Choice Experiments to Assess Farmers' Willingness to Participate in a Water Quality Trading Market

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Abstract

Interest has grown in Water Quality Trading (WQT) as a means to achieve water quality goals, with more than 70 such programs now in operation in the United States. Substantial evidence exists that nonpoint sources can reduce nutrient loading at a much lower cost than point sources, implying the existence of gains from trade. Despite the potential gains, however, the most commonly noted feature of existing WQT markets is low trading volume, with many markets resulting in zero trades. This paper evaluates one explanation for the lack of participation from agricultural nonpoint sources. We test for and quantify the "intangible costs" that may deter farmers from trading even if the monetary benefits from doing so outweigh the observable out-of-pocket costs. We do so by designing and implementing a series of choice experiments to elicit WQT trading behavior of Great Plains crop producers in different situations. Attributes of the choice experiment included market rules and features (e.g., application time and effort, penalties for violations, means of monitoring compliance) that may affect farmers' willingness to trade. The choice experiments were conducted with a total of 135 producers at four locations in the state of Kansas between August 2006 and January 2007. A Random Parameters Logit model is appropriate to analyze the resulting data, revealing diversity in the way that the attributes affect farmers' choices.

Choice Experiments to Assess Farmers' Willingness to Participate in a Water Quality Trading Market

Water Quality Trading (WQT) has received increased attention as a means to achieve water quality goals. Several such trading programs have been adopted in several states throughout the nation, with more than 70 programs now in operation (Breetz et al., 2004). In principle, such programs could be applied to any water-borne pollutant and allow trading among point sources, among nonpoint sources, or between point and nonpoint sources (the latter is known as ‘point-nonpoint trading’). Most of the existing programs are designed with point-nonpoint trading to limit nutrient loading: point sources are allowed to meet their nutrient emission limits by purchasing water quality credits from agricultural producers in the surrounding watershed. These producers are then obligated to implement a best management practice (BMP) that reduces expected nutrient loading by an amount commensurate with the number of credits sold.

Substantial evidence exists that nonpoint sources can reduce nutrient loading at a much lower cost than point source polluters in many watersheds. This suggests that a well functioning WQT program would be a more cost-effective strategy for meeting total maximum daily load requirements than regulating point source polluters alone (Faeth, 2000). The potential for pollution trading to lower control costs has already been realized in the active air quality trading markets (NCEE, 2001).

Despite the potential gains from WQT, perhaps the most commonly noted feature of existing programs is low trading volume; none of the programs have had extensive trading activity and many have had no trading at all (Hoag and Hughes-Popp, 1997). Our particular interest in this paper is the participation of nonpoint sources, almost always agricultural crop producers in existing programs. The reluctance of farmers to participate in WQT reflects a broader reluctance to adopt environmental practices in exchange for monetary payments (e.g., Cooper and Keim 1996).

Evidently, farmers perceive some intangible costs of participating in WQT markets that are not offset by the monetary gains from trading. These costs may include the disutility of the managerial effort required to maintain BMPs, and/or a distaste for the WQT market procedures and rules. For example, farmers may object to the intrusiveness of being inspected or monitored to ensure their BMP is in place, or find the process of signing up for the program to be too onerous.

Although the existence of intangible costs is apparent from empirical evidence, the factors giving rise to these costs are not well understood. The objective of this paper is to quantify the impact of different institutional factors on farmer's stated behavior in a WQT market. In particular, we wish to determine the importance – relative to monetary trading income – of various WQT market attributes on farmers' willingness to participate in such a market. The magnitude of these factors will provide information about how to design a program to encourage participation and, more broadly, will identify the situations where a WQT market is feasible given that certain rules are necessary.

The method of choice experiments is well suited to our research question. Choice experiments were originally developed in the marketing literature in order to determine the implicit market value of various product attributes. Subjects in these experiments make a choice from a side-by-side comparison of 3 or more products, which vary by different attributes including price. The choice data is then analyzed using discrete choice regression models, such as conditional logit, to estimate the effect of each attribute on the probability that the consumer chooses the product. This method has been widely adopted by environmental economists studying choice behavior related to environmental quality, such as selection of recreation sites (e.g., Adamowicz et al., 1997) and housing location (e.g., Earnhart, 2001). Economists studying agricultural markets have also applied the method to understand the attributes of food products influencing consumers' shopping choices (e.g., Fox et al., 2002).

This paper describes a set of choice experiments designed to elicit WQT trading behavior of Great Plains crop producers in different situations. In our case, the attributes to be varied across choices are the features of trading, such as the effort required for signup and the monitoring the farmer would need to undergo. Choice experiments were conduced in person with producers at events in different locations in Kansas from August 2006 through January 2007.

Experimental Design

The purpose of our experiments is to identify market rules and attributes that influence farmers' willingness to participate in a point-nonpoint WQT market. After reviewing the operations of existing programs and consulting with Extension personnel and a small group of farmers in Kansas, we identified four market attributes that are likely to affect participation: (1) application time and effort, (2) the monitoring method, (3) penalties for violations, and (4) the BMP to be adopted. Embedded within the definition of BMPs is another key attribute: the degree of flexibility a farmer would have in fulfilling his trading obligations. As noted above, the price of credits is an additional explicit attribute, which will ultimately allow us to compute the implicit values of the other four. These attributes are listed in Table 1 and are described in more detail below.

By designing our experiments with different levels of our five attributes, we generate a dataset that allows us to test whether the institutional attributes affect trading choices, and if so, the magnitude of these impacts relative to price. Farmers were asked to choose among different opportunities to trade, which varied across the five attributes. Such choice scenarios would arise in an actual trading program, for example, if a WQT program were established in some region that allowed buyers to spell out the terms of the trading contract. Different buyers would then develop different contracts suiting their needs, giving rise to a range of trading opportunities for farmers. In the choice experiment method, the attributes are varied systematically based on experimental design principles, so that the resulting dataset maximizes statistical efficiency. In what follows, we describe the attributes we vary in our choice experiments and then explain the procedures we followed to design our choice sets.

Design Attributes

This section describes each of the attributes varied in our experiments and rationale for the levels we selected (Table 1). As noted above, trading opportunities are defined as different combinations of these attribute levels. A sample choice scenario presented to farmers is in Figure 1. Each scenario asks farmers to choose one of two trading opportunities, labeled Option A and Option B, or else choose Option C - “do not enroll.” To facilitate comparison, all trading opportunities were assumed to be for a 10-year contract on a 100-acre field.

The first attribute in the choice experiment is Application Time. This refers to the amount of time a potential seller would have to spend to establish his eligibility to enter into a WQT contract. This time would be expended on such activities as meeting with the staff of the entity managing the market, compiling data on the field to be enrolled, and filling out paperwork. Application Time would vary depending on the complexity of the program and the desires of the buyer in the contract. We set this attribute to vary from 4 to 40 hours to enroll a 100-acre field, a range we assumed was large enough to capture a wide range of contract complexity.

The Monitoring Method has two categorical levels. If Monitoring Method = Annual Verification, then farmers entering into a contract would be visited at an unannounced time each year to ensure they are meeting the terms of the contract. The field where the contracted BMP is to be installed would be inspected to verify that the practice is being implemented and maintained as agreed. If Monitoring Method = Spot Check, then the farmer would be visited with a 10% probability each year, implying that one visit would occur during an average 10-year contract period. If visited, the type of inspection would be the same as with Annual Verification. These two possibilities reflect varying levels of “intrusiveness” the seller must be willing to accept.

The Penalty is a one-time fine to be paid if the seller is found in violation of the contract. Levels of this attribute range from \$50/acre to \$500/acre, a sufficiently wide variation to ensure that farmers would not find it rational to “plan on cheating” and paying the fine when caught. For example, under the Spot Check system of monitoring, the upper end of this range produces an expected penalty from cheating of \$50/acre/year. This exceeds the maximum revenue that could be earned from entering into a contract (\$25/acre/year - see below), which is also the maximum possible gain from cheating on a contract.

The BMP is the fourth attribute, which takes on four categorical levels indicating four distinct BMPs. The four BMPs vary along two dimensions. The first dimension is the type of practice – the farmer must either install a filter strip or implement no-till. The second dimension is the level of flexibility the farmer would have in meeting his contract obligations. In the case of filter strips the more flexible option would allow farmers to hay and or graze the filter-designated area. For no-till, flexibility comes in the form frequency of use – "rotational no-till" allows for some other tillage practice in 5 out of the 10 years under contract. We designed our scenarios so that Option A was always of the filter strip variety and Option B was always of the No-till variety. This reduces the number of degrees of freedom in our experimental design, by effectively reducing this four-level attribute to a two-level attribute.

The BMPs will be a significant determinant of farmers' choice if they value flexibility, or if they perceive differences in implementation costs. One complication in comparing the BMPs is that filter strips involve up-front installation costs: the land for the filter strip must be tilled, leveled, and seeded to grass in the first year. On the other hand, KSU Extension crop budgets indicate an expected cost of zero for a typical Kansas farmer to implement no-till. To make this comparison more straightforward for respondents, they were told that the installation costs of filter strips would be covered from "an outside source." This is not unrealistic, as cost share funds from both state and federal programs are available to pay for installing buffer strips statewide.

Another reason we removed the installation costs was to focus the respondent's attention on comparing the ongoing managerial costs of the practices. To clarify the managerial costs of each of these practices, farmers were given specific definitions of the practices along with a list of maintenance responsibilities. "100% No-till," for example, was defined as the tillage practice where the only equipment that breaks the soil surface is a planter, and this occurs at most once annually. For filter strips, the maintenance requirements were to regularly check for and repair any gullies that develop, to avoid using the filter strip as a roadway, and to avoid broadcast application of chemicals or manure in the filter strip area.

The final attribute is trading revenue, or the price per credit multiplied by the number of credits generated from the BMP. We varied trading revenue from $3/acre/year to $25/acre/year, following the range used by Cooper and Keim (1996) and Cooper (1997). Each BMP was assumed to generate a fixed number of credits (Table 2), and the price per credit was calculated in each scenario so that price times credits equaled the specified revenue level. For example, in Option A of the scenario shown in figure 1, our experimental design called for a revenue of $15/acre/year and a BMP of Filter Strip (with haying/grazing), a practice which would generate 6 credits/acre (Table 2).The price per credit was then calculated as $15/6 = $2.50. As described below, we generated 32 different choice sets encompassing 64 distinct trading choices. Across all 64 choices, the variation in credits (see table 2) combined with the variation in revenue ($3-$25) produced a variation in the price per credit of $0.25 to $5.00.

Design Procedures

As noted above, our experimental subjects were to respond to choice sets, each of which contains two trading opportunities with five attributes. Thus there are a total of ten attributes to be varied across choice sets. Our experimental design problem is to construct a collection of choice sets by systematically varying these 10 factors. 6 of these factors have 4 levels and the remaining 4 have 2 levels, implying that a complete factorial spanning all possible combinations these factors would require 65,536 distinct choice sets – obviously a prohibitive number of scenarios to present to respondents.

We used the SAS %MktRuns macro (Kuhfeld, 2005) to identify the minimum number of choice sets in an orthogonal main effects design. An orthogonal main effects design is a small sample of all combinations in the full factorial, where the chosen combinations exhibit a zero correlation among the attributes. The smallest orthogonal main effects design contains 32 choice sets, and such a design was constructed using the SAS %MktEx macro (Kuhfeld, 2005). The choice sets were then blocked into two sets of 16, so that our choice experiment came in two versions. The choice sets in our design are shown in table 3.

Data

Collection Procedures

Our choice experiments were conducted in person with farmers at different producer-oriented conferences in Kansas. A total of 135 subjects completed the experiment at four different events between August 2006 and January 2007 (Table 4). The Risk and Profit Conference is an annual event hosted by the Agricultural Economics Department at KSU, drawing participants from all around the state. The second event was a statewide Farm Bureau conference, in January 2007 in Wichita. The Agricultural Profitability Conferences are run by KSU Extension economists at various locations around the state in winter months, and mainly draw regional audiences (Colby and Smith Center are in western and central Kansas, respectively). The Farm Bureau conference is also a statewide event. The events were chosen in part to ensure a representative geographic distribution of farmers across the state.

Our data collection procedures at all these events were as follows. First, experimental subjects were recruited via a pre-registration mailing and an announcement at the opening conference session. The choice experiment itself was conducted during a 1-hour session, typically scheduled as a parallel session in the conference program. During this session, subjects wewre first shown a brief presentation on the concept of Water Quality Trading, followed by instructions to complete the choice experiments.

The instructions include much the same information as in the Design Attributes section above. A hypothetical situation was first described, in which subjects are asked to imagine that a WQT program had been developed in their region with different buyers giving them different types of opportunities to sell credits. The opportunities varied along five dimensions (the attributes in table 1). These attributes and their various levels were then explained. BMPs were explained in more detail than the other attributes to ensure that the producers understood what their contract responsibilities would be under each. Finally, the respondents were shown an example choice set to give them practice in completing the experiment.

After allowing for clarification questions, the subjects then filled out a booklet with 16 choice sets. A printed copy of the background and instruction slides were also provided to subjects for their reference, and the instructions were also summarized at the beginning of the booklet. Each choice set in this booklet is followed by an open-ended question asking, “Why did you make this choice?” As explained in more detail below, these qualitative responses were helpful in choosing our econometric specification. After completing the booklet each subject completed a questionnaire eliciting information on his/her farm operation, his/her attitudes toward water quality issues and policies, and demographic data. Copies of all materials used in these sessions are available from the authors.

After the instruments have been completed, each subject was paid an honorarium of $50 in cash. This is announced in the pre-registration mailing and at the opening conference session to encourage participation. Our data collection procedures and instruments were pre-tested with a small group (12) of producers from the Great Plains.

Questionnaire Data

Summary statistics from the questionnaire responses (*n*=135) are in Table 5. The average farmer in this sample owns 824 acres of cropland and rents 773 acres, for an average farm size of 1,597 acres. However, the distribution of size is skewed, with a few very large operations; the maximum owned acres is 6,000 and the maximum rented acres is 10,000. These statistics are reflective of the overall distribution of farm sizes in Kansas, which has a few large farms at the upper tail of the distribution. Based on the 2002 Census of Agriculture, about 10% of all farm operations in Kansas exceed 2,000 acres (NASS).

Many of the producers in the sample currently use one or more BMPs. The most popular BMP is minimum tillage, used by 55% of respondents, while the least popular on the list was filter strips, with only 19% of respondents using this practice. Notwithstanding farmers' willingness to adopt BMPs, there is a persistent gap between their awareness of conservation programs and their participation in them. For example, 97% respondents are aware of the Conservation Reserve Program, but only 45% have participated in it. The gap is particularly stark for the Environmental Quality Incentives Program (EQIP), which has an awareness rate of about 80% but a participation rate of 31%. Similarly large gaps are present for the Conservation Security Program and the Kansas Buffer Initiative. Because these programs offer incentives that match and in some cases outweigh the monetary expenses of installing BMPs, the observed participation gap is consistent with the presence of intangible costs as reviewed above.

In terms of perceptions, farmers agree with the sentiment that water quality needs to be protected and that BMPs help reduce nutrient and sediment runoff. However, the average respondent was neutral on whether Kansas water supplies are polluted. The average response was also neutral on the statements that "*Mandating BMP installation and management is unfair* *to producers*,” and that “*Environmental legislation is often unfair to producers*.” Two perception questions were included to test a commonly state hypothesis in the literature (e.g., King and Kuch, 2003) that farmers are reluctant to participate in WQT because they fear future regulation. The average respondent in our sample only slightly agreed with the statements that “*A farmer who participates in a WQT market is more likely to be regulated in the future, compared to nonparticipants*,” and that “*If WQT markets emerge and are successful, future government regulations on agriculture will be more stringent than otherwise*.” However, neither average is statistically different from zero. Thus, we find little evidence that such concerns prevent farmers from participating, at least explicitly. Finally, the experiment itself appeared to increase subjects’ knowledge of WQT, with the self-assessed level of knowledge increasing, on average, about 1.3 points on a 5-point scale. The distribution of scores was also significantly tighter following the experiment.

The demographic data from our sample suggest it is fairly representative of the larger farm population. The average age of producers in our sample is 41.5 and is not statistically different from the population average of 56 based on the 2002 Census of Agriculture (NASS). About 81% of our respondents were male, compared to 91% of primary farm operators in Kansas, but again the difference is not statistically significant. The average producer has 15 years of formal education, or about 3 years beyond high school, and about 58% of respondents farm as their primary occupation.

Choice Data

Turning now to the choice experiments, we recorded the choice made in 16 distinct scenarios by 135 subjects, producing a dataset with 2,147 usable observations.[1] To give a sense of the choices the subjects made, Figure 2 shows the composition of these data across the 3 choices (options A, B, C) for the first 39 subjects in our dataset. Subjects in the figure are sorted by their frequency of choosing option C, the "do not participate" alternative. All 39 subjects chose to participate in the program (i.e., selecting either option A or B) in at least one scenario, and four subjects chose to participate in all 16 scenarios.

Participation was not dominated by either filter strip (option A) or no-till (option B) contracts. In scenarios where they participated, all but six subjects stated a willingness to choose either option, switching between the two as the non-BMP attributes (application time, monitoring, etc.) varied. In particular, only three subjects (#9, #25, #37) never chose option A and three additional subjects (#22, #26, #39) never chose B. Across the 620 choice sets in this sub-sample, the distribution across the three choices were: A – 235 (38%), B – 205 (33%), and C – 180 (29%).

On the whole, our dataset is quite balanced dataset across the three alternatives. This property is one way of validating the ranges of the non-BMP attributes: these attributes were varied widely enough to entice participation in both types of BMP contracts, but also led to nonparticipation in some cases. Balance is also important because we will employ a discrete choice econometric model for analysis – a model family known to be unstable and to predict poorly if the dataset is unbalanced across choices.

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[1] Across all 135×16 = 2,160 choice sets presented to subjects, 13 choice responses were either missing or unreadable.

Model

Various discrete choice econometric methods have been used to analyze choice experiment data, but all these methods are motivated by the random utility model. Suppose that on occasion t, individual i must chose one of several alternatives indexed by j. Let U_{ijt} denote the utility enjoyed by individual i if he chooses alternative j on occasion t. The random utility model posits that U_{ijt} can be partitioned into two additive components:

$$U_{ijt} = V_{ijt} + \varepsilon_{ijt},$$

where (dropping subscripts for simplicity), V is a function of observable variables and ε is a function of unobservable variables. Although individual i knows the values of both V and ε, the researcher lacks data on ε. This introduces a random element in utility across individuals from the researcher’s point of view.

An estimable econometric model is developed from the random utility model by (a) assuming that individuals make choices to maximize utility, U, (b) specifying V as a function of a vector of observable variables, $\mathbf{x}$, and (c) making a specific distributional assumption about ε. For example, if V is specified as the linear function $V = \boldsymbol{\beta}'\mathbf{x}$ and ε follows an extreme value type II distribution then the probability that i chooses j at time t is

$$P_{ijt} = \Pr\{U_{ijt} > U_{ikt} \text{ all } k \neq j\} = \frac{\exp(\boldsymbol{\beta}'\mathbf{x}_{ijt})}{\exp(\boldsymbol{\beta}'\mathbf{x}_{ijt}) + \sum_{k \neq j} \exp(\boldsymbol{\beta}'\mathbf{x}_{ikt})}$$

This is known as the conditional logit model and is widely used in the literature. Given data on actual choices by sample of individuals, estimation of the parameters $\boldsymbol{\beta}$ can be achieved via maximum likelihood (Greene, 2003).

One assumption embedded in the conditional logit model is that the parameters, $\boldsymbol{\beta}$, are invariant across individuals. In our context, the variables in $\mathbf{x}$ would include the attributes of the various trading choices. The β parameters can be interpreted as the marginal utilities of these attributes, so that the conditional logit model would assume the marginal utility of each attribute is identical across subjects.

However, the qualitative data collected in our choice experiment survey directly contradict this assumption. For example, in their written follow-up responses to scenarios where one of the alternatives had a much higher Penalty than the other, different subjects provided different types of comments. One variety is well summarized by the response, "*I am assuming that I am going to comply and so I am not concerned with the penalty*." These individuals chose the option with the higher penalty, based on other attributes they found attractive such as higher revenue. Other subjects, who did not select the high penalty option, made comments similar to the following: "*Payment is great per acre … but penalty is very high and checked every year. Sure I probably would not violate but don't want to take the chance.*" Here, the concern appeared to be that the farmer would be found in violation of the contract even though he *intends* to comply.

These responses lead us to hypothesize that farmers have differing preferences with respect to our key attributes. For the Penalty attribute, the heterogeneity in preferences would arise from differences in farmers' subjective probabilities of being found in violation when intending to comply, as well as differences in their risk preferences. In order to test this hypothesis, we must specify a model that allows the β parameters to differ across individuals. One such model is the random parameters logit model. One or more of the parameters in the β vector are assumed to have a distribution across individuals, which can be specified by the researcher (e.g., normal or log-normal distribution). Rather than estimating the values of the β's per se, the econometric problem is to estimate the underlying distributional parameters of the randomly specified β's across people (e.g., means, variances, and covariances). This model will be pursued to formally test whether the marginal utility parameters differ across farmers.

Concluding Remarks and Next Steps

The econometric model to be estimated from the choice data will be capable of predicting the trading choices of farmers in a WQT program under different trading rules. As part of our ongoing research project, our next goal is to run trading simulations under different types of rules to assess their effect on market performance. These simulations will be accomplished by inserting our estimated equations into a trading simulation model already developed by Smith (2004), which in turn is based on the sequential bilateral trading algorithm of Atkinson and Tietenberg (1991).

Once the trading simulation model is complete, it will be linked to a biophysical watershed model being developed for the Kansas/Delaware Subbasin using SWAT (Arnold et al., 1998; Neitsch et al., 2001). The linked models will then be run in tandem to assess the joint performance of various market designs on economic measures as well as on water quality in different river segments. The objective is to identify a set of trading rules that are simple enough to attract adequate participation while being sufficiently tailored to ensure that water quality goals are indeed met.

As this project is a work in progress and data collection is still underway, only very preliminary results are available. The initial results obtained from our choice experiments suggest that the attribute levels provide a range of incentives to which subjects respond in different ways. Demographic variables in our dataset suggest our sample is so far weighted somewhat toward younger and female producers. More formal tests of demographic representativeness will be conduced as data collection progresses, and adjustments will be made as needed to change our sampling strategy or correct our regression by reweighting different demographic cohorts.

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Table 1. Design Attributes and Levels

Attribute	Variable Name	Levels
Application Time (hours)	*Time*	4, 16, 24, 40
Monitoring method	*Monitoring*	Annual verification, Spot check
Penalty ($/acre enrolled)	*Penalty*	50, 100, 250, 500
Annual trading revenue ($/acre enrolled)	*Revenue*	3, 7, 15, 25
Best Management Practice	*BMP*	Filter strip (no haying/grazing), Filter strip (with haying/grazing), 100% No-till, Rotational No-till

Table 2. Credits Generated by Best Management Practices

Best Management Practice	Credits Generated
	credits/acre/year
Filter strip (no haying/grazing)	12
Filter strip (with haying/grazing)	6
100% No-till	9
Rotational No-till	5

Table 3. Designed Choice Sets

		Option A Attributes					Option B Attributes				
Set	Ver.[a]	*Time*	*Monitoring*[b]	*Penalty*	*Revenue*	*BMP*[c]	*Time*	*Monitoring*[b]	*Penalty*	*Revenue*	*BMP*[d]
1	1	24	SC	50	7	FSH	4	AV	500	25	NT
2	1	4	SC	500	15	FSH	16	AV	100	15	NT
3	1	24	SC	250	15	FSNH	24	SC	500	15	RNT
4	1	40	AV	50	25	FSNH	24	AV	100	3	RNT
5	1	4	AV	500	25	FSH	4	SC	250	15	RNT
6	1	4	AV	100	3	FSNH	24	AV	250	25	NT
7	1	4	SC	250	3	FSH	40	SC	50	3	NT
8	1	24	AV	100	15	FSH	40	AV	100	7	RNT
9	1	40	SC	250	7	FSH	16	AV	250	7	RNT
10	1	40	AV	100	7	FSNH	4	SC	50	15	RNT
11	1	40	SC	50	15	FSNH	40	SC	250	3	NT
12	1	16	AV	500	3	FSNH	40	AV	500	7	RNT
13	1	24	AV	50	3	FSH	16	SC	50	25	RNT
14	1	16	AV	100	25	FSH	16	SC	500	3	NT
15	1	16	SC	250	25	FSNH	4	AV	100	25	NT
16	1	16	SC	500	7	FSNH	24	SC	50	7	NT
17	2	40	AV	250	3	FSH	4	SC	100	7	NT
18	2	4	AV	250	7	FSH	24	AV	500	3	RNT
19	2	16	AV	250	15	FSNH	16	SC	250	25	RNT
20	2	16	SC	50	3	FSH	24	SC	100	15	RNT
21	2	24	AV	250	25	FSNH	40	AV	50	15	NT
22	2	16	AV	50	7	FSH	40	AV	250	15	NT
23	2	4	AV	50	15	FSNH	4	SC	500	7	NT
24	2	24	SC	500	3	FSNH	4	AV	250	3	RNT
25	2	4	SC	100	7	FSNH	40	SC	100	25	RNT
26	2	24	AV	500	7	FSNH	16	SC	100	3	NT
27	2	24	SC	100	25	FSH	24	SC	250	7	NT
28	2	40	AV	500	15	FSH	24	AV	50	25	NT
29	2	16	SC	100	15	FSH	4	AV	50	3	RNT
30	2	40	SC	100	3	FSNH	16	AV	500	15	NT
31	2	4	SC	50	25	FSNH	16	AV	50	7	RNT
32	2	40	SC	500	25	FSH	40	SC	500	25	RNT

[a] Survey version. Sets 1-16 were in version 1; 17-32 in version 2.

[b] SC = Spot check; AV = Annual verification

[c] FSH = Filter strip (with haying/grazing); FSNH = Filter strip (no haying/grazing)

[d] NT = 100% No-till; RNT = Rotational No-till

Table 4. Data Collection Sites

Date	Event Name	Location	Subjects
August 17, 2006	Risk and Profit Conference	Manhattan, KS	38
December 7, 2006	Sunflower Agricultural Profitability Conference	Smith Center, KS	11
January 12, 2007	Post Rock Agricultural Profitability Conference	Colby, KS	44
January 26, 2007	Kansas Farm Bureau Conference	Wichita, KS	42
Total			135

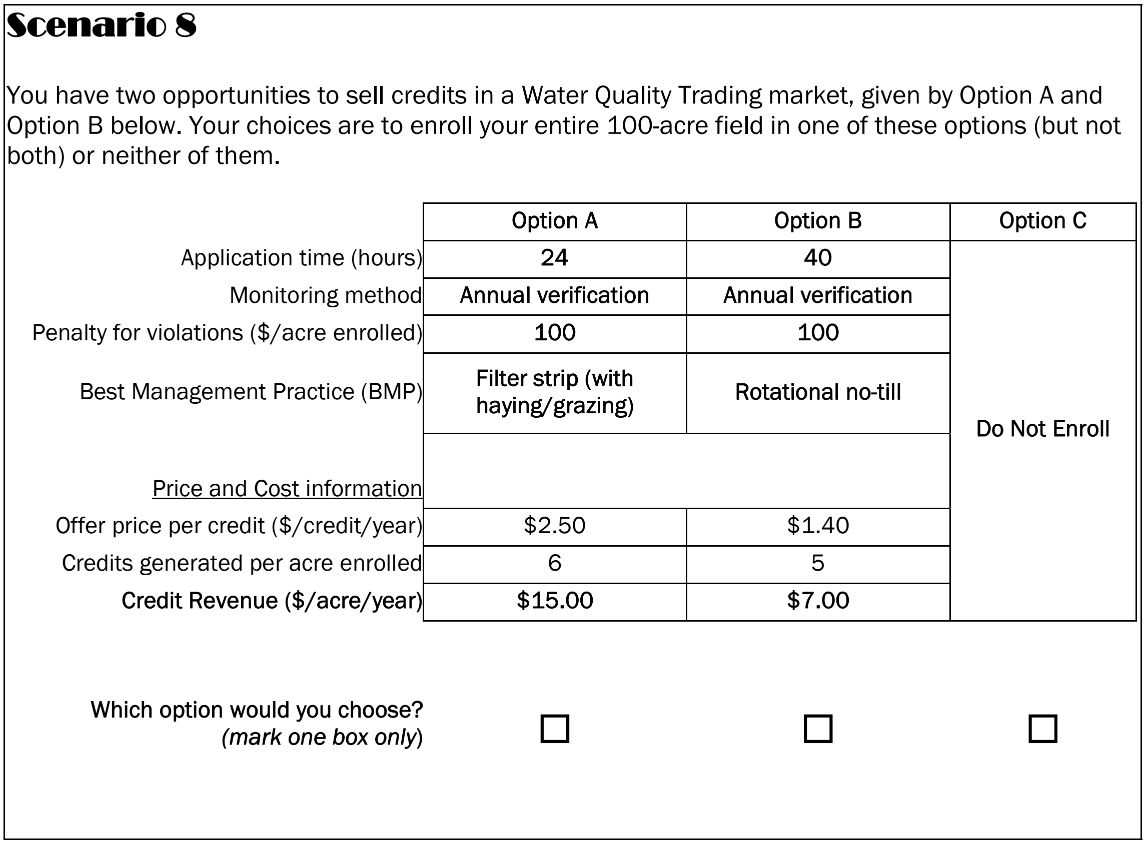
Table 4. Summary Statistics of Initial Questionnaire Data

Item	**Mean**	**Standard Deviation**	**Minimum**	**Maximum**
Farm Characteristics				
Owned cropland (acres)	824	1237	0	6000
Rented cropland (acres)	773	1298	0	10000
Cropland bordering waterbodies (proportion)[a]	0.782	0.414	0	1
Best Management practices in use (proportion)[a]				
Filter strip	0.187	0.391	0	1
Minimum tillage	0.552	0.499	0	1
Rotational no-till	0.433	0.497	0	1
Exclusive (100%) No-till	0.276	0.449	0	1
Terraces	0.724	0.449	0	1
Sub-surface application of fertilizer	0.358	0.481	0	1
Contour farming	0.336	0.474	0	1
Familiarity/participation with conservation programs (proportion)[a]				
Conservation Reserve Program: Familiar With?	0.970	0.172	0	1
Conservation Reserve Program: Participated In?	0.453	0.500	0	1
Environmental Quality Incentives Program: Familiar With?	0.805	0.398	0	1
Environmental Quality Incentives Program: Participated In?	0.306	0.463	0	1
Conservation Security Program: Familiar With?	0.632	0.484	0	1
Conservation Security Program: Participated In?	0.100	0.301	0	1
Kansas Buffer Initiative: Familiar With?	0.444	0.499	0	1
Kansas Buffer Initiative: Participated In?	0.083	0.278	0	1
Perceptions				
Level of agreement with the following statements:[b]				
"Best management practices (BMPs) reduce nutrient and sediment runoff."	1.16	0.78	-2	2
"Kansas surface water quality needs to be protected."	1.24	0.71	-2	2
"Kansas groundwater quality needs to be protected."	1.32	0.65	-2	2
"Mandating BMP installation and management is unfair to producers."	0.32	0.99	-2	2
"Environmental legislation is often unfair to producers."	0.47	0.90	-2	2
"Kansas surface waters are polluted."	0.24	0.87	-2	2
"Kansas groundwater supplies are polluted."	-0.04	0.82	-2	2
"A farmer who participates in a water quality trading market is more likely to be regulated in the future, compared to nonparticipants."	0.19	1.08	-2	2
"If water quality trading markets emerge and are successful, future government regulations on agriculture will be more stringent than otherwise."	0.68	0.91	-2	2
Self-assessment of knowledge of Water Quality Trading:[c]				
Before participating in experiment	-1.03	0.95	-2	2
After participating in experiment	0.28	0.65	-1	2
Demographics				
Gender (1=male, 0=female)	0.806	0.397	0	1
Age (years)	41.5	15.6	18	81
Years of formal education (12=high school, etc.)	15.1	2.0	12	20
Farming primary occupation	0.579	0.496	0	1

[a] Responses in proportions indicate the share of subjects choosing a particular response, not a share of acreage.

[b] Responses measured on a 5-point scale, where -2=strongly disagree, -1=disagree, 0=neutral, 1=agree, and 2=strongly agree.

[b] Responses measured on a 5-point scale, where -2=very low, -1=low, 0=moderate, 1=high, and 2=very high.



Scenario 8

You have two opportunities to sell credits in a Water Quality Trading market, given by Option A and Option B below. Your choices are to enroll your entire 100-acre field in one of these options (but not both) or neither of them.

	Option A	Option B	Option C
Application time (hours)	24	40	Do Not Enroll
Monitoring method	Annual verification	Annual verification	
Penalty for violations ($/acre enrolled)	100	100	
Best Management Practice (BMP)	Filter strip (with haying/grazing)	Rotational no-till	
<u>Price and Cost information</u>			
Offer price per credit ($/credit/year)	$2.50	$1.40	
Credits generated per acre enrolled	6	5	
Credit Revenue ($/acre/year)	$15.00	$7.00	
Which option would you choose? *(mark one box only)*	☐	☐	☐

Figure 1. Sample Choice Set

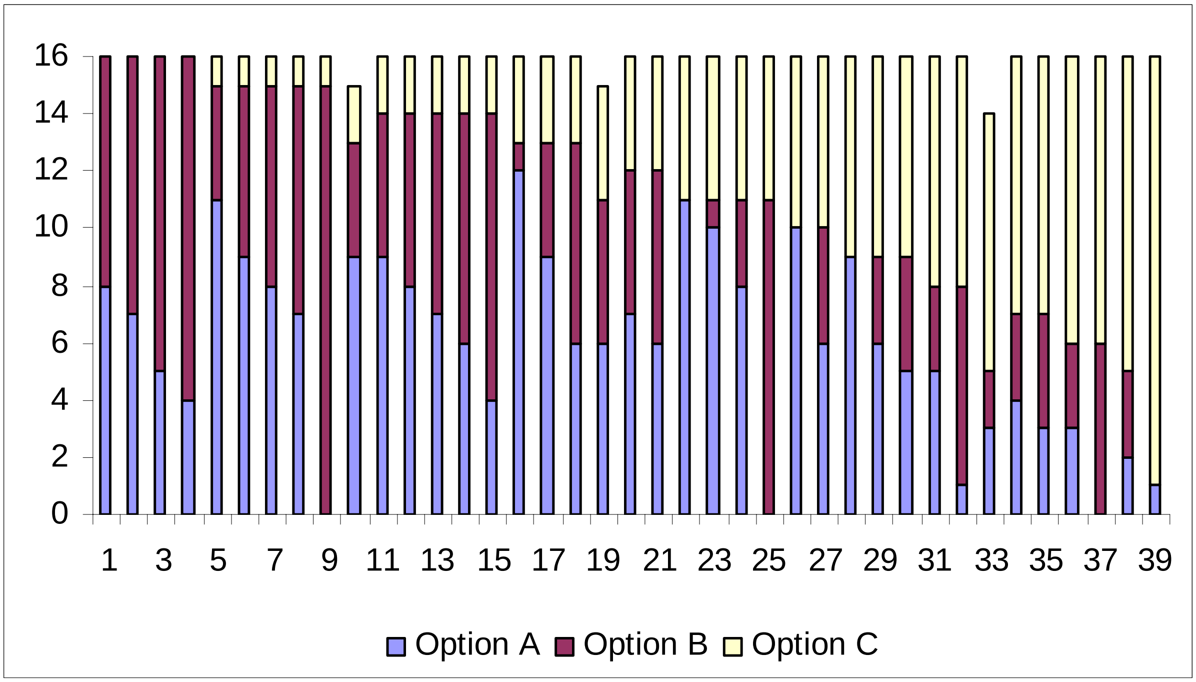


Figure 2. Distribution of Responses from Choice Experiments, First 39 Subjects