Farmers' Willingness to Participate in Best Management Practices in Kentucky

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Abstract: This article investigates farmers' willingness to participate in the best management practices (BMPs) through a proposed Water Quality Trading (WQT) program in Kentucky. This analysis includes two parts; the first part is to investigate the factors influencing farmers' current usage of BMPs; the second part is to estimate farmers' willingness to implement BMPs given different levels of compensation proposed through a survey. The results show that farmers who participate in conservation programs from the USDA are more likely to use BMPs, but these farmers may not accept the offer to implement additional BMPs. Farmers' perceptions about BMPs are more likely to convince them to adopt additional BMPs than the amount of compensation/cost-share offered through WQT. The results also find that the probabilities of fencing off animals and building up waste storage facility are positively correlated with the levels of compensation.

Key words: best management practices, conservation programs, contingent valuation method, water quality trading

JEL Code: Q25, Q51, Q52

Introduction

Water quality trading (WQT) programs are market-based programs that establish a mechanism that allows the party with higher abatement costs to purchase emission permits directly or indirectly from the party with lower abatement costs. As a result, those with higher abatement costs will abate less while those with lower costs will abate more but be compensated by the permit buyers. The overall goal is to maintain or improve the water quality in a watershed where the buyers and sellers of permits coexist (EPA 2004).

In WQT programs, agricultural nonpoint sources (NPSs) are the supplier of emission permits for two reasons. One of the reasons is that it is often cheaper for agricultural NPSs to abate than point sources (PSs). Another reason is that the traditional solutions to control PSs discharges are not available for agricultural NPSs (Segerson 1988). As an alternative, agricultural NPSs are encouraged to engage in Best Management Practices (BMPs) to abate discharge. This allows agricultural NPSs to supply water quality credits.

However, WQT programs are criticized that the trading markets often do not perform well, especially when trading involves agricultural NPSs (Ribaudo and Gottlieb 2011; OECD 2012). Shortle (2013) points out that most research in WQT programs focuses on market mechanism design but fails to understand the factors influencing farmers' engagement in BMPs and participation in WQT programs. This research investigates the factors affecting farmers' choices in BMPs through a proposed WQT program.

The purpose of this article is to explore farmers' willingness to implement BMPs in order to prepare them to participate in a proposed WQT program in Kentucky. A contingent valuation method (CVM) is used in this study through a survey of farmers in the Kentucky River watershed. The survey data were collected from 2011 to 2012. The WQT program did not exist in Kentucky when the data are collected, and does not exist so far. Since the WQT program is designed to offer farmers compensation to implement BMPs, the CVM question is whether the respondents will accept the offer of some compensation to use the BMPs specified by the WQT program. The BMPs featured in this article are riparian buffers, fencing off animals, no-till, waste storage facility, and nutrient management[1].

In this article, the empirical analysis includes two parts. The first part is to discuss who is participating in BMPs in Kentucky, and the empirical model investigates the factors influencing farmers' current usage of BMPs. The second part is to investigate who may participate in additional BMPs through WQT programs, so the empirical model estimates farmers' willingness to implement BMPs given different levels of compensation that could be offered through a WQT program. Other explanatory factors considered in this analysis are farms' characteristics, farmers' demographic characteristics, and environmental characteristics. The article is organized with following sections: literature review, data, theoretical model, empirical model, result, and conclusion.

Literature review

Few studies focus on understanding farmers' choice in WQT programs (Shortle 2013). One of the reasons is that most researchers are interested in market mechanism issues. Another reason is that the qualitative data are insufficient to support such an analysis. The assumptions made in previous research

[1] U.S. Department of Agriculture. Technical Resources-Conservation Practices: Alphabetical Index

are sometimes unrealistic. On the one hand, Windle et al. (2005) and Peterson et al. (2007) design choice experiments to investigate farmers' willingness to participate in WQT programs. Unfortunately, both studies do not conclude with any substantial statistical result, because the qualitative data in their surveys are insufficient to support statistical analysis. Instead, they only justify that farmers' preference in WQT programs could be examined by choice experiments using mixed logit model. On the other hand, Movafaghi, Stephenson and Taylor (2013) simulate the decisions of commercial cash grain farms to predict farmers' water quality credit supply response in Virginia's WQT program. In their model, they assume that the farms simulated have already achieved the baseline requirement. The baseline requirement is the minimum level of requirements that NPSs must first comply with if they wish to generate credits for trading. Thus, their results may not reflect the market response in the real world, because they do not include the farms below the baseline requirement in their model.

Following previous work, this study uses a survey with a contingent valuation question to investigate the factors influencing farmers' willingness to participate in BMPs through WQT programs. In this article, the work of Cooper and Keim's (1996) is followed closely. They estimate the factors encouraging farmers' adoption of BMPs, and predict the probability of farmers adopting practices as a function of the compensation. They use the bivariate probit with the sample selection model, and the double hurdle model in their econometric estimation and prediction, because the CVM question in their survey is conducted only if a farm is not currently using water quality practices. In our survey, the CVM question is conducted regardless of whether a farm is currently using BMPs in order to avoid sample selection issues. The details of the survey and data are discussed in the data section.

Data

In order to investigate the willingness to implement BMPs through WQT programs, a survey was conducted among farmers in the Kentucky River Watershed. The survey data were collected from randomly chosen farmers across 35 counties from 2011 to 2012. The response rate is 23%, and there are 357 valid observations out of 459 responses. The surveys' questions include current usage of BMPs, willingness to participate in BMPs, participations in environmental programs, farm's characteristics, and respondents' demographic characteristics. Table 1 presents all variables and summary statistics for the entire sample. Table 2 explains discrete levels in explanatory variables.

The CVM question is "Regardless of whether you are currently participating in any government cost share programs, if you knew that by using water quality management practices on your land, a nearby waste/sewage water treatment plant or factory will cover X% of your cost of implementing these practices, would you be interested in using additional water quality management practices (BMPs) in the form of the following activities: riparian buffers, fencing off animals, no-till, waste storage facility and nutrient management?" The amounts of compensation (X%) are 75%, 80%, 85%, 90%, 95%, 100%, 105%, 110%, 115% and 120%, and are randomly assigned with equal probability to the survey. Each respondent only saw one version of the survey with one level of compensation. In order to avoid the sample selection problem, CVM questions are asked regardless of whether a respondent is currently using the BMPs.

A respondent could answer "yes", "no", or "not possible for me" with respect to each practice. When farmers answer "not possible for me" with respect to a BMP, it indicates that this BMP is not applicable in their farm. If "not possible for me" were not provided in the survey, farmers, who could not implement BMPs in their farms because this practice is not applicable, would respond "no" to CVM questions. Thus, without the "not possible for me" option, answers may not reflect farmers' real preferences. The strategies to deal with "not possible for me" in the estimation are discussed in the empirical model. Table 3 presents the frequency of responses for willingness to adopt BMPs.

Furthermore, the survey is designed with different levels of information explaining the meaning of WQT programs. There are four levels of information in the survey. Basically, the higher the information level is, the more information explaining the WQT program was provided. One of the four levels of the information is randomly assigned with equal probability to the survey. This design is to examine whether the different levels of information will influence an individual's response. Results of the impact of information are useful but are not the focus of this article.

Theoretical Model

A farmer's choice is understood through random utility theory (McFadden 1974). U_a and U_b denote the individual utility from two choices, "yes" or "no". In this article, for the first part, "yes" means the respondent is currently using BMPs; "no" means otherwise. For the CVM question, "yes" indicates the respondent accepts the offer to implement BMPs through WQT programs; "no" indicates otherwise. Equation 1 is the utility functions of U_a and U_b.

$$U_a = x'\beta_a + \varepsilon_a \quad and \quad U_b = x'\beta_b + \varepsilon_b \quad (1)$$

In equation 1, x is a vector of observed variables in individual utility function, including compensation (C) offered from the survey; β is a vector of coefficients; ε is the $i.i.d.$ random variable with zero mean. If $U_a > U_b$, an individual will choose "yes", then the observed indicator y equals 1. If $U_a \leq U_b$, an individual will choose "no", then the observed indicator y equals 0. Therefore, the probability that an individual will choose "yes" could be written as equation 2 (Greene 2007).

$$\begin{aligned} Prob[y = 1|x] &= Prob[U_a > U_b|x] \\ &= Prob[x'\beta_a + \varepsilon_a > x'\beta_b + \varepsilon_b \ |x] \\ &= Prob[x'(\beta_a - \beta_b) + (\varepsilon_a - \varepsilon_b) > 0 \ |x] \\ &= Prob[x'\beta + \varepsilon > 0 \ |x] \qquad (2) \end{aligned}$$

In this article, the binary choice is estimated using a logit model. Thus, the probability function, equation 2, is rewritten as logistic cumulative distribution function, equation 3. The equation 4 is a mathematical representation of the binary logit model derived from equation 3.

$$Prob[y = 1|x] = \frac{e^{x'\beta}}{1 + e^{x'\beta}} \qquad (3)$$

$$\log\left[\frac{P(y = 1)}{1 - P(y = 1)}\right] = x'\beta \qquad (4)$$

Empirical Model

The empirical model includes two parts; the first part is to investigate the factors influencing farmers' current usage of BMPs. The second part is to estimate farmers' willingness to implement additional

BMPs given different levels of compensation and different levels of information explaining the meaning of WQT offered through the survey.

In this research, individuals who respond “not possible for me” are removed. The goal of research in this article is to look at farmers’ willingness to participate in BMPs through WQT programs. Apparently, policy makers are only interested in the responses from farms, who can feasibly implement BMPs. Thus, “not possible for me” is not a meaningful response in the choice model. Therefore, these infeasible farms are not included in the logit analysis of farmers’ willingness to participate in BMPs. After removing individuals who answer “not possible for me” with respect to each practice, the answer to the CVM question is still a binary choice with yes/no answers.

First part: current usage of BMPs models

The first part of the empirical model estimates farmers’ actual usage of BMPs. The survey question used in this part is “are you currently using any of the following water quality management practices on the farm you are operating?” Those practices are riparian buffers, fencing off animals, no-till, waste storage facility and nutrient management. The answer for each BMP is a binary choice, yes/no, and is estimated using logit models.

There are six models estimated in the current usage of BMPs models. One model uses pooled data of all types of BMPs included. If a farmer uses any of the five practices, the decision is a “yes”, otherwise “no”. The other five models are analyzed for each of the five different types of BMPs. Equation 5, derived from equation 4, is a mathematical representation of logit model estimating all of the current usage of BMPs models.

$$\log\left[\frac{P(y_i = 1)}{1 - P(y_i = 1)}\right] = \alpha_{i0} + (\sum_{n=1}^{N} \alpha_{in} x_n) \quad (5)$$

Where, $i = 1, 2, 3, 4, 5, 6$, each i also identifies a model, and there are six models in total.

N is the number of variables

α_{i0},and α_{in} are coefficients

Dependent variable: $y_1, y_2, y_3, y_4, y_5, y_6$

$P(y_1 = 1)$= probability of currently using any BMPs among riparian buffers, fencing off animals, no-till, waste storage facility and nutrient management

$P(y_2 = 1)$= probability of currently using riparian buffers

$P(y_3 = 1)$= probability of currently using fencing off animals

$P(y_4 = 1)$= probability of currently using no-till

$P(y_5 = 1)$= probability of currently using waste storage facility

$P(y_6 = 1)$= probability of currently using nutrient management

Independent variable: x_n

x_n= farm's characteristics, farmer's characteristics, environmental characteristics and targeted farms.

The dependent variable is the current usage of BMPs (1 if yes, 0 if no). Model 1 investigates the factors affecting farmers' current usage of any BMPs, so the binary dependent variable (y_1) is whether farmers are currently using any of the five BMPs in their farms. Models 2-6 investigate the factors affecting farmers' current usage of each type of BMPs. In these five models, the binary dependent variables (y_2, y_3, y_4, y_5 ,y_6) are whether farmers are currently using each of those BMPs: riparian buffers, fencing off animals, no-till, waste storage facility and nutrient management, respectively.

The explanatory variables include five groups: farm's characteristics, farmer's characteristics, environmental characteristics, and targeted farm. The same explanatory variables are used in models 1–6. Farm's characteristics include land size, rent percent, surface water, returns from farm, investment to farm, crop farm, and livestock farm. Farmer's characteristics include age, gender, education, income level, farming experience, and water recreation activities.

The environmental characteristics include farmers' participation in conservation reserve programs, participation in working-land programs, and farms' water quality. The Conservation Reserve Program

(CRP) is the land retirement program from conservation programs sponsored by the USDA. Participants in the CRP are compensated annually to retire environmentally sensitive land from agricultural production for 10 to 15 years. The Working-Land Program (WLP) is one of the conservation programs that encourage farmers to adopt BMPs on working-land to achieve environmental benefits. In our survey, the WLP includes the Conservation Stewardship Program, Environmental Quality Incentives Program, and Wildlife Habitat Incentives Program. The participations in CRP and WLP are examined by binary variables. Farm's water quality is a discrete variable rated by farmers themselves.

The targeted farmers include beginning farmers and socially disadvantaged farmers. The targeted farmers are defined as beginning (farming less than 10 years), limited-resource (farm gross sales less than $105,000), and socially disadvantaged (non-white) farmers. Thus, targeted farmers are examined in models by two dummy variables, non-white and beginning farmers. The variable income level is a proxy to approximate the targeted farmers with limited resources.

Second part: willingness to implement BMPs models

The second part of the empirical model estimates farmers' willingness to implement BMPs given different levels of compensation. The binary outcome is whether farmers will implement BMPs (1 if yes, 0 if no) through WQT programs, and is estimated using logit models.

In the willingness to implement BMP models, the empirical models include six models using equations 6 and 7, which are derived from equation 4. Using equation 6, model 7 investigates the factors affecting farmers' willingness to implement any BMPs. Thus, the binary dependent variable (y'_1) is whether farmers would accept the offer to use any BMPs among the five different types of BMPs (1 if yes, 0 if no). Using equation 7, models 8–12 investigate the factors affecting farmers' willingness to implement the five different types of BMPs. In these five models, the binary dependent variables (y'_2, y'_3, y'_4 ,y'_5, y'_6) represent whether farmers would accept the offer to implement each of the different types of BMPs, respectively, and those five practices are: riparian buffers, fencing off animals, no-till, waste storage facility and nutrient management.

$$\log\left[\frac{P(y'_{1}=1)}{1-P(y'_{1}=1)}\right]=\beta_0+\beta_1 C+(\sum_{n=1}^{N}\beta_{1n}x_n)+\theta_{11}y_1 \quad (6)$$

$$\log\left[\frac{P(y'_{i}=1)}{1-P(y'_{i}=1)}\right]=\beta_0+\beta_i C+(\sum_{n=1}^{N}\beta_{in}x_n)+(\sum_{n=2}^{6}\theta_{in}y_n) \quad (7)$$

Where, $i = 2,3,4,5,6$, each i also identifies a model, and there are five models in total.

β_0 , β_1, , β_{1n}, θ_{11}, β_i, β_{in} and θ_{in} are coefficients.

Dependent variable y'_1 y'_2, y'_3, y'_4 ,y'_5, y'_6

$P(y_1' = 1)$= probability of accepting the offer to implement any BMPs among riparian buffers, fencing off animals, no-till, waste storage facility and nutrient management

$P(y_2' = 1)$= probability of accepting the offer to implement riparian buffers

$P(y_3' = 1)$= probability of accepting the offer to implement fencing off animals

$P(y_4' = 1)$= probability of accepting the offer to implement no-till

$P(y_5' = 1)$= probability of accepting the offer to implement waste storage facility

$P(y_6' = 1)$= probability of accepting the offer to implement nutrient management

Independent variable C, x_n, y_1, y_n

x_n= farm's characteristics, farmer's characteristics, environmental characteristics, targeted farm and information level

y_1= a dummy variable which indicates a farm is currently using any BMP.

y_n= the dummy variables which indicate a farm is currently using riparian buffers (y_2), fencing off animals (y_3), no-till (y_4), waste storage facility (y_5), and nutrient management (y_6).

C= the percentage of compensation which will cover the cost of implementing the BMPs.

The explanatory variables include six groups: farm's characteristics, farmer's characteristics, environmental characteristics, targeted farms, compensation offers (C), information and the perception of BMPs (w_n). Except the perception of BMPs, all explanatory variables are the same in each model. The farm's characteristics, farmer's characteristics, environmental characteristics and targeted farms are identical to those of the first part. Compensation offers and information are obtained from the survey. Information is a categorical variable as a measure of information level provided in our survey. These information levels examined in each model are level 2, level 3, and level 4.

The current usage of BMPs is the proxy to measure the unobserved variable: perception of BMPs (y_1 , y_n). The perception of BMPs means farmers are currently using a BMP, so they have experience with BMPs. To be specific, in the willingness to implement any BMPs model (model 7), the perception variable (y_1) is a binary variable, which indicates a farm is currently using any of the five BMPs. In the willingness to implement the different types of BMPs model (models 8-12), perception variables (y_n) include five binary variables, which indicate a farm is currently using riparian buffers (y_2), fencing off animals (y_3), no-till (y_4), waste storage facility (y_5), or nutrient management (y_6). In addition, the cross-effect of adopting BMPs is examined through including the current usage of the five types of BMPs in models 8-12. The cross-effect of adopting BMPs means that using a type of BMPs would influence farmers to implement other types of BMPs in the future.

6. Results

First part: current usage of BMPs

Table 4 reports the results of logit models for farmers' current usage of BMPs. Model 1 is the current usage of any BMPs model; models 2-6 are the current usage of the five different types of BMPs models.

For farms' characteristics, the type of farms is a highly significant factor explaining the current usage of BMPs. Holding other factors constant, crop farms are more likely to use riparian buffers, no-till, and nutrient management; livestock farms are more likely to use fencing-off animals, since this BMP is designed for livestock farms. Besides, the results in farms' characteristics tell that the current usage of BMPs is also determined by returns from farms, rent area, and surface water on farmland.

For famers' characteristics, farmer's education and water recreation activities would affect the current usage of BMPs. Holding other factors constant, farmers with higher education prefer to adopt BMPs, especially adopting riparian buffers, no-till, and nutrient management. Farmers participating in water related recreation at least once a year would like to use BMPs, especially using riparian buffers. In addition, older farmers are more likely to build up waste storage facility. Male famers are less likely to use nutrient management. However, there is no evidence found that farming experience and farmers' income level is related to the current usage of BMPs. Featherstone and Goodwin's (1993), Lynch and Lovell (2003), and Núñez and McCann (2004) also conclude a similar result that the income level is not a determinant factor for conservation practices.

For environmental characteristics, participations in the CRP and the WLP are the important contributors to the current usage of BMPs, but the poor water quality near farms may not stimulate farmers to implement BMPs. The results show that farms participating in the WLP prefer to adopt fencing off animal and nutrient management; farms participating CRP tend to use no-till and fencing off animal.

In addition, no statistical evidence suggests that targeted farms have any special preference for BMPs. Also, 10 years of farming experiences is not a threshold period for farming decisions on BMPs. Socially disadvantaged farmers do not have any special preference for BMPs.

Second part: farmers' willingness to participate in BMPs through WQT programs

Table 5 presents the results of logit models for the willingness to participate in BMPs models. Model 7 is the willingness to participate in any BMPs model; models 8-12 are the willingness to participate in the different types of BMPs models.

Offer (C) is the most important variable in the willingness to participate in BMPs models. In expectation, compensations could influence farmers' participation in BMPs, so the offer (C) would be statistically significant with positive sign. Unfortunately, the estimation results show that the compensations do not change the probability of participation in the riparian buffers, no-till, and nutrient management, but only positively affect the probability of participating in fencing off animals and waste storage facility. At the bottom of Table 5, Wald test for offer (C) variables are given, and also confirms the results.

For farms' characteristics, farm size, rent area, surface water on farmland, investment on farms and farm types all play a role in participation in BMPs through WQT programs. Large-size farms are less likely to use fencing-off animals. Farmers who rent more farmland are less likely to implement no-till through WQT programs, but this result is opposite in the current using the BMPs model. Farms with surface water resources prefer to build up waste storage facility, because this practice is designed to prevent a farm to contaminate water flows. Famers investing large shares of income to their farms prefer to implement riparian buffers and build up waste storage facility through WQT programs. Livestock farms have no interest in implementing fencing off animals through WQT programs, but crop farms prefer to implement no-till and nutrient management through WQT programs.

For farmers' characteristics, the factors affecting farmers' willingness to implement BMPs are age, gender, farming experiences, education and water recreation activities. Specifically, older farmers may refuse to implement fencing-off animal, no-till and nutrient management through WQT programs. Male farmers prefer to use fencing-off animal. Farmers with more farming experience tend to adopt no-till through WQT programs, but may refuse to use riparian buffers on their farms. Farmers with higher education are more likely to use no-till and nutrient management. Farmers with water related recreation at least once a year prefer to adopt riparian buffers, fencing-off animals, and no-till.

For environmental characteristics, the results show that participations in conservation programs could not influence farmers to implement BMPs through WQT programs, but the water quality near the farm could. Farmers participating in the CRP would decline the offer to use no-till. Farms participating in the WLP are less likely to accept the offer to adopt nutriment management. Farms with the CRP prefer to build up waste storage facility through WQT programs. Although conservation programs are the important contributors to the current usage of BMPs in Kentucky, there is no statistical evidence found that these programs would encourage farmers to implement BMPs through WQT market in the future, except for the waste storage facility. However, water quality near the farm could stimulate farmers to implement BMPs through WQT programs. The poor water quality near the farm would lead farmers to use riparian buffers, fencing-off animal, no-till and waste storage facility in the future, but could not influence the current usage of BMPs.

One interesting finding among environmental characteristics shows that the coefficient of the CRP is significant with negative sign in the willingness to implement the no-till model but is significant with positive sign in the current usage of the no-till model. In other words, it implies that if farmers participate in the CRPs, they are more likely to use no-till currently but are less likely to use no-till through WQT programs in the future. One possible explanation is that farmers with the CRP have already adopted no-till as much as they could, so there is no eligible land for them to expand the scope of this practice.

The perception of BMPs has a significant effect on encouraging farmers to implement BMPs through WQT programs. If farmers are currently using a BMP in their farm, they are more likely to use the same BMP through WQT programs in the future, except for waste storage facility. In addition, the results find several cross-effects among the different types of BMPs. If farmers are currently using waste storage facility on the farm, they may not adopt riparian buffers in the future. If farmers are currently adopting riparian buffers, they will probably refuse the offer for no-till. If farmers are currently using nutriment management, they tend to use no-till through WQT programs.

For the targeted farms, most results are similar to the ones in the current usage of the BMPs model. There is no statistical evidence found that targeted farms have special preferences to the implementation of BMPs currently and in the future, except that beginning farmers prefer to implement nutrient management through WQT programs.

Conclusion

This article explores the willingness to participate in the Best Management Practices (BMPs) through Water Quality Trading (WQT) programs in Kentucky. This article aims to investigate who is participating in BMPs and who may implement additional BMPs through WQT programs in Kentucky. The study includes two parts. The first part is to investigate the factors influencing farmers' current usage of BMPs. The second part is to estimate farmers' willingness to participate in BMPs through WQT programs given different levels of compensation offered through the survey.

In the first part, the most significant result is that farmers already participating in conservation programs are more likely to use BMPs currently. Besides, the farm's type affects farmers' current usage of BMPs. The result also confirms that the source of income could influence the current usage of BMPs but income level could not. Furthermore, targeted farms do not have any special preference to adopt BMPs, and 10 years of farming experience is not a threshold period for farming decisions on using BMPs.

In the second part, the most important finding is that higher compensations from WQT programs only encourage farmers to implement fencing off animals and build up waste storage facility. Another interesting finding is that the perception about BMPs is more effective to influence farmers to implement BMPs than the compensation. In contrast to the result in the first part, farmers participating in the CRP or WLP have no interest in implementing BMPs. This will help policy makers facilitate trading market.

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Table 1. All Variables and Summary Statistics for the Entire Sample (N=357)

Variable	Definition of Variables	Mean	Std. Dev.
Current BMPs adoption:			
y_1	Currently using any BMPs (=1); otherwise (=0)	0.739	0.44
y_2	Currently using riparian buffers (=1); otherwise (=0)	0.367	0.483
y_3	Currently using fencing off animals (=1); otherwise (=0)	0.465	0.499
y_4	Currently using no-till (=1) ; otherwise (=0)	0.311	0.464
y_5	Currently using waste storage facility (=1) ; otherwise (=0)	0.067	0.251
y_6	Currently using nutrient management (=1) ; otherwise (=0)	0.241	0.428
Cost coverage compensation:			
Offer	The percentage of treatment plant or factory will cover the cost of implementing the BMPs if the farmer uses the additional BMPs, there are 10 different levels of compensation. Those levels are 0.75, 0.8, 0.85, 0.9, 0.95, 1, 1.05, 1.1, 1.15 and 1.2.	0.97	0.15
Explanatory variables:			
Land size	Land size for operating includes renting size for operating and owning size for operating. (unit: 1000 acre)	0.282	0.537
Rent percent	Rent size for operating / Land size for operating	0.142	0.275
Surface water	Surface water on farmland (=1) ; otherwise (=0)	0.86	0.348
Returns from farms	Share of pre-tax household income from farming (see table 2)	2.417	1.815
Investment to farms	Share of pre-tax household income back to farming (see table 2)	2.529	1.542
Crop farms	Farms earning revenue from crop or farmers planting crop in their land (=1) ; otherwise (=0)	0.423	0.495
Livestock farms	Farms earning revenue from livestock or farmers raise livestock (=1) ; otherwise (=0)	0.798	0.402
Age	Farmer’s age	60.154	11.908
Male	Male =1; otherwise (=0)	0.857	0.35
Education	The education level of farmer (see table 2)	4.078	1.92
Income level	The household annual pre-tax income level (see table 2)	4.359	1.499
Farming experience	Farming experience (year)	32.22	15.307
Water recreation	Participating in water related recreation at least once a year (=1) ; otherwise (=0)	0.661	0.474
CRP	Currently participating in Conservation Reserve Program (CRP) (=1) ; otherwise (=0)	0.118	0.323
WLP	Currently participating in Working-land Program (WLP) (=1); otherwise (=0). WLP includes Conservation Stewardship Program (CSP), Environmental Quality Incentives Program (EQIP), Wildlife Habitat Incentives Program (WHIP)	0.204	0.404
Water quality	The water quality nearest to farmers’ property	5.038	1.365
Targeted farmers:			
Beginning farmers	Farming less than ten years (=1) ; otherwise (=0)	0.12	0.326
Non-white	Operator’s race is not white (=1) ; otherwise (=0)	0.045	0.207
Information: The survey was designed with 4 levels of information explaining the meaning of WQT programs			
Level 1	The least detailed information level (=1); otherwise (=0)	0.235	0.425
Level 2	The less detailed information level(=1); otherwise (=0)	0.261	0.44
Level 3	The more detailed information level(=1); otherwise (=0)	0.21	0.408
Level 4	The least detailed information level(=1); otherwise (=0)	0.294	0.456

Note: the discrete levels in table are interpreted in table 2.

Table 2. the Explanation for Discrete Levels of Variables

Level	Returns from farms	Investment to farms	Education	Income level ($)	Water Quality
1	0-15%	0-15%	Not a high school graduate	0 to 14999	Lowest quality
2	16-30%	16-30%	High school graduate	15000 to 24999	Lower quality
3	31-45%	31-45%	Some college, no degree	25000 to 49999	Low quality
4	46-60%	46-60%	Associate degree	50000 to 74999	Fair quality
5	61-75%	61-75%	Bachelor degree	75000 to 99999	High quality
6	75-90%	75-90%	Master degree	100000 to 149999	Higher quality
7	above 90%	above 90%	Professional degree	above 150000	Highest quality
8	-	-	Doctorate	no response	-

Table 3. Frequency of responses for willingness to adopt BMPs

BMPs	N	Frequency of responses		
		Yes (=1)	No (=0)	Not possible for me (=2)
All BMPs included (y_1')	234	22.41%	19.33%	58.26%
Riparian buffers (y_2')	149	17.37%	33.61%	49.02%
Fencing off animals (y_3')	182	18.77%	31.09%	50.14%
No-till (y_4')	178	22.69%	19.61%	57.7%
Waste storage facility (y_5')	151	18.49%	30.81%	50.7%
Nutrient management (y_6')	176	22.41%	19.33%	58.26%

Table 4. First Part: Logit Models for Current Usage of BMPs

	(1) All BMPs included	(2) Riparian Buffers	(3) Fencing off animals	(4) No-till	(5) Waste storage facility	(6) Nutrient management
Farms' characteristics:						
Land size	1.382	0.451	-0.134	0.434	-0.128	0.293
	(0.889)	(0.346)	(0.235)	(0.276)	(0.557)	(0.230)
Rent percent	0.161	0.00896	0.114	0.956*	0.708	0.496
	(0.632)	(0.485)	(0.472)	(0.497)	(0.878)	(0.517)
Surface water	-0.279	0.995**	0.373	-0.428	0.0185	-0.824**
	(0.408)	(0.452)	(0.368)	(0.391)	(0.822)	(0.390)
Returns from farms	0.233*	0.0888	0.0155	0.202**	0.0420	0.0173
	(0.132)	(0.0895)	(0.0883)	(0.0945)	(0.161)	(0.0969)
Investment to farms	0.112	0.0344	0.0329	0.0272	0.268	0.194*
	(0.137)	(0.104)	(0.104)	(0.112)	(0.178)	(0.114)
Crop farms	1.027***	0.783***	0.0986	1.187***	0.0152	0.627**
	(0.335)	(0.258)	(0.256)	(0.278)	(0.482)	(0.291)
Livestock farms	1.016***	0.116	2.148***	0.487	1.550	0.168
	(0.373)	(0.339)	(0.410)	(0.364)	(1.073)	(0.385)
Farmers' characteristics:						
Age	-0.0175	-0.0117	0.00272	0.0168	0.0568**	-0.00778
	(0.0154)	(0.0134)	(0.0131)	(0.0146)	(0.0275)	(0.0147)
Male	0.177	0.484	0.0465	0.317	0.135	-0.584
	(0.424)	(0.403)	(0.362)	(0.426)	(0.857)	(0.389)
Education	0.269***	0.216***	0.0964	0.154**	-0.0782	0.284***
	(0.0871)	(0.0723)	(0.0703)	(0.0775)	(0.133)	(0.0812)
Income level	0.0448	0.00345	0.0538	0.111	0.0961	0.0472
	(0.111)	(0.0944)	(0.0909)	(0.102)	(0.169)	(0.106)
Farming experience	-0.0132	0.00581	-0.0124	-0.00521	-0.00997	0.000179
	(0.0146)	(0.0128)	(0.0128)	(0.0138)	(0.0237)	(0.0147)
Water recreation	0.809***	0.637**	0.244	0.294	0.0508	0.281
	(0.305)	(0.275)	(0.258)	(0.295)	(0.509)	(0.312)
Environmental characteristics:						
CRP	1.810**	0.0510	0.670*	1.270***	0.662	0.346
	(0.795)	(0.392)	(0.397)	(0.401)	(0.538)	(0.410)
WLP	1.410***	0.494	0.925***	0.126	0.733	0.764**
	(0.543)	(0.310)	(0.318)	(0.336)	(0.505)	(0.328)
Water quality	0.0733	0.0667	0.0291	-0.0501	0.174	-0.0960
	(0.106)	(0.0957)	(0.0894)	(0.101)	(0.188)	(0.104)
Targeted farmers:						
Beginning farmers	-0.297	-0.433	-0.241	0.304	0.372	0.332
	(0.558)	(0.503)	(0.477)	(0.510)	(1.005)	(0.519)
Non-white	0.176	-0.239	0.503	0.213	-0.0841	0.496
	(0.664)	(0.651)	(0.587)	(0.636)	(1.163)	(0.675)
Constant	-1.898	-3.975***	-3.404***	-4.710***	-9.770***	-2.145*
	(1.296)	(1.146)	(1.099)	(1.221)	(2.349)	(1.183)
N	357	357	357	357	357	357
pseudo R^2	0.263	0.154	0.152	0.197	0.143	0.158

Note: Standard errors in parentheses; *, * and *** imply the significant level at the 1%, 5%, and 10%, respectively.

Table 5 Second Part: Logit Models for Willingness to Participate in BMPs

	(7) All BMPs included	(8) Riparian Buffers	(9) Fencing off animals	(10) No-till	(11) Waste storage facility	(12) Nutrient management
Cost coverage compensation:						
Offer	2.326	2.067	2.751*	1.417	2.920*	2.388
	(1.962)	(1.627)	(1.592)	(1.770)	(1.629)	(1.602)
Farms' characteristics:						
Land size	-0.00196	-1.106	-1.818*	0.726	0.0148	-0.123
	(0.393)	(0.933)	(0.969)	(0.825)	(0.402)	(0.295)
Rent percent	-0.786	1.252	0.519	-1.820*	0.0399	0.305
	(1.056)	(1.145)	(0.927)	(1.045)	(0.790)	(0.868)
Surface	0.476	0.476	-0.898	0.159	1.297*	0.0566
water	(0.721)	(0.766)	(0.756)	(0.873)	(0.723)	(0.719)
Returns	0.197	-0.147	0.407*	0.135	-0.159	0.107
from farms	(0.232)	(0.178)	(0.217)	(0.208)	(0.155)	(0.179)
Investment	0.244	0.623***	0.144	0.0555	0.548***	0.261
to farms	(0.250)	(0.204)	(0.240)	(0.206)	(0.184)	(0.191)
Crop farms	1.333**	-0.274	0.0439	1.511***	-0.0377	0.956**
	(0.612)	(0.508)	(0.532)	(0.567)	(0.452)	(0.466)
Livestock	-0.666	-0.491	-0.676	-2.088**	-0.383	-0.527
farms	(0.780)	(0.672)	(0.722)	(0.846)	(0.663)	(0.800)
Farmers' characteristics:						
Age	-0.0350	-0.00691	-0.0747**	-0.105***	-0.0194	-0.0425*
	(0.0297)	(0.0268)	(0.0293)	(0.0339)	(0.0230)	(0.0255)
Male	1.123	0.0312	2.085***	-0.425	-0.929	-0.106
	(0.803)	(0.769)	(0.768)	(0.862)	(0.804)	(0.736)
Education	0.107	0.130	0.411***	0.0170	0.0394	0.250*
	(0.158)	(0.137)	(0.155)	(0.160)	(0.123)	(0.150)
Income level	0.0177	-0.0832	0.00412	0.185	-0.182	-0.0270
	(0.210)	(0.182)	(0.172)	(0.185)	(0.160)	(0.189)
Farming	-0.0136	-0.0486**	0.0239	0.0655**	-0.0134	0.0150
experience	(0.0272)	(0.0243)	(0.0251)	(0.0287)	(0.0218)	(0.0223)
Water	0.434	1.527***	1.113**	1.160**	-0.0597	0.586
recreation	(0.546)	(0.517)	(0.499)	(0.562)	(0.473)	(0.486)
Environmental characteristics:						
CRP	-	-0.282	0.436	-2.378***	1.080*	1.171
	-	(0.733)	(0.872)	(0.855)	(0.629)	(0.846)
WLP	-0.742	-0.0758	0.0762	0.303	0.570	-1.039*
	(0.639)	(0.582)	(0.626)	(0.597)	(0.488)	(0.632)
Water	-0.755***	-0.376**	-0.851***	-0.505***	-0.324**	0.00640
quality	(0.262)	(0.183)	(0.224)	(0.195)	(0.165)	(0.186)
Perception of BMPs:						
y_1	2.450***	-	-	-	-	-
	(0.659)	-	-	-	-	-
y_2	-	1.308**	0.0692	-1.579***	0.108	0.0542
	-	(0.515)	(0.510)	(0.602)	(0.467)	(0.520)
y_3	-	0.619	2.963***	0.887	0.356	0.360
	-	(0.498)	(0.601)	(0.548)	(0.458)	(0.527)
y_4	-	0.853	-0.122	3.899***	0.456	1.543**
	-	(0.584)	(0.674)	(0.829)	(0.557)	(0.607)
y_5	-	-2.772**	1.720	0.529	0.396	-1.699
	-	(1.148)	(1.134)	(1.026)	(0.699)	(1.035)
y_6		-0.547	-0.948	-0.517	-0.168	2.174***
		(0.554)	(0.622)	(0.660)	(0.537)	(0.656)

(Continued)

Table 5. Continued

	(7) All BMPs included	(8) Riparian Buffers	(9) Fencing off animals	(10) No-till	(11) Waste storage facility	(12) Nutrient management
Targeted farmers:						
Beginning farmers	0.520	-0.326	0.354	0.688	1.034	1.771*
	(1.248)	(0.942)	(1.018)	(1.044)	(0.852)	(0.927)
Non-white	2.401	0.670	2.832	2.984	2.654	2.284
	(1.921)	(1.697)	(3.050)	(2.082)	(1.664)	(2.027)
Information level:						
Level 2	1.482*	0.537	2.154***	0.803	0.981*	1.768***
	(0.865)	(0.663)	(0.783)	(0.663)	(0.577)	(0.667)
Level 3	0.364	0.133	0.157	1.011	1.416**	1.136
	(0.750)	(0.703)	(0.720)	(0.747)	(0.679)	(0.710)
Level 4	0.335	0.113	-0.295	-0.513	0.717	1.100*
	(0.649)	(0.628)	(0.593)	(0.642)	(0.627)	(0.650)
Constant	1.444	-1.405	0.658	4.199	-1.636	-4.206
	(3.261)	(2.991)	(2.821)	(3.346)	(2.736)	(2.873)
N	234	149	182	178	151	176
pseudo R^2	0.355	0.329	0.432	0.454	0.224	0.381
Wald Test : Offer						
chi2(1)	1.41	1.61	2.99	0.64	2.95	2.22
P value	0.2358	0.2039	0.0839	0.4233	0.0730	0.1361

Standard errors in parentheses; *, * and *** imply the significant level at the 1%, 5%, and 10%, respectively.
Note: In model (7), the CRP in environmental characteristics is omitted because of collinearity.