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Limited Access to Conservation: Limited-Resource Farmer Participation in the Conservation Security Program in the Southeast

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The paper examines the joint adoption of conservation tillage, crop rotations, and soil testing by small and limited-resource farmers in the Southeast. The objectives are to determine the potential eligibility of small farmers for the Conservation Security Program, examine socioeconomic factors affecting adoption, and assess the interdependence between adopting different conservation practices. Results indicate that conservation management, ethnicity, and farm characteristics affect practice adoption. Of the producers surveyed in the study, 7% meet Conservation Security Program eligibility requirements, while the other 93% have less than a 20% likelihood of adopting the needed practices to qualify.

Key Words: adoption, conservation, Conservation Security Program, conservation tillage, limited-resource farmers, logistic regression, small farms, soil testing

JEL Classifications: C35, Q12, Q58

The National Commission on Small Farms, United States Department of Agriculture (USDA) (1998) outlined a vision for small farms in the 21st Century that emphasized the need for the adoption of sustainable agriculture as a profitable, ecologically, and socially sound strategy for small farms. The report highlighted that the majority of farms are less than 180 acres in size and control a significant percentage of farmland, which could provide significant environmental benefit through proper management of soil, water, and wildlife.[1] The 2002 Farm Bill created the Conservation Security Program (CSP), a voluntary conservation entitlement program that pays farmers who have met prescribed natural resource stewardship guidelines (i.e., for soil, water, air, energy, plant, and animal life) established by the USDA Natural Resource Conservation Service (NRCS) to maintain and

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[1] In Alabama, Georgia, and Mississippi, farms with less than $50,000 in gross farm sales represent 57% of agricultural land (National Agricultural Statistics Service, USDA, 2002a, 2002b, and 2002c).

enhance conservation practices on their land (NRCS, 2004).[2] The CSP was designed to motivate farmers to intensify their conservation efforts and encourage other farmers to adopt similar conservation practices in order to become eligible. Thus, the CSP could provide a mechanism for small and limited-resource farmers to improve natural resource management and environmental stewardship in the Southeast. The program was initiated in select watersheds in 2004, but has only been offered in additional select watersheds to date, due to funding restrictions (Pease, Schweikhardt, and Seidl, 2008).

By primarily rewarding past conservation efforts, the CSP has been limited in its ability (using monetary incentives) to intensify on-farm conservation efforts (Cox, 2007). The Food, Conservation and Energy Act (Farm Bill) of 2008 may help alleviate some of the shortcomings of the original program. The new legislation rechristens the CSP as the Conservation Stewardship Program[3]; doubles funding levels; streamlines eligibility requirements; does away with the tiered system; and sets an enrollment goal of approximately 13 million acres per year (Pease, Schweikhardt, and Seidl, 2008).[4] Thus, the CSP may still provide a potential resource for small and limited-resource farmers, if they can qualify. Conservation contract selection under the CSP will be based on a farmer's current conservation efforts, willingness to intensify conservation on-farm, and level of willingness to accept compensation for these efforts (similar to the Environmental Quality Incentives Program (EQIP)) (U.S. House, 2008).

The CSP does not restrict participation based on size of farm or by crop or livestock produced, given that many small and limited-resource farms raise livestock and produce specialty crops. As over three-fourths of the farms in Alabama, Georgia, and Mississippi are small and limited-resource farms, the opportunity exists to increase participation in conservation programs and improve environmental stewardship (Molnar, Bitto, and Brant, 2001; NRCS, 2004). Eligibility requirements for the CSP may be a factor that limits participation. For example, in Alabama, row crop producers must: practice conservation tillage; use crop rotations; have prescribed grass waterways and terraces installed; soil test; utilize needed integrated pest management and crop nutrient management practices; and control eroded areas in their fields for at least a 2-year period (NRCS, 2008). Many small and limited-resource farmers have not adopted these practices due to a lack of information, limited contact with NRCS or other public agencies, a perceived negative economic risk from adoption, and historical large-farm bias in farm programs (Molnar, Bitto, and Brant, 2001; National Commission on Small Farms, USDA, 1998). Under the revised Conservation Stewardship Program, farmers' must only meet one identified natural resource concern (e.g., soil, water, air) and an additional resource concern at set stewardship thresholds

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[2] The incentive payments offered under the Conservation Security Program included: stewardship payments as a form of rental payment for maintenance of existing conservation practices; cost-share assistance for adopting new conservation practices; and enhancement payments to encourage farmers to increase management intensity of conservation practices. Furthermore, the program places participants in one of three tiers based on conservation management intensity on-farm, placing an upper limit on the total financial benefits that can be earned. The three tier levels represent the number of resource concerns addressed and the extent of the operation under a conservation stewardship contract with USDA-NRCS. Tier 1 has an upper benefit limit of $20,000 and requires the producer to place at least one or more fields in the program meeting established soil and water stewardship criteria. Tier 2 has an upper benefit limit of $35,000 and requires the farmer to include all fields in the operation in the program and meet soil and water stewardship criteria. Tier 3 has an upper benefit limit of $45,000 and requires the farmer to have their entire operation in the program and meet all pertinent resource stewardship criteria (NRCS, 2004).

[3] The acronym for the CSP is used interchangeably for both the Conservation Security Program and/or Conservation Stewardship Program. When needed, the specific name of the program will be utilized for clarification purposes.

[4] The new farm bill requires that the program be administered to achieve a national average payment rate of $18 per acre, capping the amount a farmer can earn in a 5-year period to $200,000 (U.S. House, 2008).

by the end of the contract period (5 years) (U.S. House, 2008). This change may relax requirements for overall eligibility, but for crop producers base requirements are still likely to include conservation cropping practices (e.g., conservation tillage), crop rotations, and soil testing to meet soil and water quality thresholds.[5]

The purpose of this paper is to jointly examine small and limited-resource farmers' adoption of conservation tillage, crop rotation, and soil testing in order to elicit the likelihood of such farmers in Alabama, Georgia, and Mississippi being eligible for the CSP. Furthermore, the paper examines socio-economic factors that contribute to the likelihood of a small and limited-resource farmer adopting the necessary practices to become eligible for the CSP. We also determine if the adoption of certain conservation practices increases the likelihood of adopting other conservation practices to study adoption patterns. These results help policymakers motivate ineligible participants to adopt required conservation practices for eligibility in the CSP. The adoption of conservation tillage, crop rotation, and soil testing is jointly assessed using a multinomial logistic regression model following Wu and Babcock (1998).

We first provide background information and review some of the literature concerning small and limited-resource farmers and conservation practice adoption. Subsequent sections present the model and data used to examine the likelihood of adopting conservation tillage, crop rotation, and soil testing, respectively. We examine the results obtained from the estimated model and the dependence between adopting the different conservation practices, and then provide some concluding remarks.

[5] This assertion is based on current program standards (NRCS, 2008) that require soil testing every 5 years for records purposes and nutrient management, crop rotations, and soil conserving practices (such as conservation tillage). Furthermore, the 2008 Farm Bill places additional emphasis on resource conserving crop rotations (U.S. House, 2008).

Small and Limited-Resource Farmers and Conservation Practice Adoption

In this study, a small and limited-resource farm (also referred to as small farmers/farms) has gross farm sales that are less than or equal to $40,000. The categorization follows Molnar, Bitto, and Brant (2001) to encompass small part-time owner-operators and limited-resource farmers. Many of these farmers are characterized by low-income; limited access to capital, labor, and equipment; and smaller than average farm size. Other social, cultural, and language factors include: lack of awareness of governmental programs, limited management skills, lower levels of formal education, and risk-averse behavior (Molnar, Bitto, and Brant, 2001; Nelson, Brown, and Toomer, 1991).

Small farms are numerically the largest group of farmers in the United States, and play a significant role in the economic well-being of rural communities by providing greater consumer demand for local goods and services and a stable source of labor for attracting new business to rural communities (Brown, Christy, and Gebremedhin, 1994). Molnar, Bitto, and Brant (2001) state that the future of small and limited-resource farmers in general agricultural commodities (e.g., corn, hogs, soybeans, cattle, etc.) is dim, but these farmers can survive in niche markets for specialty crops (e.g., organic vegetable production). The 2008 Farm Bill legislation places greater emphasis on organic and specialty crop producers, even providing specific guidance on working with these producers in qualifying for the CSP (U.S. House, 2008).

The low adoption of conservation practices by small and limited-resource farmers in the southern United States can be attributed to a number of factors mentioned earlier, such as limited management skills, risk-aversion preferences, small size of operation, and limited income. Small and limited-resource farmers may have different goals, such as financial security, survivability, or balance of work and lifestyle, all of which can affect the extent of conservation practice adoption (Pannell et al., 2006). Environmental stewardship may motivate farmers to adopt conservation practices, but only after basic economic and survival needs have been satisfied (Dunlap and Van Liere, 1984; Kabii and Horwitz, 2006). Uri (1999) found that farm size, risk-averse behavior, and limited management skills are all factors that can adversely affect the decision to adopt conservation tillage. Gould, Saupe, and Klemme (1989) found that farmers who work off-farm (which include many small farmers) are less likely to adopt conservation tillage due to a lack of information or commitment to the farm operation. Demissie (1989) found that the majority (69%) of limited-resource farmers they surveyed in the South were part-time farmers or worked off-farm. Soule (2001) found that small (less than $250,000 in gross sales) and limited-resource farmers were less likely to adopt conservation tillage or soil testing practices.

Roberts et al. (2004) found that farm size negatively affected the adoption of site-specific information technology and in turn variable rate application of fertilizers by southeastern cotton producers. Soule, Tegene, and Wiebe (2000) concluded that limited-resource, retired or part-time corn producers are less likely to adopt conservation tillage and medium-term conservation practices, such as contour farming, strip-cropping, and grassed waterways. Small farmers may find these conservation practices less viable due to limited-resources, time constraints, and other familial issues (Pannell et al., 2006). Furthermore, adjustment costs (e.g., new equipment, increased management demands, changes in other cropping practices) from adopting new conservation practices on-farm may make adopting conservation practices by small farmers less profitable (Pannell et al., 2006). Thus, the marginal benefits from conservation investments may be too small to motivate adoption. Featherstone and Goodwin (1993) found that farmers in Kansas were less likely to make long-term investments in conservation practices as both farm size and income decreased. Fuglie and Bosch (1995) state that lower farm sales tended to indicate a lower probability of performing soil nitrogen tests. Both Molnar, Bitto, and Brant (2001) and Soule (2001) find that low farm sales are likely to lower the likelihood of adopting crop nutrient management practices, which include crop rotations.

Operator age and experience of the farmer may negatively affect the adoption of conservation practices (Featherstone and Goodwin, 1993; Gould, Saupe, and Klemme, 1989; Molnar, Bitto, and Brant, 2001; Roberts et al., 2004; Wu and Babcock, 1998). In contrast, in the same studies, a college education could increase the likelihood of adoption. On the other hand, less educated farmers may not recognize the benefits from conservation practice adoption or have access to needed information (Demissie, 1989; Pannell et al., 2006). Demissie (1989) found that the educational level of many limited-resource farmers was lower than the reading level of technical publications provided by the USDA.

Featherstone and Goodwin (1993) found that farmers are less likely to invest in conservation practices on rented land than on owned land. Soule, Tegene, and Wiebe (2000) and Soule (2001) support this finding for conservation tillage, but Soule (2001) found that renters are more likely to conduct soil tests. Molnar, Bitto, and Brant (2001) found that small and limited-resource farmers who produce row crops are more familiar with and likely to adopt conservation tillage and soil testing practices. Wu and Babcock (1998) found that farmers with a conservation plan are more likely to adopt conservation practices, of which many small and limited-resource farmers may not have (Demissie, 1989). Other significant factors affecting adoption include: social networks, personal circumstances, family situation, farmer personalities, and cultural barriers (Pannell et al., 2006). Social networks with respectful relationships between farmers and conservation agencies and extension may increase the likelihood of adoption (Pannell et al., 2006), but with small and limited-resource farmers these relationships may be strained (Molnar, Bitto, and Brant, 2001).

Molnar, Bitto, and Brant (2001) surveyed small and limited-resource farmers in Alabama, Georgia, and Mississippi and found that 23% of the respondents participated in the Conservation Reserve Program (CRP), 11% in the Forestry Incentive Program, 10%

in the Wildlife Habitat Incentive Program, 8% in EQIP, and 6% or less in other USDA–NRCS conservation programs. Sixteen percent of the respondents indicated that they did not understand program requirements, which could be a result of less education from this farmer group (see Demissie, 1989). Seven percent felt they could not afford to be in the programs. Furthermore, 49% of the respondents had no contact with NRCS in the year the survey was administered. Many small farmers raise livestock and/or produce specialty crops, such as fruits and vegetables, which have not historically been included in federal programs, thereby not providing any income or price protection for these operations. In addition, many past programs were based on taking land out of production (e.g., CRP) or on historical levels of production, which benefited larger farming operations with larger areas of land (Davis, 1991). In effect "agricultural policy has been oriented toward farm production efficiency by increasing the size of the operation, reducing the relative labor input, and enhancing the movement toward growth in farm size" (Davis, 1991; p. 1477). The CSP may offer an opportunity to help reverse some of these trends.

NRCS took steps in the Amendment to the Interim Final Rule for the CSP in 2005 to make the program friendlier to small and limited-resource farmers by eliminating payment caps that disadvantaged small and limited-resource farmers in areas with low rental rates (NRCS, 2005). In addition, the program provides higher cost-share assistance to small and limited-resource farmers, as well as, the ability for states to provide preference for eligible small farms to obtain CSP contracts. Increased access is countered by the conservation standards required by the CSP; fulfilling eligibility requirements may be cost prohibitive for small and limited-resource farmers (NRCS, 2005). These changes will likely continue under the revised CSP.

The Model

The model developed here is fashioned after the polychotomous-choice selectivity model of crop management plans presented by Wu and Babcock (1998). This model is used to examine the joint adoption of conservation tillage, crop rotation, and soil testing by small and limited-resource farmers.

Modeling the Joint Adoption of Conservation Practices

Suppose a farmer has the option of adopting J different conservation practices. These practices can be combined to form a set of $M = 2^J$ conservation management plans, representing different combinations of conservation practices from those available. Denote a specific conservation management plan as δ_m, $m = 1, \ldots, M$, where δ is a $(J \times 1)$ vector of indicator variables (Y_j) equal to 1 if the jth practice is part of plan m, making the set of conservation plans $C = \{\delta_m, m = 1, \ldots, M\}$. A farmer will adopt δ_m, if:

$$(1) \qquad u^E_{i,m} = h_m(\mathbf{z}_i; \gamma_m) + v_{i,m} = \max\left(u^E_{i,1}, \ldots, u^E_{i,M}\right),$$

where $u^E_{i,m}$ is the expected utility of choosing δ_m, $\boldsymbol{h}_m(\cdot;\cdot)$ is the systematic component of the farmer's expected utility function, $\mathbf{z}_i$ is a $(K \times 1)$ vector of explanatory variables (i.e., a set of physical and socioeconomic characteristics of the farmer and operation), γ_m is a vector of parameters, and $v_{i,m}$ is the nonsystematic (or random) component of expected utility. If the residuals, $v_{i,m}$, $m = 1, \ldots, M$ are independently distributed with extreme value distribution (type 1), then the probability of a farmer choosing δ_m can be represented as:

$$(2) \qquad \mathbf{P}(I = m) = \frac{\exp\left(\alpha'_m \mathbf{z}_i\right)}{\sum_{s=1}^{M} \exp\left(\alpha'_s \mathbf{z}_i\right)}, \quad \textit{for } m = 1, \ldots, M$$

where I is a polychotomous index denoting the choice of conservation plan by the farmer and $\alpha_m = (\alpha_{m,1}, \ldots, \alpha_{m,K})$, $m = 1, \ldots, M$ are appropriate vectors of parameters. Equation (2) gives rise to a multinomial logistic regression model (Train, 2003; Wu and Babcock, 1998). Parameters of the model are estimated using the method of maximum likelihood following the Newton-Raphson method (see Gourieroux, 2000). Marginal effects for both the conservation management plans and individual conservation practices can be derived along with associated standard errors using the delta method (Greene, 2003; Wu and Babcock, 1998).

conditional rather than unconditional probabilities to give rise to the following conditional measure:

$$(3)\qquad \tau_{j,r} = \frac{\sum_{\pi_j=0,1}\sum_{\pi_r=0,1}\frac{\left(\sum_{m\in\{\delta_m : Y_j=\pi_j \text{ and } Y_r=\pi_r\}}\mathbf{P}(I=m)\right)^2}{\sum_{m\in\{\delta_m : Y_r=\pi_r\}}\mathbf{P}(I=m)} - \sum_{\pi_j=0,1}\left(\sum_{m\in\{\delta_m : Y_j=\pi_j\}}\mathbf{P}(I=m)\right)^2}{1-\sum_{\pi_j=0,1}\left(\sum_{m\in\{\delta_m : Y_j=\pi_j\}}\mathbf{P}(I=m)\right)^2},$$

Modeling Dependence between Conservation Practices

Given that we are examining the joint adoption of multiple conservation practices, the proposed multinomial logistic regression can be viewed as arising from a multivariate Bernoulli distribution, where the binary dependent variables are the adoption of each of the conservation practices being examined (see Liang, Zeger, and Qaqish, 1992, for a presentation using this type of approach). The benefit from this viewpoint is that the joint modeling framework adopted can be used to elicit the interdependence or association between adopting different conservation practices.

A particular measure of association in the statistical literature related to the correlation coefficient is Goodman and Kruskal's tau (Goodman and Kruskal, 1954). This statistic is also known as a concentration coefficient. The unconditional form of this statistic measures the association between two nominal variables or how the classification of one nominal variable provides help in conjecturing about the classification of another variable (Spanos, 1999).[6] The unconditional Goodman and Kruskal's tau can be modified by using

where $\mathbf{P}(I = m)$ is given by Equation (2), Y_j is an indicator variable equal to 1 if conservation practice j is part of conservation management plan δ_m, and $\tau_{j,r} \in [0, 1]$. When $\tau_{j,r} = 0$ the jth and rth practices are conditionally independent, while if $\tau_{j,r} = 1$ the jth and rth practices are perfectly associated. This measure can then be used to generate a type of conditional correlation matrix between the conservation practices being examined. This matrix may provide information that could be used to provide guidance about what practices should be supported by governmental agencies to ensure active participation by farmers in conservation programs, by promoting combinations of conservation practices that farmers will adopt. This measure is the one utilized in this paper. Standard errors for the measure given by Equation (3) can be derived using the delta method (Greene, 2003).

Data

The survey data used in the paper were collected in 2001 in a study examining the perceived barriers to adoption of conservation practices by small and limited-resource farmers in Alabama, Georgia, and Mississippi (Molnar, Bitto, and Brant, 2001). As presented earlier, a small and limited-resource farmer for the survey was defined as a farm with less than \$40,000 in gross farm sales and with row crop control data for cotton, corn, peanuts, or soybeans. The sampling design for the survey was

[6] Nominal variables are random variables that take values with no natural ordering, such as marital status, gender, religious affiliation, ethnicity, etc. (Spanos, 1999).

structured to yield an equal number of black and white participants in each state surveyed. The final number of black and white respondents by state is presented in Table 1.

The National Agricultural Statistical Service of the USDA mailed a self-administered mail survey to 4,349 farmers in Alabama, Georgia, and Mississippi. To increase the response rate, a second questionnaire was sent to nonrespondents and a limited amount of follow-up by telephone was conducted. The mail response rate was 16.3% or 834 completed surveys. The response rate was similar for response rates obtained by mail surveys to farmer groups administered by USDA, National Agricultural Statistics Service in the Southeast during that time period. Data from the 1997 Agricultural Census was used to obtain the stratified sample from USDA–National Agricultural Statistical Service. Given changes in farm characteristics in the interim period prior to the administration of the survey, 20 farms that responded to the survey had gross farm sales greater than $40,000. These farms were removed from the data set, reducing the number of usable observations to 814. Comparisons of farm demographics of survey respondents to 2002 Agricultural Census data in Table 1 reveal that the dataset is somewhat representative of the general population of small and limited-resource farmers, but given the low response rate some caution should be given to the results found here. Furthermore, given the stratified sampling to obtain an equal number of black and white respondents, the dataset is more heavily representative of black minority farmers. This is in contrast to the actual population, where only about 7% of farmers with less than $50,000 in gross farm sales were black (or native American) following the 2002 Agricultural Census (National Agricultural Statistics Service, USDA, 2002a, 2002b, and 2002c).

The survey data included variables concerning the adoption of conservation tillage practices, crop nutrient management, integrated pest management, and conservation buffers for each respondent, as well as demographic, farm, financial, and conservation program participation data. Definitions and summary statistics of the variables used in the empirical model are presented in Table 1. Summary statistics were calculated using weighted averages, where the weights represented the proportion of respondents by state and race and are reported in Table 1. The three conservation practices (dependent variables) jointly examined in this study are soil testing ($Y_{i,1}$), crop rotations ($Y_{i,2}$), and conservation tillage ($Y_{i,3}$). Conservation tillage included no till, reduced till, strip till, mulch till, and ridge till. All three variables are binary, taking a value of 1 if the conservation practice was used by the farmer being surveyed and 0 otherwise. All three practices are modeled jointly, because all three practices must be in place for at least a minimum of 2 years to qualify for the CSP. Of the respondents, 60% soil tested, 42% used crop rotations, and 12% practiced some form of conservation tillage.

Given that we are examining these practices jointly, seven different conservation management plans could be devised, each used to represent the probability of adopting one or more of the conservation practices being examined. Each of these potential management plans is presented in Table 2, along with the number of respondents who adopt each plan.

To examine the factors affecting the adoption rates of the conservation management plans presented in Table 2 a number of explanatory variables are presented in Table 1. The explanatory variables are derived from the questions asked in the survey administered by Molnar, Bitto, and Brant (2001). These variables include farmer demographics, farm characteristics and production practices. These variables were included to capture socio-economic factors that may affect the joint adoption of conservation practices as previously discussed. Summary statistics from Molnar, Bitto, and Brant (2001) show that adoption and familiarity with soil testing, crop rotation, and conservation tillage varied significantly at times by race and state. For example, 76% of white respondents were familiar with the practice of conservation tillage in Alabama compared with 56% of black respondents. In Georgia and Mississippi, the differences were 80% versus 69% and 81% versus 63%, respectively. Furthermore, Molnar, Bitto, and Brant (2001) report that there were large (significant) differences by

Table 1. Definitions of Variables and Summary Statistics

Variable	Mean[a]	Standard Deviation[b]	Mean Census 2002[c]	Definition
		Dependent Variables		
Soil Test	0.66	0.47	—	Soil testing conducted (1 = yes, 0 = no)
Crop Rotation	0.42	0.49	—	Crops rotated (1 = yes, 0 = no)
Conservation Tillage	0.12	0.33	—	Use no-till, mulch-till, ridge-till, strip-till, or other reduced tillage (1 = yes, 0 = no)
		Explanatory Variables		
Alabama	0.36	0.48	—	Reside in Alabama (1 = yes, 0 = no)
Georgia	0.28	0.45	—	Reside in Georgia (1 = yes, 0 = no)
Race	0.54	0.50	—	African-American (1 = yes, 0 = no)
Manure	0.19	0.40	—	Ever apply litter or manure (1 = yes, 0 = no)
EQIP	0.07	0.25	—	Participating in the Environmental Quality Incentive Program (1 = yes, 0 = no)
NRCS Contact	0.49	0.50	—	Contact with NRCS in last 12 months (1 = yes, 0 = no)
Plan	0.29	0.45	—	Have a conservation plan (1 = yes, 0 = no)
Age	59.48	53.67	57.34	Age of farm operator
College	0.53	0.50	—	Have you attended college (1 = yes, 0 = no)
Farm Income	0.85	0.36	0.80	About 25% or less of household income is from the farm operation (1 = yes, 0 = no)
Rent	24.96	94.88	21.79	Acres of farmland rented from others
Row Crop	0.24	0.43	—	Over 50% of farm sales is from production of crops (1 = yes, 0 = no)
Livestock	0.64	0.48	—	Over 50% of farm sales is from production of livestock (1 = yes, 0 = no)
Fruit	0.07	0.26	—	Over 50% of farm sales is from production of fruits and vegetables (1 = yes, 0 = no)
Land	124.33	215.71	151.03	Size of farm operation
Sales	2.79	14.39	2.51	Farm Sales (1 = less than \$1000, 2 = \$1001–\$2499, 3 = \$2500–\$4999, 4 = \$5000–\$9999, 5 = \$10,000–\$40,000)
Fertilizer	0.21	0.41	—	Vary amounts of fertilizer within fields (1 = yes, 0 = no)
		Numbers of Respondents (%)[d]		
Alabama				
Black	152 (19.4%)			
White	133 (16.9%)			
Georgia				
Black	111 (14.1%)			
White	117 (14.9%)			
Mississippi				
Black	157 (20.0%)			
White	115 (14.6%)			

[a] The mean is weighted by State and Race using the proportions of the total sample reported in the table under “Numbers of Respondents.”

[b] The standard deviation of all binary variables is calculated as: $\sqrt{p(1-p)}$, where p is the mean of the binary variable.

[c] Means for this column were calculated using 2002 Census of Agricultural Data (National Agricultural Statistics Service, USDA, 2002a, 2002b, 2002c). Means were weighted by level of farm sales and state from the total number of farms with sales below \$50,000, which is the closest income category we could identify in the aggregated data. An “—” indicates data were not available to calculate a mean for this variable.

[d] The number in parentheses is the proportion of the total sample that group represents.

Table 2. Conservation Management Plans Using Soil Testing, Crop Rotation, and Conservation Tillage

	Conservation Practices Used			
Management Plan	Soil Testing (S)	Crop Rotations (R)	Conservation Tillage (T)	Percent of Respondents Using Plan
S	X	—	—	26.9
R	—	X	—	8.1
T	—	—	X	1.9
SR	X	X	—	24.6
ST	X	—	X	4.5
RT	—	X	X	1.6
SRT	X	X	X	6.9
None	—	—	—	25.4

race and state in farm income and extent of row crop, livestock, and/or fruits and vegetable production. These differences suggest possible heterogeneity in the data due to differences in cultural and farm practices across state lines and racial categories.

The multinomial logistic regression model presented in the previous section is estimated using a procedure in MATLAB written by Woodcock (2005). With the limited number of observations for conservation management plans T and RT (see Table 2), it is assumed that $\mathbf{P}(I = T) = 0$ and $\mathbf{P}(I = RT) = 0$, such that they have no impact on the estimation of the other parameters of the model. Given the limited number of observations, the effects of the explanatory variables on the adoption of these management plans cannot be reliably identified. These assumptions are used in the calculation of other estimated statistics and leave 785 degrees of freedom for the estimation of the model.

Results

Parameter estimates, their corresponding standard errors, and performance statistics for the empirical model are presented in Table 3 for the conservation management plans used in the model. The model correctly predicted what conservation management plan a respondent would adopt 43.7% of the time. The model predicts correctly 69.4% of the time if the option with the second highest probability of being selected is considered, as well. The individual parameter estimates of the model are not readily interpretable, as is the case with the multinomial logistic regression model (Greene, 2003). Thus, instead it is useful to examine the marginal effects of the explanatory variables. The marginal effects of the explanatory variables for the probability of adopting each management plan and conservation practice, along with their respective standard errors, are presented in Table 4. Marginal effects and standard errors were calculated using the mean vector of the explanatory variables.

Factors Affecting Conservation Management Plan Adoption

The first two management plans represent the adoption of only one of the three practices being examined: soil testing or crop rotations. Approximately 27% of survey respondents only soil tested (S) and 8% used only crop rotations. Examining the marginal effects, producers with over 50% of farm sales from livestock production were 10.7% more likely to adopt only soil testing. Fuglie and Bosch (1995) report that livestock producers soil test to provide guidance on managing manure applications in fields or pastures. Furthermore, conservation tillage and crop rotations are primarily used for row crop production. Thus, having higher level of farm sales from livestock had no significant effect on the probability of adopting the other conservation management plans.

Table 3. Parameter Estimates and Statistics for the Joint Adoption Model

Variable/Management Plan	S	R	SR	ST	SRT
Constant	−1.337*	−0.245	−0.333	−3.014**	−3.484***
	(0.785)	(1.125)	(0.818)	(1.459)	(1.249)
Alabama	0.263	−0.797**	−0.275	−0.267	0.100
	(0.236)	(0.366)	(0.265)	(0.472)	(0.407)
Georgia	0.370	−0.053	0.657**	0.692	0.651
	(0.285)	(0.373)	(0.287)	(0.489)	(0.424)
Manure	0.204	0.484	−0.078	0.408	0.868**
	(0.282)	(0.378)	(0.308)	(0.474)	(0.399)
EQIP	0.546	−0.944	0.293	0.329	0.357
	(0.428)	(1.079)	(0.475)	(0.698)	(0.680)
NRCS Contact	0.756***	0.343	0.857***	1.334***	0.867**
	(0.227)	(0.328)	(0.243)	(0.460)	(0.369)
Plan	0.482*	0.114	0.866***	2.055***	1.403***
	(0.280)	(0.425)	(0.288)	(0.449)	(0.385)
Age	−0.004	−0.012	−0.013	−0.028*	−0.010
	(0.009)	(0.012)	(0.009)	(0.016)	(0.013)
College	−0.126	−0.533*	−0.481**	−0.382	0.211
	(0.226)	(0.324)	(0.243)	(0.423)	(0.375)
Farm Income	0.068	0.348	−0.388	0.263	0.094
	(0.315)	(0.505)	(0.319)	(0.587)	(0.497)
Rent	0.001	−0.003	0.001	0.000	0.004
	(0.002)	(0.005)	(0.002)	(0.004)	(0.003)
Row Crop	0.848**	0.968**	1.011***	0.679	1.836***
	(0.366)	(0.466)	(0.368)	(0.637)	(0.525)
Livestock	0.579*	−0.076	0.164	0.429	0.235
	(0.332)	(0.440)	(0.338)	(0.578)	(0.507)
Fruit	0.559	1.380**	1.430***	1.056	0.863
	(0.574)	(0.637)	(0.542)	(0.892)	(0.789)
Land	0.000	−0.001	0.001	−0.002	−0.001
	(0.001)	(0.002)	(0.001)	(0.002)	(0.001)
Race	−0.575**	−0.227	−0.841***	−1.390***	−1.046***
	(0.232)	(0.332)	(0.245)	(0.441)	(0.370)
Sales	0.201**	−0.145	0.256***	0.510***	0.272**
	(0.080)	(0.124)	(0.085)	(0.159)	(0.127)
Fertilizer	1.321***	1.551***	1.640***	1.240**	2.234***
	(0.353)	(0.431)	(0.357)	(0.523)	(0.433)

Other Statistics

Log Likelihood	−1090.9
Likelihood Ratio Test Statistic (for significance of variables and constant terms)	324.81
McFadden Pseudo R^2	0.13
Veall and Zimmermann's Pseudo R^2	0.38
Correct Predictions	
Conservation Management Plans	43.7%
Actual choice of plan was predicted as the first or second choice by the model	69.4%
Soil Testing	60.3%
Crop Rotation	55.5%
Conservation Tillage	87.1%

Notes: Conservation Management Plans are: S = Soil Testing, R = Crop Rotation, SR = Soil Testing and Crop Rotation, ST = Soil Testing and Conservation Tillage, and SRT = Soil Testing, Crop Rotations, and Conservation Tillage.
Asymptotic standard errors are in parentheses.
Veal and Zimmerman's Pseudo R^2 is based on Veall and Zimmermann (1992).
Asymptotic *t*-tests were used to test for significance, where * indicates statistical significance at the 10% level; ** indicates statistical significance at the 5% level; and *** indicates statistical significance at the 1% level.

Table 4. Estimated Marginal Effects for the Adoption of Conservation Management Plans and Conservation Practices

Variable	S	R	SR	ST	SRT	Soil Testing	Crop Rotation	Conservation Tillage
Alabama	0.109**	−0.054**	−0.060	−0.006	−0.002	0.040	−0.116**	−0.009
	(0.043)	(0.023)	(0.044)	(0.013)	(0.019)	(0.042)	(0.046)	(0.023)
Georgia	0.003	−0.031	0.083*	0.010	0.016	0.112*	0.068	0.026
	(0.049)	(0.022)	(0.044)	(0.013)	(0.019)	(0.047)	(0.049)	(0.024)
Manure	0.021	0.025	−0.062	0.008	0.040**	0.007	0.003	0.048**
	(0.048)	(0.023)	(0.047)	(0.013)	(0.017)	(0.048)	(0.051)	(0.022)
EQIP	0.107	−0.086	0.019	0.003	0.007	0.137	−0.060	0.011
	(0.072)	(0.069)	(0.072)	(0.018)	(0.030)	(0.086)	(0.084)	(0.036)
NRCS	0.050	−0.020	0.070*	0.023*	0.014	0.156***	0.065	0.037*
Contact	(0.040)	(0.020)	(0.038)	(0.013)	(0.017)	(0.038)	(0.042)	(0.021)
Plan	−0.024	−0.032	0.088**	0.047***	0.04***	0.157***	0.102**	0.093***
	(0.045)	(0.025)	(0.042)	(0.013)	(0.017)	(0.047)	(0.047)	(0.021)
Age	0.001	−0.000	−0.002	−0.001	−0.000	−0.001	−0.002	−0.001
	(0.002)	(0.001)	(0.001)	(0.000)	(0.001)	(0.002)	(0.002)	(0.001)
College	0.030	−0.023	−0.074*	−0.005	0.023	−0.025	−0.074*	0.018
	(0.040)	(0.020)	(0.039)	(0.012)	(0.017)	(0.039)	(0.042)	(0.021)
Farm	0.039	0.029	−0.096**	0.010	0.008	−0.040	−0.059	0.017
Income	(0.054)	(0.032)	(0.048)	(0.016)	(0.023)	(0.054)	(0.055)	(0.028)
Rent	0.000	−0.000	0.000	−0.000	0.000	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Row Crop	0.029	0.015	0.070	−0.003	0.059**	0.156***	0.144**	0.056*
	(0.062)	(0.028)	(0.055)	(0.017)	(0.023)	(0.060)	(0.061)	(0.029)
Livestock	0.107*	−0.025	−0.027	0.005	−0.001	0.083	−0.053	0.004
	(0.058)	(0.027)	(0.053)	(0.016)	(0.023)	(0.055)	(0.058)	(0.028)
Fruit	−0.071	0.045	0.185**	0.009	0.005	0.128	0.235***	0.014
	(0.094)	(0.036)	(0.076)	(0.024)	(0.034)	(0.089)	(0.088)	(0.042)
Land	0.000	−0.000	0.000	−0.000	−0.000	0.000	0.000	−0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Race	−0.010	0.024	−0.083**	−0.026**	−0.027*	−0.146***	−0.087**	−0.054***
	(0.040)	(0.020)	(0.038)	(0.012)	(0.017)	(0.039)	(0.042)	(0.021)
Sales	0.014	−0.022***	0.027**	0.011**	0.006	0.058***	0.011	0.017**
	(0.014)	(0.008)	(0.013)	(0.004)	(0.006)	(0.014)	(0.015)	(0.007)
Fertilizer	0.048	0.028	0.130***	0.002	0.058***	0.238***	0.215***	0.060***
	(0.047)	(0.022)	(0.043)	(0.013)	(0.017)	(0.054)	(0.049)	(0.021)

Notes: Conservation Management Plans are: S = Soil Testing, R = Crop Rotation, SR = Soil Testing and Crop Rotation, ST = Soil Testing and Conservation Tillage, and SRT = Soil Testing, Crop Rotations, and Conservation Tillage.
Asymptotic standard errors are in parentheses.
Asymptotic *t*-tests were used to test for significance, where * indicates statistical significance at the 10% level; ** indicates statistical significance at the 5% level; and *** indicates statistical significance at the 1% level.

The adoption of two or more conservation practices was affected by a number of the explanatory factors investigated in the study. Factors, including recent contact with USDA-NRCS, presence of a conservation plan, ethnicity, higher farm sales, and use of crop nutrient management practices significantly affected the probability of adopting more than one conservation practice. When contemplating changes on-farm, information is a critical resource for producers in the decision-making process concerning the adoption of conservation practices (Pannell et al., 2006). Information can come from a variety of sources, including contact with conservation agencies (e.g., USDA–NRCS) and conservation planning activities. The marginal effect on the probability of adopting multiple conservation practices ranged from 2.3–7% for contact with NRCS and 4–8.8% for conservation planning. Higher farm sales increased the likelihood of adopting soil testing with crop rotations or conservation tillage by 1.1–2.7%, while varying fertilizer rates increased the probability of adopting conservation plans with both soil testing and crop rotations by 5.8–13%. The latter finding may be indicative of farmers who are more aware of the benefits of crop nutrient management.

Of particular interest is that, black farmers were 3–8% less likely to adopt multiple conservation practices, which may be due to cultural norms still present in the Southeast (Bagi, 1984; Molnar, Bitto, and Brant, 2001). Thus, past biases may be an issue with participation in the CSP. "Representatives of minority and female farm groups point out that previous discrimination in USDA programs has helped to produce these very conditions [such as smaller farms, lower average crop yields, and likelihood not to plant program crops] now used to explain disparate treatment" (Molnar, Bitto, and Brant, 2001; p. 5). Thus, NRCS will have to be aware of its outreach efforts for the CSP and make sure that they are serving the needs of the small and limited-resource farmer.

Producers with greater than 50% of farm sales from fruits and vegetables, which represented 7% of all respondents, were 18.5% more likely to adopt both soil testing and crop rotations, but not conservation tillage. Use of conservation tillage techniques in fruit and vegetable production systems has been limited due to factors such as compaction, low soil temperatures, and additional pest pressures, such as weeds, which are partially controlled through tillage practices (Glancey, 2003; Uri, 1999).

Factors Affecting Conservation Practice Adoption

The multinomial logistic regression model estimated can be used to examine factors affecting the adoption of the individual conservation practices, as well. For all three practices, presence of a conservation plan; producers with over 50% of sales from row crop production; ethnicity; and varying fertilizer rates among fields of the operation were all significant factors in predicting individual conservation practice adoption. Presence of a conservation plan increased the likelihood of adoption by 9.3–15.7%, likely given the information it provides the farm operator. In the same regard, contact with NRCS had a positive effect on the likelihood of adopting soil testing and conservation tillage. Molnar, Bitto, and Brant (2001) indicate that "soil testing is a fundamental step in economically sound and environmentally responsible farming," (p. 34) and is heavily promoted by NRCS.

Farmers with significant row crop enterprises were 5.6–15.6% more likely to adopt all three conservation practices. This result is not unexpected, as crop rotations and conservation tillage are predominately row crop practices. As before, black farmers were 5.4–14.6% less likely to adopt each of the individual conservation practices. Historically, this set of farmers is more risk averse (U.S. Government Accountability Office, 1997) and cultural norms affecting adoption may still play a strong role in this region of the country (Molnar, Bitto, and Brant, 2001). In addition, use of varying fertilizer rates, which could be indicative of crop nutrient management on-farm, increase the probability of adopting all three conservation practices. For soil testing and crop rotations, the marginal effects were above 20%.

Other factors, including higher sales, education, state of residence, as well as fruit and vegetable production affected the adoption of individual practices, but were not significant for all the practices. Fuglie and Bosch (1995) support the result that higher sales increase the likelihood of a farmer soil testing. Furthermore, small and limited-resource farmers with low farm sales may be less likely to adopt conservation practices if they could adversely impact farm revenues. Fruit and vegetable producers were 23.5% more likely to adopt crop rotations, which is expected given the variety of crops usually grown by such producers. An unexpected result was that farmers with a college education were 7.4% less likely to adopt crop rotations. Pannell et al. (2006) suggest that education is likely not an important predictor of adoption as compared with participation in specialized training and technical assistance (e.g., from NRCS), which may be the case for small and limited-resource farmers. Finally, adoption of individual conservation practices did vary by state in some cases. Farmers in Alabama were less likely to adopt crop rotations relative to farmers in Georgia and Mississippi, while farmers in Georgia were more likely to adopt soil testing relative to farmers in Alabama and Mississippi.

Eligibility of Small and Limited-Resource Farmers for the CSP

Following the eligibility criteria for the CSP, it is assumed that for farmers to qualify for the CSP they must adopt all three conservation practices being examined: soil testing, crop rotations, and conservation tillage. Of the respondents, only 7% have adopted all three. Another aspect of the study was to elicit the likelihood of small and limited-resource farmers being eligible for the CSP. Figure 1 provides a smooth histogram or density plot across survey respondents of the estimated probability (from the multinomial logistic regression model) that they would adopt the conservation management plan with all three conservation practices. The mean of the distribution was at 7.1%, indicating that on average a small and limited-resource farmer would be likely to adopt this management plan 7.1% of the time. Of the respondents, 57 had greater than a 20% likelihood of adopting this management plan, while only one had greater than a 50% likelihood of adoption. Thus, under current eligibility requirements small and limited-resource farmers may have a difficult time qualifying for the CSP.

From the examination of the factors affecting adoption above, a number of factors point toward strategies that could improve the likelihood of small and limited-resource farmers' eligibility status. USDA–NRCS may be able to assist small and limited-resource farmers by: helping them form a conservation plan; targeting producers with a significant share of their farm in row crop production; helping farmers to establish beneficial crop nutrient management practices (e.g., through increased participation in the Environmental Quality Incentives Program); and actively countering the cultural issues still prevalent in the Southeast

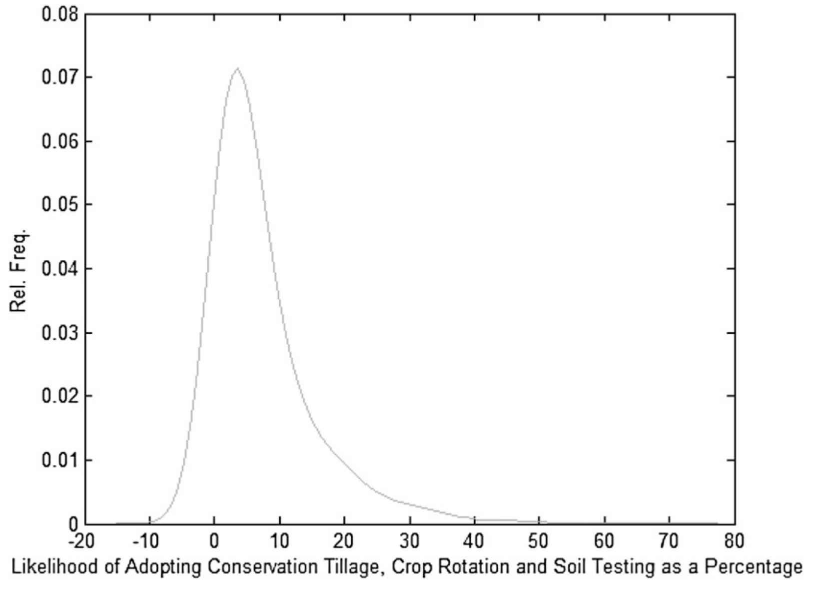

Figure 1. Smoothed Histogram of the Likelihood of Jointly Adopting Conservation Tillage, Crop Rotation, and Soil Testing Practices

related to race. Akobundu et al. (2004) found that increasing participation intensity of extension efforts for limited-resource farmers in Virginia increased the benefits of outreach, training, and technical assistance programs. Thus, NRCS may need to become more involved with the broader needs of small and limited-resource farm communities to fully engender their participation in new agri-environmental programs.

Dependence between Conservation Practice Adoption

To assess the association or dependence between adopting different conservation practices, Table 5 presents the matrix of conditional association measures following Equation (3) for soil testing, crop rotations, and conservation tillage. The low values of the estimated measures and lack of statistical significance indicate that there were no strong associations between adopting any of the conservation practices. That is, the adoption of one conservation practice does not necessarily indicate that other conservation practices will be adopted. This is not surprising, given that limited-resource farmers do not implement conservation practices as frequently as full-time or larger farmers (Onianwa, Wheelock, and Hendrix, 1999). Demissie (1989) found that a majority of the small and limited-resource farmers they surveyed felt they did not have conservation problems, which would definitely affect conservation practice adoption and conservation program participation. In addition, as mentioned earlier, small and limited-resource farmers may be less interested in adopting multiple practices, due to adjustment costs, limited-resources (e.g., capital and land), time constraints, conflicting goals, risk aversion, and other familial issues that could be magnified in small operations (Pannell et al., 2006).

Table 5. Conditional Dependence Statistics Between Soil Testing ($Y_{i,1}$), Crop Rotation ($Y_{i,2}$), and Conservation Tillage ($Y_{i,3}$)

	Goodman and Kruskal's (1954) Matrix of Concentration Coefficients: $\tau_{j,r}$		
Variable	$Y_{i,1}$	$Y_{i,2}$	$Y_{i,3}$
$Y_{i,1}$	—	0.046 (0.842)	0.040 (0.897)
$Y_{i,2}$	—	—	0.020 (0.847)
$Y_{i,3}$	—	—	—

Note: Only the upper diagonal portion of the matrix is reported because the matrix is symmetric. Asymptotic standard errors were calculated using the delta method and are provided in parentheses under the parameter estimates.

The implications for policy are that programs such as EQIP may be more desirable for small and limited-resource farmers than the CSP. EQIP will fund individual conservation practice adoption by farmers more readily than the CSP, because EQIP does not require that a limited conservation system already be established on-farm. Given that participation in EQIP did not increase the likelihood of adopting any of the conservation management plans or practices, USDA–NRCS may need to readdress how to get small and limited-resource farmers more involved in this program, as well as the CSP.

Conclusion

Small and limited-resource farmers could play a role in helping to provide environmental benefits from agricultural lands. The Conservation Stewardship Program (formerly, the Conservation Security Program) under the 2002 and recent Farm Bills provides an opportunity to help eligible farmers improve on-farm conservation and environmental stewardship. Given the current state of the program, many small and limited-resource farmers who may be practicing some form of conservation, may not meet the eligibility requirements to be able to participate. These requirements include the adoption of a minimal conservation system on-farm, which includes conservation tillage, crop rotations, and soil testing. Of the producers surveyed in the study only 7% would meet these eligibility requirements and the other 93% of these producers have less than a 20% likelihood of meeting the eligibility requirements under current guidelines. To improve the likelihood of small and limited-resource farmers qualifying for the program, USDA–NRCS should recognize and actively promote conservation planning; encourage more frequent contact with NRCS; assist row crop producers with conservation practice adoption; promote crop nutrient management practices; and develop special assistance to address issues associated with black limited-resource farmers. Furthermore, programmatic efforts should recognize the resource limitations of this farmer group and their adoption patterns. While the CSP promotes the adoption of a conservation system or bundles of conservation practices, research findings suggest that practices are adopted individually, not following a systems approach, which will likely affect the eligibility of small and limited-resource farmers for these types of programs.

An attempt to promote the involvement of small and limited-resource farmers in the CSP without recognizing these needs (as well as the broader deficits of low income communities) may result in a very low rate of participation. The revamping of the CSP in the 2008 Farm Bill provides an opportunity to help small and limited-resource farmers qualify for the program, by lowering eligibility standards in meeting established stewardship thresholds and providing an opportunity for small and limited-resource farmers to be more competitive when bidding for conservation stewardship contracts. Future research needs to examine the difference in farm typologies, such as livestock versus row crop producers, to provide a more detailed picture of these types of farms' individual needs.

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