0.036 (−0.16) | −0.01 |
| *EXPERIENCE*[4] | 0.993 (2.19) | 8.31 | 0.972 (1.29) | 0.38 |
| *GOVT* | −0.001 (−0.64) | −0.35 | $4 \times 10^{-4}$ | 0.03 |
| *NEXTH20* | 0.287 (2.60) | 4.16 | 0.229 (1.40) | 0.12 |
| *OFFINC* | −0.314 (−1.72) | −11.25 | −0.608 (−1.26) | −0.63 |
| *METRO* | −0.137 (−1.35) | −2.16 | −0.374 (−0.75) | −0.13 |
| *CONSTANT* | −2.613 (−9.50) | | −1.884 (−2.09) | |
| ρ | 0.666 (4.95) | | | |
| Log likelihood | −384,051 | | | |
| McFadden's $R^2$ | 0.14 | | | |
| Sample size (farms)[5] | 305 (74,335) | | 159 (44,265) | |

[1] $t$-tests are in parentheses. $t$-tests are calculated using jackknifed standard errors. Critical values for $t$-tests at the 5%, 10% and 15% are 2.14, 1.76, and 1.52, respectively. Elasticities are calculated under the scenarios Pr(Land retirement is 1, Working land is 0), and Pr(Land retirement is 0, Working land is 1).

[2] Elasticities were calculated as the mean of the elasticity evaluated for each respondent in each group

[3] In thousands.

[4] In hundreds.

[5] Sample size total; $n$ is 5,332 usable observations (2,012,129 farms).

Coefficients for the regional dummy variables are available on request

Source: 2001 ARMS, phase III, version 1.

install grass filters, contour strips, etc.) than are farms relying more on revenue from livestock production. This seems to be consistent with the overall emphasis of the CRP, since pastureland is generally not eligible for enrollment. This finding is also consistent with expectations about working farms, since retiring cropland from production does not necessarily coincide with the goal of producing crops for revenue. Nonetheless, the absence of a negative relationship suggests that for some working farms, reliance on revenue from crop production is consistent with taking land out of production through CRP's land retirement component.

Tenure (*TENURE*), the ratio of land owned to total acres operated, was positively associated with the decision to participate in the CRP land retirement component. Tenure was unrelated to the decision to participate in the working-land component of the program. Holding other factors constant, working farms that own more of their land are likely to find land retirement through CRP more appealing than working farms that rent more of the farmland they operate. This finding is consistent with the hypothesis that it may be easier for an owner/operator to make long-term land-use decisions regarding productive cropland acres than it is for a tenant farmer. The positive relation of tenure with participation in the land retirement component may also reflect the transition out of farming toward retirement. Operators approaching retirement that have scaled down production by renting less land may perceive enrollment of cropland as a retirement strategy. But tenure is less likely to be important in the decision to participate in working-land programs, since such enrollments tend to be small and are less likely to radically alter farm profitability. This makes landlord-tenant negotiations over land-

use decisions potentially easier. And, in the event that enrollment affects the efficient use of remaining farm assets, additional land can often be rented by the operator.

Holding other factors constant, farm size, as measured by cropland acres operated (*CROPLAND*), was positively related with the decision to participate in the CRP land retirement component. However, farm size was unrelated to the decision to participate in the CRP working-land component. This also seems to be consistent with the finding that larger farms have more flexibility with respect to land-use decisions in the context of retiring relatively large portions of marginal cropland from production.

Household and operator characteristics associated with the decision to participate in the CRP land retirement component were household composition (*HH18*) and operator experience (*EXPERIENCE*). These factors were not correlated with the decision to participate in the working-land component of the program. These results may appear somewhat at odds with other studies that found many CRP land retirement participants to be retired, or approaching retirement (e.g., Sullivan et al.). However, because the focus is on working farms, the sample includes a mixed distribution of farms with operators who may be approaching retirement or who may still be raising families and consider farming an important goal. All else equal, operators with children under the age of 18 living with them were more likely to participate in the CRP land retirement component. For farmers deciding to participate in the land retirement program, farming experience was positively related to the land retirement participation decision.

The aggregated, county-level measure of environmental sensitivity (*HEL*) was positively associated with the decision to use the CRP to retire cropland. In the case of the working-land participation decision, the case is less clear. The lack of association may be because there is not a selection process conditional on EBI scores for the working-land CRP component. In addition, the site-specific conditions addressable through working-land structures may be unrelated to the countywide measure of erodibility used in the model. Given the proxy used here, the hypothesis that operators located in counties with highly erodible land are more likely to participate in the CRP working-land component is not tenable. Proximity of the farmstead to a water body was also positively related to the land retirement participation decision, but not to the working-land participation decision. This variable may be capturing the expected water quality benefits of taking land out of production.

In sum, there were fewer farm structure and household attributes that were related to the decision to participate in the working-land component of the CRP. This result may also be an artifact of the data. The number of farms participating in the working-land component of the CRP was small relative to the number participating in the program's land retirement component. The option to enroll land in the working-land component was not available to growers until 1997. With this in mind, the 2001 ARMS sample only covers three continuous signup periods (14, 17, and 19), whereas many more signup periods are included for growers that successfully enrolled in the land retirement component of the program.

### *Acreage Allocation Model*

The Smith-Blundell procedure was used to test whether cropland acres, tenure, and off-farm income were endogenous in the land retirement and working-land acreage supply equations (Wooldridge). The Bonferroni procedure was used to adjust probabilities associated with *t*-tests. For the land retirement equation, the null hypothesis that cropland acres, tenure, government payments, *HEL*, crop revenue, and off-farm income were exogenous could not be rejected at the 10% level ($P$ = 0.41, 0.88, 0.67, 0.99, 0.55, and 0.28, respectively). For the working-land acreage supply equation, the null hypothesis of exogeneity could not be rejected for the variables presumed to be exogenous ($P$ = 0.34, 0.62, 0.34, 0.67, 0.82, and 0.96 for cropland, tenure, government payments, *HEL*, crop revenue, and the off-farm income ratio, respectively).

The correlation between the acreage supply equations was positive, but not significant at the 10% level ($\rho = 0.11$, Wald test = 2.89, df = 1). Once the decision is made to participate in the CRP, and if the operator participates in both components, the hypothesis that acres supplied to both program components are correlated is not tenable (Table 3). This may not be too surprising since the provisions of each program are quite distinct from one another.

CRP per-acre payments (CRPPMT) were positively related with the acres supplied to the land retirement CRP component.[12] Per-acre payments also exhibited a positive relationship with the working-land CRP component, but the relationship was not significant. The magnitude of the elasticity associated with conservation acres was greater than unity (17%).[13,14] The magnitude of this elasticity was due to the skewed distribution of acres enrolled into the land retirement component and the per-acre payments received for those acres. Some farms had enrolled very few acres but received large rental payments, perhaps reflecting efforts to conserve critical, rare, or endangered habitats. When evaluated at the median, the price elasticity was 1.27.

The only variable that was significantly correlated with the working-land acreage supply equation was off-farm income as a proportion of total household income. Off-farm income was negatively associated with the acres supplied to working-land conservation structures. This result is consistent with the hypothesis that farms relying more on income from farming may find working-land conservation practices more compatible with management practices that maximize profit from farming, or are compatible with ongoing production goals (e.g., El-Osta, Mishra, and Ahearn). In contrast, farm households that work on and off the farm may be less inclined to undertake conservation practices that don't save time or have clear and immediate onsite benefits.

Farm size (*CROPLAND*) was positively correlated with the number of acres enrolled into the CRP land retirement component. The elasticity of the variable was 1.98. It appears that as farms grow in size, they are likely to enroll more land into the CRP, even after adjusting for the amount of land they control.

Land retirement and working-land CRP acres were combined in a sensitivity regression (Table 3). The same procedure was applied to test whether the hypothesized variables were exogenous. The null hypothesis of exogeneity could not be rejected at the 10% level for any of these variables. The combined results were similar to the censored bivariate results for the land retirement equation: per-acre CRP payments, crops as the primary production focus, and farm size were positively associated with the total acres enrolled into the CRP. Operator experience was also positively correlated with total acres supplied to the CRP.

## Conclusions

Farm operators and landowners have little private incentive to adopt conservation farming practices that do not have onsite benefits in terms of soil quality or input savings. Conservation programs can help eligible farmers overcome short-term funding constraints or offset the cost of foregone production associated with the adoption of conservation

[12] This is in contrast to the negative relationship reported by some studies in the literature (Fleming; Goodwin and Mishra). Since we are focusing only on working farms and have separated continuous signup and general signup enrollments, we have removed most of the confounding factors that may have distorted the price-quantity supply relationships found in previous studies.

[13] The price elasticity as used here should not be confused with producer response to economic returns, or the payment less the producer's opportunity cost of lost production. Acreage response in this case may be quite different than the response to a percentage increase (or decrease) across the board in rental rates. Additionally, elasticities are usually understood to imply causation. Given the cross-sectional nature of our data, we report them only as a point of reference.

[14] The enrollment decision is a joint decision between the producer (to offer land) and the federal government (to accept the offer). In this context, the term acreage response would represent more than just the producer's response to price. The first step toward modeling this process would require information about bid and offer prices. Unfortunately, these data are not currently available.

**Table 3.** Bivariate Tobit Marginal Effects and Elasticities of Acreage Supply Equations for Farms Reporting Crop or Livestock Sales, 2001 ARMS

| | Land Retirement | | | Working Land | | | All CRP Acres | | |
|---|---|---|---|---|---|---|---|---|---|
| Variable | Marginal Effect | *t*-test[1] | Elasticity[2] | Marginal Effect | *t*-test | Elasticity | Marginal Effect | *t*-test | Elasticity |
| *CRPPMT* | 0.207 | 3.84 | 15.27 | 0.056 | 1.46 | 3.90 | 0.272 | 2.99 | 17.66 |
| *REVCROP* | 4.538 | 2.97 | 2.27 | 2.822 | 1.01 | 1.08 | 6.549 | 1.90 | 2.83 |
| *TENURE* | 3.353 | 1.20 | 1.11 | −1.792 | −0.27 | −0.58 | 1.618 | 0.25 | 0.48 |
| *CROPLAND*[3] | 5.049 | 1.98 | 2.17 | 1.189 | 0.82 | 0.44 | 7.097 | 1.92 | 2.53 |
| *HEL* | −0.207 | −0.02 | −0.01 | 5.803 | 0.81 | 0.40 | 2.965 | 0.26 | 0.17 |
| *EXPERIENCE*[4] | 7.063 | 1.08 | 1.26 | 14.159 | 1.66 | 2.56 | 16.029 | 2.44 | 2.56 |
| *NEXTH20* | 1.876 | 1.01 | 0.57 | 1.381 | 0.70 | 0.47 | 3.093 | 0.95 | 0.85 |
| *GOVTPMT* | −0.009 | −0.60 | −0.29 | −0.001 | −0.08 | −0.01 | −0.013 | −0.30 | −0.36 |
| *OFFINC* | −2.839 | −1.10 | −1.10 | −1.726 | −1.80 | −0.45 | −3.424 | −1.52 | −1.19 |
| *COLLEGE* | −0.392 | −0.24 | −0.07 | 0.644 | 0.52 | 0.05 | −0.185 | −0.11 | −0.03 |
| *HH18* | 1.673 | 0.91 | 0.32 | 2.031 | 0.69 | 0.32 | 2.669 | 0.92 | 0.44 |
| *METRO* | −2.21 | −0.94 | −0.41 | −1.22 | −0.07 | −0.002 | −1.43 | −1.06 | −0.23 |
| *CONSTANT* | −2100.17 | −1.35 | | −810.24 | −5.21 | | 931.392 | 4.53 | |
| $\sigma$ | 329.37 | 7.04 | | 643.40 | 1.11 | | 375.59 | 3.48 | |
| $\rho$ | 0.11 | 1.70 | | | | | | | |
| Log likelihood | −1,221,582 | | | | | | −1,132,119 | | |
| McFadden's $R^2$ | 0.13 | | | | | | 0.13 | | |
| Sample size (farms) | 5,332 (2,012,129) | | | | | | | | |

[1] Critical values for *t*-test at the 5%, 10%, and 15% are 2.14, 1.76, and 1.52, respectively.

[2] Elasticities were calculated as the mean of the elasticity evaluated for each respondent in each group.

[3] In thousands.

[4] In hundreds.

structural practices. With passage of the 2002 Farm Bill, increased emphasis was placed on working-land conservation programs. With recent interest in green payments, more conservation payments may be channeled to working farms in the future.

The objectives of this article were to (1) compare the farm structure and household characteristics of working farms participating in the land retirement and working-land components of the CRP with other farms and (2) supplement these comparisons with *ceteris paribus* associations. Based on previous research, the presumption is that land retirement conservation programs and working-land conservation programs serve different types of farms. And while this is certainly true when working farms and farm households that have ceased production are lumped together, land retirement need not signal retirement from production agriculture. Nearly 40% of the participants in the CRP remain engaged in agricultural production following enrollment.

When working farms (presumably the target of any future green payments) are considered separately, far fewer significant differences exist between participants in land retirement and working-land programs. Whether the goal is to take marginal cropland out of production, diversify the operation to include hunting or scenic viewing, address conservation compliance concerns, or reduce variability in farm returns, for farms of all sizes land retirement may be an integral part of a working-land approach to conservation.

While participants in working-land programs are generally more similar to their working farm counterparts in traditional land retirement programs than they are to nonparticipants and farms that have ceased production, factors associated with the decision to participate and the extent of participation (as measured by acreage enrolled) may differ between the two programs. Farm operators interested in reducing their focus on income from farming (either to retire or to pursue other opportunities) are likely to find land retirement far more attractive than working-land programs. On the other hand, experienced farm operators focused on agricultural production may find that working-land programs best serve their goals.[15] If future conservation efforts focus on influencing the farming practices of working farms, both land retirement and working-land programs appear to have a role.

This research is only a first step toward understanding the characteristics of working farms participating in the land retirement and working-land components of the CRP in particular and participation in working-land conservation programs in general. Our empirical models are not without problems, and the results should be kept in perspective. On the one hand, our findings are only descriptive accounts. We cannot make any assertions about causality because, in most cases, the decision to participate in the CRP occurred long before respondents were interviewed about their farm enterprises. Future analyses using the ARMS to analyze CRP participation might consider using acres enrolled or the participation decision as the *explanans* instead of the *explicandum*. Such an approach could potentially evaluate the impact of program participation decisions made in previous years on current farm management practices. Secondly, the tests we used for exogeneity have no alternative hypotheses. Failing to reject the null hypothesis of exogeneity does not necessarily imply the variables we tested are not endogenous according to economic logic.[16] Finally, our regression results rely heavily on normality assumptions. If the assumption is not maintained, regression coefficients may be

[15] In addition to appealing to different types of farm households, land retirement and working-land programs can have different environmental impacts. Retiring contiguous fields from production may provide a broader array of environmental benefits than is easily accomplished through working-land conservation structures (Haufler; Warner et al.).

[16] In addition, any test for exogeneity implies that the researcher is willing to assume (or is able to identify) instruments that are exogenous (Freedman). But even if the null hypothesis of exogeneity is rejected, associations between variables can still be discussed, and the hypothesis can be tested as to the importance of these associations (Cameron and Trivedi, p. 95).

inconsistent. But with these caveats in mind, and without recourse to alternative bivariate censored or limited dependent-variable models free of distributional assumptions and capable of accommodating large complex surveys like ARMS,[17] our results shed some light on the associations between farm structure and household characteristics of working farms and their participation in working-land and land retirement programs.

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[17] We attempted to model the program participation choice using nonparametric discrete choice methods, but failed to attain convergence. To our knowledge, there are few (if any) commercially available algorithms that can feasibly estimate nonparametric bivariate probit or tobit models based on complex survey data.

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