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Agricultural landowners' willingness to participate in a filter strip program for watershed protection

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ABSTRACT

Non point source (NPS) pollution remains a challenge to communities meeting watershed management objectives around the world. Installing agricultural best management practices (BMPs) such as filter strips is a widely accepted mechanism to control NPS pollution and agricultural runoff. Government programs in the form of payment for environmental services (PES) have been introduced to encourage BMP adoption for watershed protection. However, the voluntary nature of these programs makes landowners' decision to participate in them critical to achieving program goals. Understanding the drivers behind landowners' decisions to participate in watershed protection programs is essential for designing effective and efficient programs. This study examines agricultural landowners' decisions to participate in a conservation program involving filter strips. Using responses from a survey of agricultural landowners in Michigan's Saginaw Bay watershed, the study examines key programmatic, socio-psychological, and demographic determinants of landowners' participation decisions. The study results suggest that making contract durations shorter with enhanced rental payments, and educating landowners about program efficacy as well as on- and off-farm benefits of the conservation practice would enhance participation.

1. Introduction

Agricultural non-point source pollution remains a key challenge to communities meeting watershed management objectives in the United States and worldwide (Duncan, 2014; Ma et al., 2014; Organisation for Economic Co-operation and Development, 2001; Stuart et al., 2014). Nutrients, sediments, pesticides and pathogens, especially from agricultural sources, impact aquatic ecosystems with adverse effects on water quality and wildlife habitat. In the United States, the National Water Quality Inventory identified agricultural non point source pollution as the leading source of water quality impacts to surveyed rivers and lakes, the third largest source of impairments to surveyed estuaries, and a major contributor to ground water contamination and wetlands degradation (US EPA, 2012b). The Organization of Economic Co-operation for Development (2001) also estimates that agriculture in the European Union contributes about 40–80% of the nitrogen and 20–40% of phosphorus entering surface waters. Similar trends of pollution from agricultural non point source pollution have also been reported in other parts of the world (Agrawal, 1999; Duncan, 2014; Li and Zhang, 1999; Novotny, 1999). With climate change predicted to increase the incidence of severe storm events, water resources are likely to be in further decline if the transport of agricultural pollutants is not adequately checked (Jeppesen et al., 2009; Milly et al., 2005).

Agricultural best management practices (BMPs) are widely accepted among scholars and resource managers as a way to address the issue of nonpoint source pollution and agricultural runoff (Bratt, 2002; Giri et al., 2012; Ryan et al., 2003). Practices such as filter strips and cover crops have proven to be successful measures to control agricultural pollution and improve overall environmental quality (Giri et al., 2012; Shan et al., 2014; Zhang et al., 2010). Recognizing the relevance of BMPs to NPS control, various government programs in the form of payment for environmental services (PES) have been introduced worldwide to encourage BMP adoption. Many of these PES programs target land use and BMPs for agricultural landowners (Asquith et al., 2008; Chen et al., 2009a; Kaplowitz et al., 2012). For instance, Ecuador's SocioPáramo program, the Rural Environment Protection

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Scheme in Ireland, and several other agri-environmental schemes in Europe and Australia have all been used to incentivize landowners to implement BMPs to protect water and land-based resources (Bremer et al., 2014; Burton and Schwarz, 2013; Greiner and Gregg, 2011; Murphy et al., 2014). Likewise, in the United States, programs like the USDA Natural Resource Conservation Service's Environmental Quality Incentive Program (EQIP), Conservation Reserve Program (CRP), and Conservation Stewardship Program (CSP) have encouraged, with varying degrees of success, landowners to adopt various BMPs by offering financial and technical assistance to participants with eligible agricultural lands (Baylis et al., 2008).

Recently, the US Agricultural Act of 2014 (commonly referred to as the "farm bill") maintained conservation on working lands as a top priority. The Farm Bill consolidates some existing conservation programs, links crop insurance subsidies to conservation compliance, and provides more than $1 billion of funding for PES programs to boost participation in the conservation programs (Natural Resource Conservation Service, 2014). The implementation of BMPs by agricultural landowners is at the heart of the Act's focus on conservation programs. In the United States, national agricultural and environmental protection efforts are often implemented in conjunction with state partners. For example, in 2000, the state of Michigan in partnership with the federal government and some private organizations introduced the Conservation Reserve Enhancement Program (CREP) to help control soil erosion, improve water quality, and enhance wildlife habitat in priority watersheds. Modeled after the US Department of Agriculture's Conservation Reserve Program (CRP), CREP offers agricultural landowners enhanced monetary incentives including annual rental payments for the length of the contract and cost-share assistance to establish select BMPs on their lands for watershed protection. The voluntary nature of this scheme makes agricultural landowners' decisions to enroll their lands critical to achieving policy goals. As a number of the original CREP contracts approach their end dates and enrollment rates in Michigan's CREP declines, policymakers are interested in ways to organize the program to help attract new enrollment while encouraging current participants to reenroll their lands when their current contract expires.

This paper uses an examination of the willingness of agricultural landowners in the Saginaw Bay watershed to participate in CREP to explore how programmatic, socio-psychological, and demographic factors impact agricultural landowners decision to participate in government-sponsored BMP programs. Although the CREP program includes other eligible BMP, this study focuses on enrollment in filter strips which is the most widely adopted practice under CREP in Michigan and because of filter strips' demonstrated effectiveness as a pollutant reduction practice even with minimal width (Abu-Zreig et al., 2004; Zhang et al., 2010).

2. Background

2.1. Agricultural landowners and conservation programs

The literature is replete with studies assessing factors believed to influence farmer's adoption of conservation practices (See reviews from Baumgart-Getz et al., 2012; Knowler and Bradshaw, 2007; Prokopy et al., 2008; Hynes and Garvey, 2009). Some of this literature has specifically explored farmers' willingness to participate in agri-environmental programs (Ma et al., 2012; Mishra and Khanal, 2013; Vanslembrouck et al., 2002). Nevertheless, most of these studies have focused on farmer and farm-level factors to explain adoption of conservation practices or willingness to participate in agri-environmental schemes offering no monetary incentives for participation. Generally, this line of literature suggests willingness to participate in agri-environmental programs is positively related to farm size, educational attainment, farmer's interest and/or experience with conservation, environmental attitudes, access to and quality of information, perceived financial and farm-level related benefits, but negatively related to farmer's age. While such factors influence participation, they are less amenable to policy changes besides providing avenues for targeting potential participants. In recent years, a few studies, mostly from Europe, have explored the role of programmatic factors as determinants of participation in agri-environmental programs (Christensen et al., 2011; Espinosa-Goded et al., 2010; Mettepenningen et al., 2013; Ruto and Garrod, 2009). For instance, Ruto and Garrod (2009) used a choice experiment approach to investigate the role of program design characteristics on participation in agri-environmental schemes among farmers from ten European countries. They found that farmers would require greater financial incentives to participate in schemes with longer contracts or that offer less flexibility or higher levels of paperwork. Similarly, in a comparative study of Belgium and American farmers, Mettepenningen et al. (2013) noted farmers' preferences for flexible approaches toward agri-environmental schemes, in which they have the freedom to decide on contract terms and the related payments. Nonetheless, the effect on participation of programmatic rules and payments, which influence the economic attractiveness of agri-environmental programs remain largely understudied especially in the United States.

At the same time, a few studies have explored farmers' preferences for agri-environmental programs involving filter strips (Howard and Roe, 2013; Lant et al., 1995; Loftus and Kraft, 2003; Purvis et al., 1989). Purvis et al. (1989) examined farmers' willingness to participate in a filter strip program and showed that their decisions are determined by the yearly payments, perceptions of environmental change, and farm opportunity cost. Loftus and Kraft (2003) also reported that farmers who rely less on farm-generated income as a percentage of total household income, and those informed about the eligibility of their land for the program tend to be more willing to participate in CRP involving filter strips. Nevertheless, a high proportion of the previous studies on filter strips involve hypothetical agri-environmental programs (e.g. Howard and Roe, 2013). Those studies exploring specific agri-environmental programs do not consider the role of program specific factors in the farmers' enrollment decision making (Loftus and Kraft, 2003). This study addresses this gap by exploring how program participation is affected by the program characteristics of an existing agri-environmental program involving filter strips. Insights into the contribution of program characteristics on participation will allow resource managers to reorganize the program to reflect landowners' preferences and boost participation.

In addition to the above literature, a number of studies have demonstrated the role of non-economic concerns as determinants of landowners' decision-making regarding conservation programs (Greiner and Gregg, 2011; Januchowski-Hartley et al., 2012; Kvakkestad et al., 2015). Socio-psychological factors including landowners' social and moral concerns and their attitude toward the environment and government-run conservation programs have been shown to influence participation (Dupraz et al., 2003; Larson and Lach, 2008; Mzoughi, 2011). Conservation practices differ in land and management requirements, as well as esthetics, and thus may elicit different adoption rates or participation in programs involving them (Prokopy et al., 2008; Ryan et al., 2003). In addition to being compatible with existing farming practices, the degree to which landowners perceive the conservation practice to offer environmental, social, and private benefits as well as the risk, time, and effort required to implement the targeted practice have been shown to be closely related to adoption (Ma et al., 2012; Sattler and Nagel, 2010; Wauters et al., 2010). In a qualitative study exploring the role of social factors and expected private benefits as a determinant of participation in

riverine restoration programs, Januchowski-Hartley et al. (2012) reported that a sense of stewardship and improved landscape esthetics were the most commonly reported private benefits influencing participation. Likewise, Greiner and Gregg (2011) points to a strong stewardship ethic relative to financial and social considerations as the primary motivation for conservation practice adoption among Australian farmers. Ryan et al. (2003) also found that farmers are likely to engage in conservation practices that are esthetically pleasing and make their farms appear well managed.

Socio-psychological scholars also emphasize the relevance of social norms and concerns in individual behavioral decision-making (Larson and Lach, 2008; Mzoughi, 2011). Taking actions that are approved of societally or by other relevant reference groups is often associated with some status benefits. Normative expectations and approval of behavior by others who are important to the decision maker have been demonstrated to influence conservation behavior (Beedell and Rehman, 1999; Chen et al., 2009b; Mzoughi, 2011). In a recent survey of Ohio farmers, Howard and Roe (2013) found that farmers indicating a high degree of concern for the environment were more likely to opt into programs involving filter strips. Hence, in determining potential areas to direct policy efforts to enhance participation, this paper also explores the role of some socio-psychological variables on landowners' enrollment decision. Relative to demographic factors, socio-psychological factors may be amenable to policy changes though at some cost. For example, environmental attitudes and conservation concerns might be influenced through public education and, in turn, may result in increased program enrollment.

Previous studies with mixed results have examined the effect of farm operator characteristics on the likelihood of enrollment in conservation programs (Burton, 2014; Prokopy et al., 2008). These studies have generally shown that landowners with relatively high educational attainment, and those with previous experience in conservation schemes tend to be more willing to participate in agri-environmental schemes (Baumgart-Getz et al., 2012; Schroeder et al., 2013; Vanslembrouck et al., 2002). In a study involving ten European countries, Ruto and Garrod (2009) found that farm households that are dependent on their farm for more than half of their household income are less likely to enter into programs requiring longer-term contracts. The authors attributed this unwillingness to commit to longer term agri-environmental programs to a potentially greater opportunity cost of such arrangements in terms of income foregone should market conditions changes. Similarly, in the United States, Loftus and Kraft (2003) reported that farmers who rely less on farm-generated income as a percentage of total farm income were more likely to participate in filter strips under the conservation reserve program. While demographic characteristics are typically not amenable to policy changes, they can be useful for targeting potential participants to enhance participation rates. For instance, knowledge of the kinds of farmers who would most likely enroll in CREP could help policymakers to tailor their program and educational resources to meet the needs of this group and enhance participation rates. Consequently, this study also explored the role of demographic characteristics as a determinant of landowners' decisions to participate in CREP.

2.2. CREP in Michigan

CREP is a federal-state partnership conservation program that targets significant environmental effects related to agriculture. CREP in Michigan was launched in October 2000 following an agreement between Michigan and the U.S. Department of Agriculture's Farm Service Agency to implement a program to improve water quality in three priority watersheds in Michigan – Saginaw Bay, the River Raisin, and Lake Macatawa. Primarily, the program seeks to protect the watersheds from NPS pollutants and sediments resulting from crop production by encouraging landowners who meet program requirements to implement specific conservation practices on their agricultural land in contracts of 15 years in duration. The CREP program also seeks to promote use of native species, improve wildlife habitat and diversity, and leverage federal matching dollars. Relative to the traditional CRP, CREP offers participating landowners enhanced monetary incentives including signing bonuses, annual soil rental payments, and cost-share assistance for establishing practices. For a 15 year contract under the existing CREP program, landowners receive $150 per acre as signing bonus and 140% cost-share assistance for practice installation (100% of the installation cost and a 40% incentive). The CREP also pays 140% of the annual soil rental payment for a county, which is predetermined by the USDA Farm Services Agency based on the soil type. At the time of the study, the average soil rental rate across these counties was $94 dollars. Also, unlike the traditional CRP, CREP enrollments are not subject to competitive bidding and only a few practices are eligible for CREP including filter strips, riparian buffers, wetland restoration, field windbreak, planting of introduced or native grasses, sediment retention control structures.

Despite initial financial obstacles, CREP enjoyed early success when introduced in Michigan; within its first year and half, Michigan landowners had enrolled about 40,000 acres of land. However, with rising commodity prices, enrollment levels in CREP have declined. At the close of the 2011 fiscal year, a total of 6710 contracts had been executed under CREP. These contracts represented about 75,366 acres of all lands enrolled under CREP, falling just short of the initial goal of 80,000 acres. Most of the CREP contracts are within the Saginaw Bay watershed and implemented filter strips and riparian forest buffers for approximately 37,000 acres of the total land enrolled (Michigan Department of Agriculture and Rural Development, 2011). With a declining enrollment rate coupled with the imminent expiration of some of the original contracts, and in light of the emphasis the new farm bill places on conservation programs, managers are considering measures to boost CREP enrollment. This study is thus part of the efforts to re-organize the CREP program to make it attractive to eligible landowners.

3. Methods

3.1. Research site

Participants of this study were drawn from the Saginaw Bay watershed located on the eastern side of Michigan, United States. Saginaw Bay is a prominent bay on Lake Huron, one of the Laurentian Great Lakes. The watershed covers approximately 8700 square miles and all or part of 22 counties in Michigan. It is the State's largest drainage basin draining about 15% of the total land area of the State. It also features more than 175 inland lakes and about 7000 miles of rivers and streams, and contains America's largest contiguous freshwater coastal wetland system. Saginaw Bay is home to more than 1.4 million people and its rich resources support a variety of activities including agriculture, manufacturing, tourism and outdoor recreation. It also supports a vast variety of wildlife including large populations of waterfowl, birds, and more than 90 fish species (Saginaw Bay Watershed Initiative Network, 2012; US EPA, 2012a).

With agriculture constituting over 50% of the land use in the area, the Saginaw Bay, like many watersheds, faces a range of NPS pollution, which has adversely impacted the water quality. Increasing levels of nutrients from agricultural lands contribute to excess growth of algae and other plant mater in the water. This has also generated shoreline mats of decaying algae and plant material commonly called 'muck'. The muck has been shown to hold and nourish harmful bacteria and pathogens (Watson et al., 2008).

These developments have negatively impacted water quality, aquatic wildlife habitats, and recreational opportunities in the lake. The U.S. Environmental Protection Agency has listed the Saginaw Bay watershed as an Area of Concern and has emphasized the need to mitigate, among other things, agricultural NPS pollution in the area (US EPA, 2012a). As part of several efforts to reverse the trend of pollution, the watershed was selected as a priority area for the implementation of CREP to encourage agricultural landowners to adopt conservation practices to reduce NPS pollutant entering the watershed.

3.2. Research questions

This study examines the willingness of agricultural landowners to participate in a conservation program involving filter strips for watershed protection and focuses on understanding programmatic, socio-psychological, and demographic factors that shape agricultural landowners decisions. The study was guided by the following research questions:

1. What is the effect of filter strip program elements on BMP program enrollment?
2. What socio-psychological factors motivate or inhibit agricultural landowners participation in filter strip programs?
3. What effect do landowner demographic characteristics have on participation in BMP programs?

3.3. Survey instrument design

The data used in this analysis came from a survey of agricultural landowners in the Saginaw Bay watershed. The survey instrument was designed using an iterative process (Kaplowitz et al., 2004). First, a draft of the survey instrument was constructed following a review of the literature and a series of individual interviews with key informants including local and state officials at the Farm Services Agency of the Michigan Department of Agriculture and Rural Development. The key informant interviews sought to understand, among other things, the range and severity of the water quality as well as the goals, scope, and design elements of the CREP program. The draft instrument was then pretested using cognitive interviews (Willis, 2004) with a convenience sample of five students at Michigan State University with agricultural backgrounds. This was followed by further pretesting with 11 agricultural landowners in the targeted watershed recruited from a web-survey panel maintained by Survey Sampling International. The agricultural landowners recruited for pretesting administered the draft web survey remotely with the help of screen sharing application, 'TeamViewer' and were then interviewed on the phone. The screen sharing application made it possible for researchers to recruit participants from the targeted watershed without the team members traveling. It also allowed the research team members to observe the participants navigate through the survey without creating any disturbance. The cognitive interview following the survey administration focused on participants' understanding of the information provided, their ability to answer the questions according to the information provided, and/or personal experiences, opinions and attitudes as well as the relative ease with which the survey can be navigated. After each interview, the research team debriefed and revised the web survey instrument where necessary, to address difficulties respondents encountered during the process. The input of resource experts and program managers were sought and duly incorporated throughout the process to ensure the survey communicated accurate information.

The final survey instrument consisted of multiple sections addressing a range of issues including attitudes toward conservation programs involving filter strips, motivations and barriers to enrollment in conservation programs, demographic characteristics, and a choice experiment component asking agricultural landowners to indicate their willingness to participate in a proposed CREP program involving filter strips. Respondents were first presented with information on eligible land and asked a series of questions about their land to determine their eligibility for the program. Secondly, they learned about water quality issues in the watershed, filter strips and their purpose, the rules for participating in CREP, and the types of payments under CREP. The information treatments provided to respondents included images to facilitate respondents' understanding and ensure that they make an informed decision. Each set of information was immediately followed by questions that require knowledge of the information set to answer as a way to encourage respondents to interact with and read the information set (Sudman et al., 1996). Respondents were then presented with choice scenarios that, across the sample, varied the duration of the contract period, signing bonus payments, percentage reimbursement of installation cost, and annual soil rental rates. For each scenario, respondents were asked to indicate whether they would enroll in the program (i.e., establish a 50 ft wide filter strip) given the proposed program conditions and payments:

> 'Given the program rules and its potential social and environmental benefits, and supposing this is the only program being offered, would you enroll a portion of your land in the Saginaw Bay CREP filter strip program for A years for a one time payment of $B per acre as signing bonus, C% refund of the actual cost of installing the filter strip, and an annual soil rental rate of $D per acre?'

Each question was preceded by a bullet list that recapped key program components (i.e., contract duration, annual soil rental rate, signing bonus, and cost share assistance). The final survey also contained a number of Likert-type scale items that solicited information on respondents' socio-psychological attitudes and questions on demographic characteristics of interest to the study.

3.4. Experimental design

The choice scenarios presented to respondents varied in length of contract period, signing bonus payments, percentage reimbursement of installation cost, and annual soil rental rates. An experimental design was used to eliminate collinearity between variables (Johnson et al., 2007). Specifically, we developed a D-efficient orthogonal design using the algorithms in NGene to construct the scenarios presented to respondents (Choice Metrics, 2011). This design allows for the use of priors to enhance the efficiency of the design and eliminate dominated alternatives. Following a review of the literature, results from the analysis of our pretest survey, and key informant cognitive interviews, the attribute levels were assigned expected signs that reflected hypothesized relationships between participation choices and the attribute levels. NGene generated 108 alternative scenarios. The sample population was randomly divided into 36 groups, with each group receiving a different version of the questionnaire that contained three choice scenarios.

3.5. Sampling procedure and survey implementation

Participants of this study were randomly drawn from a list of agricultural landowners in the Saginaw Bay watershed who were enrolled in the Farmland and Open Space Preservation Program (PA 116). The list of agricultural landowners was provided by the Farm Services Agency of the Michigan Department of Agriculture and Rural Development. The Farmland and Open Space Preservation program is designed to preserve farmland through agreements restricting non-agricultural development of the land. Landowners

participating in the PA 116 program receive relief from the higher property taxes and assessments that can occur in areas with development pressure (e.g., tax credits and exemptions from special assessments for sanitary sewer, water, lights or non-farm drain projects). The program includes eligibility requirements to ensure enrolled land is sufficiently engaged in agriculture. As at 2005, over 50% of the all farmland in Saginaw Bay watershed was enrolled in the program. Absent a comprehensive list of agricultural landowners, this list represented a next best sampling alternative allowing generalization of our results to over 50% of the area's farmland. Given the focus of this study on encouraging new enrollment, the original PA 116 list was crosschecked with a list of current CREP participants so that that no current CREP enrollee was sampled for this study. The final sampling frame consisted of about 5889 agricultural landowners in the watershed. From this list, a random sample of 3949 agricultural landowners were selected and invited to participate in the study.

The survey was implemented as a mixed-mode, web-based and mail, survey during Summer 2013 following best practices and principles (Dillman et al., 2008). First, invitation letters were sent to all members of the sample informing them of the study and providing them with a link to the web-based survey and a $1 bill. This was followed by a small postcard reminding potential respondents who had not responded to the first invitation to do so. Those members of the sample who had not responded to the first two invitations including those indicating they did not have access to the internet were then mailed paper copies of the survey. This third invitation also included a letter providing potential respondents with a link to the survey and giving them an option to either complete the paper copy or the web-based survey. Non-respondents were then contacted for the last time via an oversized postcard. This oversized postcard provided them with a link to the survey, an offer for a replacement paper copy of the survey, and appealed to the addressees to complete either the web-based or paper version of the survey. Completed surveys, returned mail and other outcomes were recorded for each member in the sample. Responses to the web survey were downloaded into a spreadsheet for subsequent analysis. Mail survey responses were compiled in a spreadsheet for subsequent analysis using a double data entry method that checked for errors.

3.6. Empirical model

A Random Utility Model is used to estimate how program characteristics, socio-psychological factors, and demographics relate to participation in the CREP filter strip program. Assume that a landowner (i) derives utility U_{ij}, from choosing to participate in CREP when faced with a choice between participation (j) and non-participation (k) in CREP. The derived utility, U_{ij} can be expressed as a sum of a deterministic or observable component (V_{ij}) and a random error term (ε_{ij}) representing the unobservable aspects of utility:

$$U_{ij} = V_{ij} + \varepsilon_{ij} \quad (1)$$

The deterministic component V_{ij} is also a function of the specific attributes of that particular CREP program (X_j) they are faced with and the characteristics of the individual landowner (Z_i) including demographic and socio-psychological factors, which influences their preferences and their derived utility. Hence, taking into account that each respondent to the survey answered up to three choice scenarios, the indirect utility function for landowners deciding to participate in CREP is given by

$$V_{ij} = \beta X_j + \alpha Y_i + \delta Z_i + \varepsilon_{ij} \quad (2)$$

where V_{ij} = utility of CREP program j to individual i on contingent scenario j, X_j = vector of CREP program attributes specific to contingent scenario j, Y_i = vector of landowner socio-psychological characteristics, Z_i = a vector of individual-specific landowner characteristics, β = a vector of preference parameters for the CREP program design attributes; α = a vector of parameters related to the socio-psychological characteristics; δ = a vector of parameters related to the landowner characteristics; ε_{ij} = random error term

Assuming that the error terms follow a type I extreme value distribution yields a logit form for the probability that a landowner will choose to participate in CREP, P_{ij}, which is given by

$$P_{ij}(\text{participate}) = \frac{e^{\beta X_j + \alpha Y_i + \delta Z_i}}{1 + e^{\beta X_j + \alpha Y_i + \delta Z_i}} \quad (3)$$

Maximum likelihood estimation was used to estimate the parameters of the probability that an agricultural landowner with a set of socio-psychological attributes, Y_i and demographic characteristics, Z_i and facing program characteristics X_j will choose to participate in CREP. From the survey, respondents indicated their willingness to participate or not participate in CREP providing a dichotomous dependent variable. Since respondents to the survey responded to more than one choice scenario, the estimation employed the robust clustered error option in Stata to control for possible correlation in error terms across responses from the same respondent (Cameron and Miller, 2011).

Using the estimated parameters from the logit model, the marginal rate of substitution (MRS) that respondents make between the attributes was computed as the ratio of the coefficients (Haab and McConnell, 2002). The MRS represents the rate at which a landowner would give up one attribute of the program in exchange for a one-unit change in the level of another attribute while maintaining the same level of utility. Researchers often compute MRS in terms of a cost parameter allowing them to translate the trade-off in monetary terms. In this study, the MRS is computed in terms of relative changes in annual soil rental payments. Hence, the computed MRS captures the additional amount of money ($) in soil rental payments that a landowner would be willing to accept (or give up) for a unit change in another attribute holding all other factors constant. The MRS provides further insights into the relative importance of each of the attributes to landowners and the trade-off they would be willing to make to move from one level of an attribute to another holding all other factors constant.

3.7. Model variables

Table 1 presents a description of the independent variables used in the logit models. We designed explanatory variables to represent each of the three conceptual categories in our model. First, the program characteristics category corresponds to the rules and payments associated with the CREP program that were part of our experimental design: the duration of contracts, payment amount for signing bonus, percentage of the cost-share assistance for practice installation and annual soil rental payments per acre of land enrolled. The decision to vary these factors in our design was informed by the demonstrated effect of contract lengths and monetary incentives on participation in conservation programs (Ruto and Garrod, 2009; Van Herzele et al., 2013) as well as inputs from program managers and pretest participants.

The second category of independent variables in the model (Table 1) represents the socio-psychological variables included in the model. Several statements reflecting different aspects of respondents' socio-psychological attitudes were included in the survey, and respondents were asked to indicate their level of agreement with each of the statements on a five point Likert-type *scale.* Responses to those statements were combined into indices for various socio-psychological variables using principal component analysis (Brown, 2012). The variables considered reflected

Table 1
Description of variables in model estimating willingness to enroll in CREP.

Model variables	Description	Possible values	Mean	Std. deviation
Program attributes				
Year	Duration of contract	10–20 years	15.00	4.08
Refund	% Cost-share assistance of installation cost	0–140%	79.77	47.29
Bonus	Onetime payment per acre for signing up	$0–200	112.96	71.80
Rent	Yearly payments per acre for participation	$50–275	138.75	76.93
Socio-psychological characteristics				
FS attitudes	Attitudes toward filter strip	1–5	3.19	0.84
Envtal attitudes	General environmental attitudes	1–5	3.10	0.43
Social norms	Social norms related to filter strip	1–5	2.75	0.56
Landowner characteristics				
Age	Age of agricultural landowner	25–97 years	62.64	14.24
High school or less	Completed at least high school	0, 1	0.38	0.49
College or more	Have at least a college degree	0, 1	0.29	0.45
Conservation experience	Participated in other conservation programs	0, 1	0.37	0.48
Gender	Male landowner	0, 1	0.86	0.34
% Income from farming	Percent of household income from farming	0–100%	52.96	33.99

landowners' perceptions, preferences, and attitudes toward filter strips, the environment, and social norms/concerns that are believed to guide their utility-maximizing choices.

Previous studies suggest that the degree to which landowners perceive the conservation practice to offer environmental, social as well as private benefits to their farmland influences their decision to participate in conservation programs (Ma et al., 2012; Ryan et al., 2003; Wauters et al., 2010) Hence, respondents' attitudes toward filter strips were included in the model. Three survey items reflecting respondents' view of the esthetic benefits of filter strips and perceived efficacy of filter strips to improve water quality were combined into an index called "filter strips attitudes." The survey items were interrelated and showed high internal consistency ($\alpha = 0.81$) in the reliability analysis (Brown, 2012).[1] The index essentially captured respondents' views regarding the social (water quality improvements) and the private benefit (improvement in farmland esthetics) from filter strips. From the literature, it was hypothesized that a positive attitude toward filter strips would increase the likelihood of landowners participating in CREP filter strip program. The model also included respondents' environmental attitudes. An index of environmental attitudes was created from four interrelated items tapping respondents' views on environmental protection including government expenditure on environment and concerns about environmental pollution ($\alpha = 0.63$).[2] In line with previous literature it was hypothesized that positive environmental attitudes will increase the likelihood of enrollment in the CREP filter strip program. In addition, the role of social norms as a determinant of landowners' decision to enroll in CREP is also explored in the model. Normative expectations and approval of behavior by others who are important to the decision maker have been demonstrated to influence conservation behavior (Beedell and Rehman, 1999; Chen et al., 2009b; Mzoughi, 2011). To test this effect, an index of social norms was created and included in the model. The social norms index was created from four items reflecting respondents' perception of the likelihood that relevant reference groups (neighboring farmers, farmers association, important community members) would approve their installation of filter strips on their land.[3] The four items showed sufficient internal consistency ($\alpha = 0.65$) in the reliability analysis. It was hypothesized that landowners whose reference groups approve of filter strips or expect neighbors to also install filter strips would more likely participate in the filter strip program.

The third category of independent variables in the model (Table 1) reflects landowner characteristics. In line with previous studies (Lambert et al., 2007; Schroeder et al., 2013; Vanslembrouck et al., 2002), landowners' age, educational attainments (high school or less, college or more), gender, and experience with similar conservation programs similar were included in the model. We were initially concerned that previous experience with similar conservation may be endogenous given that unmeasured factors explaining past participation may also influence present participation. However, exploring the issue proved otherwise as dropping the variable from the model had no qualitative effect on the model results. It was hypothesized that willingness to participate in the filter strip program will be positively related to educational attainment and to experience with conservation programs but negatively related to age. Following previous studies, females were also expected to be more likely to enroll relative to men (Druschke and Secchi, 2014). In addition, the model examines the effect of landowner's dependence on income from farming on their willingness to participate in the filter strip program. In line with the findings of Loftus and Kraft (2003), we hypothesized a negative relationship between willingness to participate in the filter strip program and percentage of total household income from farming.

4. Results and discussion

4.1. Participants and response rate

From the 3949 agricultural landowners invited to participate in the study, a total of 1106 individuals participated. This represents an American Association for Public Opinion Research (AAPOR) minimum response rate (RR1) of 28.6% after accounting for undelivered invitations, deceased individuals, and refusals. For a landowner to be eligible to participate in CREP filter strips programs, he or

[1] Items in filter strip attitude index:
1. Filter strips make cropland visually pleasing.
2. Installing filter strips on my cropland will help improve water quality.
3. Filter strips make the land look well managed.

[2] Items in environmental attitude index:
1. Protecting the environment should be given priority even if it cost me money.
2. Government spends too much money on conservation practices to protect the environment.
3. The consequences of environmental pollution are over-exaggerated.
4. We will experience a major environmental disaster if pollution of water resources are not reduced.

[3] Items in the social norm index:
1. Members of my farmers' association would encourage me to install filter strips on my land.
2. People most important to me expect me to install filter strips on my land to protect water resources.
3. What my neighbors do on their farms influences the practices I adopt on my land.
4. My neighboring farmers who I respect would install filter strips on their lands.

she must own cropland immediately adjacent to a water resource (e.g. river, stream, lake) with an existing resource concern that can be addressed using filter strips. The land must also have been cropped at least 4 of the previous 6 years. From the responses to a series of survey items designed to determine a respondent's CREP eligibility, about 48.3% of the respondents were determined to own eligible land in Saginaw Bay watershed. Only those initial respondents determined to possess eligible land for CREP filter strip are included in further analysis exploring determinants of program participation. The survey asked questions to identify farmers already enrolled in a CREP filter strip program. The 24% that had installed a filter strip under CREP were not included in the stated preference questions for CREP enrollment. To ensure that the survey responses match the geographic distribution of the population, post-stratification weights based on the county of respondents were created and used in the analysis (Holt and Smith, 1979).

A vast majority of the respondents were males (~86%) and white (~98%) with a mean age of approximately 63 years old. Participants on average reported having been involved in farming for about 38 years and typically farm a total of about 615 acres of land per year. Regarding the highest level of formal education completed, about a 42.7% of the sample indicated having completed high school or less, 37.0% of them had some technical training or associate degree beyond high school, and the remaining 20.3% reported a completion of at least a bachelors degree.

4.2. Parameter estimates

Table 2 presents the estimated coefficients, *p*-values, and marginal effects of the variables included in the model estimating the willingness to participate in CREP among the agricultural landowners with eligible land. For each of the significant variables, the table also presents results of MRS computations for the factor relative to annual soil rental payments. As indicated earlier, the model estimates the probability that an individual landowner with a set of socio-psychological and demographic characteristics would participate in the CREP filter strip program given the program design attributes he/she is presented with. Hence, sign of the coefficient on the program attributes indicates the direction of the effect of that program design attribute on the likelihood that a landowner would participate in CREP. Similarly, the sign of the coefficient on the socio-psychological and demographic variables captures the direction of the likelihood that landowners with those characteristics will choose to participate in CREP filter strips. The magnitude of the estimated marginal effects shows how a one-unit change in each variable would affect the probability that a landowner would enroll his/her land in CREP filter strips.

4.2.1. Effect of filter strip program design attributes

Regarding program design attributes, the results of the analysis suggest a preference for filter strip programs with shorter contracts among agricultural landowners. As shown in Table 2, the likelihood of an otherwise qualified landowner enrolling their land in the filter strip program decreases when the duration of the contract is longer. The results indicate that a one-year increase in duration of a filter strip program's contract decreases the probability that a landowner would participate in that program by 0.6%. This finding may be indicative of landowners' expectations of future market conditions. For each year that their land is under contract, landowners stand the chance to make economic gains or loss depending on changes in future market conditions. Where future crop prices are expected to plummet, securing a payment rate in a long-term contract may insure landowners against negative crop price changes. On the hand, should market conditions change favorably, a long-term contract could represent an economic loss to the landowner. Hence, the observed negative relationship between duration of contract and willingness to participate in the filter strip program may be indicative of landowners' expectations of favorable future market conditions for their crops. Consequently, they are less willing to lock their lands in long-term contracts that will reduce their ability to take advantage of potential increases in crop prices in the future. In light of this finding, policymakers may consider reducing the contract duration as a strategy to attract new enrollment in the program.

The results also highlight the role of monetary incentives in influencing enrollment decisions of landowners. The annual soil rental payments offered to participating landowners was a significant factor in landowners' decision to enroll in the filter strip program. The results indicate that a dollar increase in soil rental payment increases the likelihood of a landowner participating in that program by 0.1%. On the other hand, one-time payments such as signing bonus and cost-share assistance for filter strip installations did not significantly influence participation in the program. As shown in Table 2, the size of the one-time signing bonus was determined to have no effect on the likelihood of landowners to participate in the filter strip program. Likewise, one-time payments in the form of financial assistance with the cost of installing the filter strip did not significantly influence new enrollment. This finding suggests that landowners place a high premium on the soil rental payments they will receive for the duration of the contract relative to the one-time payments. The parameters imply landowners would be indifferent between a $1 per acre increase in yearly rental for about $8.50 per acre in upfront payment in signing bonus. One can use the parameter values to infer a discount rate on the trade-offs between one-time payments and annual payments (Train, 1985). The relative parameters imply an 8.2% interest rate over the average 15-year contract period. For the purposes of program design, the results may imply that financial incentives focused on annual soil rental rates may enhance greater participation relative to initial one-time payments like signing bonuses. Several previous studies has emphasized the positive role that increases in yearly payments play in boosting participation rates in conservation programs (Cooper and Osborn, 1998; Purvis et al., 1989; Ruto and Garrod, 2009).

In addition to the relative preference for the filter strip program attributes, we explored the trade-offs between those program characteristics that were determined to influence enrollment. The computed trade-off further reinforced the relevance of shorter contracts to landowners' decision to participate in the program. As shown in Table 2, the MRS between duration of contract and annual soil rental rate was $5.44. The finding indicates that landowners would require an additional $5.44 in soil rental payments to be indifferent toward a year increase in duration of the program's contract all else equal. Considering that one-time payments have no significant effect on enrollment, a potential strategy would be to direct any new program's financial resources toward increasing annual rental rate to make the program more attractive to landowners presently deterred by longer contracts. Such increases in rental payments could be targeted at securing longer contracts with landowners operating in the most environmentally sensitive areas, where the greatest conservation benefits could be derived.

The model parameters can also be used to predict the portion of the landowners that would enroll in a CREP filter strip program under different prices and other characteristics. Focusing on the rental payment, the average soil rental rate in the study counties was $94 to which the CREP adds 40% which translates into an annual payment of $132. Using this payment in the estimated choice probability functions, while holding farmer characteristics at their sample means, we derive an estimated enrollment of 13 percent. Recall that 24% of the sampled landowners indicated they were already in a CREP filter strip contract and were not included in the model. Thus, the model result suggests that some landowners

Table 2
Programmatic, socio-psychological and demographic determinants of CREP enrollment.

Variables	Coefficient	*p*-value	Marginal effects	MRS[a]
Programmatic factors				
Year	−0.05	0.004	−0.06	$5.44
Refund (per 10%)	0.01	0.574	0.003	
Bonus (per $10)	0.03	0.269	0.001	
Rent (per $10)	0.09	0.0001	0.01	
Socio-psychological factors				
FS attitudes	0.80	0.0001	0.09	−$88.89
Envtal attitudes	0.79	0.004	0.08	−$87.22
Social norms	−0.27	0.304	−0.03	
Landowner characteristics				
Age	0.03	0.007	0.003	−$3.11
High school or less	0.08	0.807	0.01	
College or more	0.48	0.155	0.06	
Conservation experience	0.97	0.0001	0.12	−$108.22
Gender	−0.22	0.541	−0.03	
% Income from farming	0.002	0.698	0.0003	
Constant	−9.11	0.0001		
# of observations	930			
Log likelihood	−361.197			

[a] MRS is computed with respect to the annual rental payment.

indicate a willingness to enroll at payments that are already available to them. Why these landowners did not yet enroll, given the existence of the CREP is unclear. Although it is possible that the result reflects differences in how landowners might react to survey questions compared to actual decisions, enrolling in a CREP contract involves various transaction costs including learning about the program and the ability to undertake the requisite paperwork/documentation that we cannot easily account for. While our survey suggests over half the respondents had some awareness of CREP, we do not know how many were aware of the specific filter strip program and its payment terms. Finally, it is also possible that these landowners we modeled, i.e., the ones that are needed to increase CREP enrollment because they had not yet enrolled in CREP, are systematically different from those that have already chosen to enroll in CREP.

4.2.2. Effect of socio-psychological attributes

Although a key driver of landowners' participation decision, financial incentives are not the sole motivator for participation in the filter strip program. As the results demonstrate, non-economic factors such as socio-psychological characteristics also influenced agricultural landowners decision to participate in the program. As hypothesized, a positive attitude regarding the esthetics and water-quality improvement benefits of filter strips was generally associated with an increased likelihood of enrollment in the filter strip program. Although this study focuses on filter strips, this finding may suggest that the type of conservation practices eligible under an agri-environmental scheme and it is anticipated private benefits is an essential determinant of participation. As Ryan et al. (2003) and Januchowski-Hartley et al. (2012) noted, landowners tend to be concerned with private benefits of conservation practices on their lands and not just the financial benefits. This finding, as well as finding in previous studies (Januchowski-Hartley et al., 2012), may suggest that landowners may be more willing to participate in conservation programs whose eligible practices offer esthetics benefits, address resource concerns on their land, and allow them to project a sense of stewardship of the land. To this end, educating landowners about the on- and off-farm benefits of the various eligible practices under CREP could help increase enrollment.

Similarly, environmental attitudes were determined to be a motivator for landowners' participation in the filter strip program. The analysis revealed that landowners' reporting greater concern about the environment were significantly more likely to participate in the CREP filter strips program. This finding of a positive relationship between landowners' environmental concern and their likelihood of participating in CREP confirms similar results found elsewhere (Buckley et al., 2012; Howard and Roe, 2013). Considering that the primary goals of agri-environmental schemes like CREP include watershed protection and wildlife habitat restoration, it seems reasonable that a general concern about the environment would increase the likelihood of participation among landowners. Hence, reframing publicity information to appeal to landowners' environmental concerns could potentially increase participation in the program. Contrary to our expectations based on the literature (Chen et al., 2009a; Fielding et al., 2005), normative expectations and approval of behavior by others who are important to the decision maker did not significantly influence the likelihood of landowners participating in the filter strip program. Perhaps, normative expectation may not be an important factor in U.S. farmers' decision making as evidenced in a recent comparative study of Swiss and U.S. farmers (Celio et al., 2014). According to the authors, U.S. farmers were much more concerned about market related influences in their decision making relative to land use responsibility for Swiss farmers. Nevertheless, further research may be needed to better understand and characterize the appropriate empirical measures to represent social norms in future studies.

The trade-off analysis also confirmed the role that favorable attitudes toward the conservation practice and the environment had in influencing participation in filter strip program. The computed MRS indicates that a unit change in landowners' attitudes toward filter strips would make them indifferent to a change in annual soil rental payment of $88.9 all else equal. In other words, if a landowner's attitude toward filter strips positively increases by one unit on the likert-scale, they would be willing to accept a decrease in annual soil rental payments of $88.9 and participate in the program holding all other factors constant. Similarly, the trade-off analysis revealed that a unit change in landowners' attitudes toward the environment would make landowners indifferent to a decrease in annual soil rental payments of $87.2 holding all else equal. From these findings, it is apparent that investment in mechanisms that inspire positive attitudes toward the eligible practice and the environment could result in increase enrollment at reduced annual soil rental payments. However, changing landowners' attitudes toward conservation practices and the environment could be a complex and costly undertaking. Social psychologists report that people's attitudes are shaped by their personal knowledge of and experiences with the phenomenon as well as the social norms they attach

it (Myers, 2012). Hence, efforts aimed at influencing landowners' attitudes may require identifying and exposing eligible landowners to information and experiences that may inspire them to positively evaluate the conservation practice and the environment. Though feasible, such an undertaking can be associated with a very high transaction cost. Besides, some attitudes can be unstable and change with new information and experiences (Myers, 2012) suggesting a need for continual exposure to favorable information and experiences to maintain any desired positive attitude achieved. Also, taking into consideration that the reported mean attitudes toward filter strips and the environment on the five-point scale were 3.19 and 3.10 respectively and the relatively small variation around the means, there appears to be little room for improvement in those attitudes.

4.2.3. *Effect of landowner characteristics*

The analysis also explored the role of landowner characteristics as a determinant of participation in the filter strip program. The age of landowners was determined to positively influence the likelihood of participation in the filter strips program. This suggests that older landowners are more likely to enroll their lands in the filter strip program. The observed positive influence of age on likelihood of CREP enrollment is in contrast to findings of some previous studies (Baumgart-Getz et al., 2012; Vanslembrouck et al., 2002). Given that the average age of respondents (63 years), it is possible that older landowners may be viewing the program as a source of regular income stream as they approach retirement from active farming. On the other hand, younger farmers who can actively farm their land and potentially reap the benefits of increasing agricultural commodity prices may find the program offer less attractive. The result of the MRS calculations indicates that a year change in landowners' age makes them indifferent to a change in annual soil rental payment of $3.1 holding all things constant. That is, landowners who are 10 years younger would require an additional payment of $31 in annual soil rental payments in order to enroll their land in the filter strip program. Since landowners' age is not amenable to policy change, the finding may suggest targeting older farmers may be a useful strategy to increase participation.

Similar to findings of other studies (Schroeder et al., 2013), previous experience with similar agri-environmental schemes significantly influenced participation. The results indicate that landowners with previous experience in similar conservation programs such as EQIP and CSP were about 12% more likely to enroll in CREP filter strip program. This finding could be interpreted in multiple ways. First, it could be argued that previous experience in similar conservation programs induces positive attitudes toward government conservation programs resulting in increasing likelihood of participation. Alternatively, landowners' previous experience with conservation programs could be interpreted as an indicator of their satisfaction with the proposed CREP offer relative to similar conservation programs. In that case, the finding that previous experience in similar conservation practices enhances likelihood of enrollment in CREP could be interpreted as the attractiveness of CREP relative to other conservation programs. The trade-off analysis also revealed that landowners without experience in similar conservation programs would require an additional $108.2 in annual soil rental payment to be indifferent about enrolling in the program. Based on the computed MRS, targeting those landowners with previous experience in conservation programs appears a less costly endeavor to increase enrollment even if potential transaction cost associated with targeting are taken into account.

Previous studies also highlight education as a key determinant of participation in environmental behavior. Landowners' educational attainment is believed to influence their access to information regarding conservation practices and conservation programs, which is an essential precursor for enrollment (Vanslembrouck et al., 2002). However, as our results indicate, educational attainment of landowners, gender, and relative dependence of landowners' household on farm income did not significantly explain their likelihood to enroll in CREP. While the results do not support our initial hypothesis, it aligns with the findings of some previous studies (Baumgart-Getz et al., 2012). Researchers have generally noted an inconsistent relationship between farmer demographic variables and their conservation behavior (Burton, 2014; Prokopy et al., 2008). In a review of the adoption literature in the United States between 1980 and 2005, Prokopy et al. (2008) maintained that most of the commonly used demographic variables were insignificant or produced contradictory results in a majority of the studies that used them. Burton (2014) explains that such inconsistent relationships could be attributed to the presence of multiple causal pathways, features of the behavior under consideration, and their association with traditional farming behavior.

5. Conclusion and implications

Agri-environmental protection programs have the potential to promote adoption of best management practices by landowners on agricultural lands critical to protecting and enhancing water quality. However, this potential can only be realized if agricultural landowners are willing to enroll or continue to keep their croplands in such programs. This study has explored key programmatic, socio-psychological and demographic factors that shape agricultural landowners decision to participate in an agri-environmental scheme involving filter strips. Predictably, the results suggest that landowners' decision to participate in such a program is influenced by program characteristics such as annual soil rental payments and contract durations, as well as attitudes toward the eligible conservation practice and environmental concern. Also, previous experience with similar conservation programs and age of landowner were found to influence landowners' participation decision. The findings of this study need a few caveats. First, we recognize that not all farmers in the study area fall within the sample frame consisting of participants of the Farmland and Open Space Preservation program. Nevertheless, participants in the PA 116 program own/farm over 50% of the area's farmlands and the program's eligibility criteria yield farms and farmland that is comparable to others in the area. Hence, our results represent over half of the farmland in the area. We also recognize the limitations of our empirical model to best reflect the behavior of those landowners who may be unwilling to participate in the CREP program regardless of the program characteristics offered to them. A double hurdle model that first screens out such respondents before estimating the level of participation for the remaining respondents would be useful (see Ma et al., 2012). Although information collected in our study is insufficient to conduct such an analysis, we recommend it for consideration in future studies.

Nevertheless, the study results offer meaningful suggestions for increasing enrollment in voluntary BMP programs. First, the findings emphasized that financial incentives make a difference in landowners' decisions to enroll in BMP programs. Since increases in annual rental payments were determined to enhance the likelihood of landowners' enrollment, it is clear that participation in BMP programs could be enhanced if financial incentives are optimized for the target audience. The findings also suggest that one-time payments such as signing bonus and cost-share assistance for practice installation are not significantly influencing participation in the BMP program relative to the yearly payments. Hence, the results suggest that limited financial resources would be better allocated to increasing the rental payments rather than to increasing the one-time payments for BMP programs.

Another important mechanism to consider for improving enrollment in BMP programs is the duration of participation contracts. While long-term contracts are desirable in terms of sustained provision of the needed ecosystem services, this study suggests that longer contracts can be a deterrent to enrollment in BMP programs. Landowners generally indicated a preference for shorter contracts relative to longer ones. Hence, to boost enrollment, resource managers may consider shortening the duration of conservation practice contracts. Alternatively, landowners could be allowed to individually negotiate the duration of their contracts as opposed to having uniform conservation contract duration. While this may come with higher transaction cost and administrative burden, it will allow resource managers to capture all those who are currently being deterred from participation due to the predetermined contract duration and hence enhance participation rates. In addition, the results from our trade-off calculations indicate landowners' willingness to accept longer contracts in exchange for financial compensations in the form of yearly rental payments. Therefore, resource managers may also consider encouraging participation by adjusting the yearly rental payments upwards to levels that make landowners indifferent about additional contract years as program budgets allow. Increasing annual rental payment as a mechanism in exchange for longer contracts may not necessarily have to be program-wide. Such a strategy could be focused on securing longer contracts with landowners operating in areas where the greatest conservation benefits could be derived.

The results of this study suggest that it may be beneficial to educate landowners about the eligible conservation practices they are being asked to consider installing. This study suggests that a favorable view of the eligible conservation practices could induce participation in BMP programs. Generally, we found increases in the likelihood of participation with increasing perception that the eligible practice offers esthetics benefits on the land and improve water quality. As noted in some previous studies (e.g. Januchowski-Hartley et al., 2012), landowners might be concerned about both the private and social benefits of conservation practices they install on their lands. Hence, to increase participation in conservation programs, it may be helpful to educate eligible landowners not only about the social and environmental benefits of the eligible practices but also the private benefits such as improvement in esthetics and soil conservation improvements that such practices may provide on their land. This, in addition to clear and concise information on BMP program rules and associated payments, is likely to payoff in higher participation levels in conservation and ecosystem protection programs.

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