Factors Influencing Perception and Adoption of Conservation Practices in a Nutrient Rich Watershed

Michael Black[1], Jennie Popp, Ph.D.[2], Bruce Dixon, Ph.D. [2],
Diana Danforth[2], Andrew Sharpley, Ph.D. [2] and Mike Daniels, Ph.D. [2]
[1]Texas A&M University
[2]University of Arkansas

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1. Introduction

The upper Illinois River watershed (UIRW) in northwest Arkansas and northeast Oklahoma is a nutrient rich watershed. Agricultural production in northwest Arkansas is dominated by cattle and poultry production, which can contribute to the phosphorus and nitrogen loads of the river. Several lawsuits have been filed by downstream water users against upstream land users that include poultry integrators and several municipal wastewater treatment plants, in an effort to decrease nutrient concentrations and some impairment of receiving waters used for drinking and recreation. One option to reduce water quality impairment is through the use of voluntary conservation practices (CPs[1]). Due to their voluntary nature, understanding the decision making process and producer perceptions are vital to increasing adoption. This study estimates a generalized linear model with a count data dependent variable, to identify factors that influence adoption rates for CPs, as well as seven multinomial probit models to identify factors that influence the perception of seven common CPs.

2. Background and Literature Review

Watersheds do not conform to county or state lines, and inherently involve multiple stakeholders and interests. Collaboration and effective communication among competing interest groups have been shown to be important in crafting effective policy measures that protect water quality within watersheds (Brown and Marshall, 1996; Imperial, 2005; Oshodi, 2011; Osmond et al., 2012). However, establishing and maintaining water quality standards can be difficult because of the diverse nature of interests across users and stakeholder groups. Water quality is periodically assessed against standards within states. These standards designate official uses for various water sources, criteria to monitor the quality, and anti-degradation policies to protect the water sources from further damage (EPA, 2011). When bodies of water cross political borders, collaboration is necessary to develop a set of standards approved by competing interests.

The Illinois River, a 100 mile-long tributary of the Arkansas River, is an impaired waterway (ADEQ, 2014). The river and tributaries begin in the Ozark Mountains in Arkansas and flow west into Oklahoma. The upper Illinois River watershed (UIRW), the portion of the

[1] The Natural Resource Conservation Service (NRCS) officially recognizes over 150 CPs, sometimes referred to as 'best management practices'. The term 'conversation practices' is used in this paper, pursuant to NRCS modus operandi, to avoid the subjective term 'best'.

watershed in Arkansas, lies predominantly in Benton and Washington Counties. The watershed basin is 758 sq. miles, and is home to agricultural, urban, and industrial stakeholders (FTN Associates, 2012). Agriculture in the area is dominated by livestock operations, specifically broiler and beef production, as well as hay production (USDA NASS, 2012a, 2012b). While certainly not the only source of excess nutrients in the watershed, the heavy presence of livestock operations and extensive use of poultry and cattle manure on pastures in previous decades contributed to elevated levels of phosphorus and nitrogen, which can result in water quality degradation (Edwards and Daniel, 1993; Sharpley, Herron and Daniel, 2007). More recent studies, however, have shown improvements in water quality in the watershed since the early 2000s (e.g., Haggard, 2010; Scott et al., 2011) but elevated levels of some nutrients remain. The Illinois River watershed in northwest Arkansas contains four bodies of water listed on the 303(d) list: Moore's Creek, the Muddy Fork, Clear Creek, and a portion of the Illinois River (ADEQ, 2014). The three listed sources of impairment (all non-point source (NPS)) for these bodies include and include urban runoff, surface erosion and agriculture.

The Illinois River Watershed has gained national attention because of the high-profile conflict between Arkansas and Oklahoma over water quality standards. Oklahoma has designated the Illinois a "scenic river", and has acted to defend strict standards as the water flows from Arkansas into the state. The crossing of the state line has opened up opportunity for litigation, and in 2005 Oklahoma filed a lawsuit against poultry producers collectively defending as Tyson Foods (McBride 2011). While the final ruling of the case is pending in the Supreme Court, the states of Arkansas and Oklahoma are working to regulate litter waste (Herron et al., 2012).

Efforts to control agricultural NPS pollution that impacts water quality have historically focused on CPs. These practices are voluntary due to the NPS Clean Water Act (CWA) exemption, and rely on producers opting for adoption. The use and applicability of CPs within the Illinois River Watershed has been studied extensively (Chaubey et al., 2010; Edwards et al., 1997; Knight et al., 2012; Merryman et al., 2009; Popp et al., 2007; Rao et al., 2012; Rodriguez et al., 2011a, 2011b; Sharpley et al., 2012; Shumway et al., 2012; Tomer and Locke, 2011; among others). Adoption rates vary due to several economic and noneconomic factors. Osmond et al. (2012) and Paudel et al. (2008) show the availability of financial and technical assistance increases adoption rates. Land ownership has also been shown to positively influence adoption (SouleTegene and Wiebe, 2000). Jensen et al. (2015) showed that education level positively affects adoption rates, while producers who were more risk averse about technology were less likely to adopt CPs. Greiner, Miller, and Patterson (2009) also concluded that aversion to risk can negatively affect CP adoption rates. Environmental perceptions, or farmer sentiment of land stewardship has been identified as a positive influence of CP adoption (Jensen et al., 2015). Perception and knowledge of CPs has been shown to increase adoption rates (Glenk et al. 2014; Reimer, Weinkauf, and K. Prokopy, 2012). Similarly, connection to other farmers or watershed groups positively influences CP adoption (Baumgart-Getz, Prokopy and Floress 2012). Finally, a previous study has shown diversified producers are more likely to adopt CPs (Gillespie et al., 2007).

Local institutions also play a large role in shaping local environmental awareness, and can have an effect on farmer perception of environmental damage (Wertz-Kanounnikoff and Chomitz, 2008), which in turn can have a direct effect on adoption decisions. Additionally, perceptions of others' actions have a large impact on decision making (Helfinstein, Mumford, and Poldrack, 2015; Kamargianni, Ben-Akiva, and Polydoropoulou, 2014), as does age (Worth, 2014), the number of choices or options available (Issac and Brough, 2014), and positionality in relation to peers (Anderson, Stahley, and Cullen, 2014).

While much research has been conducted to identify the factors that impact adoption, less research is available to explain some of the perceptions that underlie the reasons for adoption/non adoption. For example, perceptions of CPs have been linked to a number of factors but the role of these factors is inconsistent across studies. While Benham et al. (2007) found no significant link between producer perception of environmental issues and perceptions of CPs, Popp et al. (2007) and Pennington et al. (2008) did find significant and positive relationships. At least one study suggests that experience in farming should improve producers' ability to manage CPs effectively (Lichtenberg, 2004), and thus in these cases producers should perceive CPs to be effective. However, other studies (Baumgaurt-Getz et al., 2012; Knowler and Bradshaw, 2007; Savage and Ribaudo, 2013) find experience insignificant in influencing adoption, therefore lessening any connection between years of experience and belief in effectiveness. Some studies show connections between perceptions of CPs and farm size and type of production (Walters and Young, 2011). Finally studies suggest gathering information from different groups, including producer groups and extension can also influence perceptions of CPs (Benham et al., 2007; Darr and Pretzsch, 2006; Knowler and Bradshaw, 2007; Tamini, 2011). Until now, however, there has been no research that measures the influence of these factors on shaping perceptions of CPs in the UIRW.

Education and outreach programs can help increase the adoption of CPs (Ribaudo, 2015), and an understanding of producers' perceptions and attitudes can inform the development of such programs. Conservation practices have been shown to have a positive effect on reducing water quality degradation (Agouridis et al., 2005; Chaubey et al., 2010; Edwards et al., 1996, 1997). Conservation practices, either structural or managerial, may effectively limit the application, and therefore runoff, of nutrients and sediment into the watershed.

One approach to understand producer perceptions is through producer surveys. These surveys can lead to a broader understanding of perceptions representative of most producers in the study area. In 2006, a sub-watershed of the UIRW was surveyed as part of a USDA-funded Conservation Effects Assessment Program (CEAP). This smaller watershed, the Lincoln Lake Watershed, lies entirely in Northwest Arkansas and is similar to the larger UIRW in which it sits. The survey in that area attempted to better understand perceptions of water quality and CPs (Hoag et al., 2012; Popp et al., 2007). The findings from that survey led to an effective education program, increased the number of farms with nutrient management plans, and increased the overall adoption of CPs (Hoag et al., 2012; Pennington et al., 2008).

This study seeks to evaluate Arkansas' Upper Illinois River Watershed producers'; 1) perceptions of water quality within the watershed, and 2) perception and adoption of CPs in the watershed. This study expands upon the Lincoln Lake CEAP producer survey with a new survey that extends the sample to include Arkansan producers operating within the UIRW. The findings from the survey can help policy makers better understand producer perceptions of water quality issues and CPs, and may be used to develop educational programs and more effective policy aimed at reducing water quality degradation.

While economic factors such as cost considerations may affect the number of CPs adopted, this study focuses on noneconomic factors that might be influenced by outreach and educational efforts. Environmental perceptions, attitudes towards CPs, information, and type of enterprise may be important factors in the number of CPs adopted, and should be understood in the absence of economic factors. Further study may bridge economic and noneconomic factors, but it is important to understand inherent attitudes when crafting policy, and when designing effective educational programs to both inform policy decisions and achieve desired results.

3. Producer Survey

A producer survey was developed using a two-stage process. The first stage utilized Dillman's widely accepted methods for creating a mixed-mode survey through the tailored design method (Dillman et al. 2008; Salant and Dillman, 1994). A mixed-mode survey (conducted through mail, online, and at producer meetings) was necessary in order to ensure a large and highly representative number of responses. The second stage of survey development utilized focus groups consisting of agricultural producers from surrounding watersheds to pretest and clarify survey questions.

The final survey was administered at producer meetings and sent via mail and online over the period of 2013 – 2014. The ultimate goal was to understand UIRW producers' perceptions of water quality and CP adoption. The survey contained 37 questions primarily related to; 1) characteristics of the farm and producer, 2) perceptions of water quality issues in the UIRW, and 3) adoption and opinions of CPs.

The choice of CPs used in the survey was based upon a list of 15 practices that were identified by the local Natural Resource Conservation Service (NRCS) office as most relevant to agricultural production in the UIRW (Pennington et al., 2008; Rodriguez et al., 2011a). These practices are: controlled grazing, filter strips, prescribed grazing, pasture management, stream bank stabilization, cattle track stabilization, stream fencing, basing fertilizer application on soil test results, litter storage sheds, manure composting, soil testing, use of legumes to reduce nitrogen applications, the use of a comprehensive nutrient management plan, and the use of manure instead of commercial fertilizer. Producers were asked, among other questions, which of these practices they believed were effective (regardless of relevance to their type of agricultural production) and which of these practices they had adopted. Survey responses were entered into an Excel database and summary statistics were generated for each of the 179 survey variables.

A total of 582 usable surveys were collected from producers operating in the UIRW sections of Benton and Washington Counties. Characteristics of respondent farms were compared to 2012 NASS Census of Agriculture Data (USDA, NASS 2012a, 2012b) to determine if significant differences existed within each county between respondents and Census farms (Table 1). While these respondent producers represent only 13 % of producers in the counties, respondent farms were, for the most part, representative of farms in the two counties with respect to principal operator, type of operation and farm size. Only one significant difference (p-value: 0.049) was found between respondents and Census farms[2].

As expected, beef, poultry, and hay/pasture producers were the dominant respondents. Across both counties, 73% of respondents engaged in pasture production, 70% in beef production, 59% in hay production, and 35% in broiler or other poultry production. The production types sum to greater than 100% due to producer involvement in multiple production categories.

Eighty-four percent of respondents believed water quality issues existed in UIRW, and 96% of all respondents were influenced by water quality concerns when choosing to use CPs on their farms. A large majority (90%) had a nutrient management plan (NMP) on file with USDA-Natural Resources Conservation Service (NRCS) and 96% of respondents had and least one CP implemented on land they owned or operated within the last three years. Conservation practices most commonly adopted by respondents were soil testing (91%), nutrient management plans (90%), basing fertilizer user on soil test recommendations (77%), pasture management (52%), and controlled grazing (32%) (Figure 1). Alternatively, the only practice adopted by no respondents was a lagoon.

Producers in the UIRW turned to a variety of sources for conservation information and assistance. Extension (64%), NRCS (56%), and other producers (52%) were the most frequently used, while paid consultants (4%), the EPA (4%), and the FSA (1%) were the least used within the watershed (Figure 2).

Producers were influenced by a variety of factors in their decision to adopt CPs. The most common reason for CP adoption was personal belief that the practice was effective at reducing nutrient/sediment loss (79%) followed by government/university/extension recommendation (59%). No more than 26% of respondents were influenced by other reasons, including cost considerations (26%) or public perception of the producer (23%).

While respondents cited belief in CP effectiveness as a large influencer for the adoption of CPs in the UIRW, their perceptions of CP effectiveness varied across practices (Figure 3). Soil testing (82%), basing fertilizer application on soil test results (82%), and controlled grazing (76%) were most often perceived as effective, while cattle track stabilization (40%), manure composting (36%), and waste treatment lagoons (11%) were least often cited as effective. For many of the

[2] The one significant difference was 1-9 acre sized farms that had had proportionately more responses in Washington County.

practices that were not highly adopted by respondents, a respondent was more likely to state he/she was unsure of the effectiveness of the practice than to state that the practice was ineffective.

Respondents were asked which CPs had been utilized on their lands within the last three years.[3] Ninety-five percent of respondents had adopted soil testing, followed by the use of a nutrient management plan (93%), and basing fertilizer application on soil test results (81%). Stream bank stabilization (2%), cattle track stabilization (2%), and waste treatment lagoons (0%) were the least often adopted CPs.

4. Estimated Models

From these survey data, models were estimated to better understand; 1) factors that influence the number of CPs adopted, and 2) factors that influence the perception of effectiveness for various CPs.

4.1 Adoption of CPs

As mentioned above, previous research has suggested that adoption of CPs can be influenced by a number of factors including environmental perceptions, attitudes towards CPs, connections to conservation organizations and/or other producers, and type of agricultural enterprise. The number of CPs adopted is discrete (integer). In the sample observations on CPS adopted range from zero practices adopted (two percent) up to 12 (one observation) for the 560 observations in the sample. The modal number is 4 practices adopted (133 observations) with 5 practices adopted (121 observations) being the next most frequent observation. Because of the discrete nature of the dependent variable, we specified a Poisson count data model and estimated the parameters by maximum likelihood. The conditional mean of this distribution (λ_i) is hypothesized to be linear in the independent variables, and of the form:

$$\lambda_i = \beta_1 + \beta_2 WQ_i + \beta_2 NE_i + \beta_3 NS_i + + \beta_4 ET2_i + \beta_5 ET3_i + + \beta_6 ET4_i \qquad (1)$$

In this model, *WQ*, belief in water quality issues ("1" if a producer believed water quality issues existed in the watershed, and "0" otherwise), represents environmental perceptions. Following the

[3] The survey questions did not ask for information on adoption year, which may have taken place earlier than the previous three years.

literature, it is hypothesized that believing in water quality issues within the UIRW will increase CP adoption (Jensen et al., 2015). *NE,* the number of the CPs a producer believes are effective at reducing nutrient or sediment runoff (ranging from 0 to 14 – lagoon was ignored as no producer had adopted a lagoon), represents attitudes towards CPs. Again, it is expected that belief that a greater number of CPs is effective will lead to increased adoption (Glenk et al. 2014; Reimer et al., 2012). *NS,* the number of sources a producer uses for information (ranging from 0 to 9 representing those sources in Figure 2), represents connection to other producers or watershed groups. Since knowledge of CPs helps increase adoption, it is hypothesized that more sources of information similarly influences adoption. Finally, the ET variables indicate the type of enterprise a producer operates and represents production diversification. This categorical variable takes the following values: ET2 equals 1 if the producer is involved in poultry production only (0 otherwise), ET3 equals 1 if the producer is involved in beef production only (0 otherwise), and ET4 equals one if the producer is involved in both beef and poultry production (0 otherwise). In this case, the base (references) enterprise is if the producer is involved in neither beef nor poultry production. It is hypothesized, following Gillespie et al. (2007) that producers engaged in both beef and poultry will be more likely to adopt than those involved in either or neither of those activities.

Table 2 presents the estimated marginal effects of the adoption model independent variables. First, as expected, belief in water quality has a significant and positive relationship with the number of CPs adopted. That is, if a producer believes water quality issues exist, s/he will adopt approximately 0.85 more practices. Similarly and also expected, the number of CPs a producer believes are effective, also significantly and positively influences total CP adoption. This was expected given 79% of producers who completed the survey listed belief in CP effectiveness as influencing their decision to adopt. In this estimation the number of CPs adopted increases by 0.05 for each CP the producer believes is effective in addressing WQ in the region. Third, the type of production a producer is engaged in also significantly influences adoption. Being engaged in beef and/or poultry activities greatly increases the percentage of CPs adopted compared to not being engaged in those activities. For example, being engaged in poultry alone increases the number of CPs adopted by 0.74 whereas being engaged in both beef and poultry increases the number of CPs adopted by 1.89. These results were expected, since many of the CPs considered in this study are more applicable to beef and poultry producers than to other types of producers. Further, it supports the Gillespie et al. (2007) finding that more diversified (here, beef and poultry) producers tend to adopt more practices than less diversified (in this case, solely beef or solely poultry) producers.

However, unexpectedly, the number of information sources had a negative, but insignificant impact on number of CPs adopted. While the reasons for this result are unclear, it could point to a failure of consistent information across sources regarding CPs. That is, different sources (extension, other producers, the NRCS, etc.) may be disseminating the same information unequally, or different information altogether or this information may be received and interpreted by the producer differently than intended. Further study is needed to understand the information flow from other producers and watershed organizations to producers in the UIRW.

4.2 Belief in CP Effectiveness

The results above suggest that the number of CPs a producer believes are effective is a significant and important factor in the decision to adopt a practice. Further, survey respondents themselves listed belief in CP effectiveness more often than other reasons for adopting a practice. However, the literature review revealed incomplete, and often conflicting, explanations of factors that can influence perception. While most producers (84%) believed water quality issues existed in the watershed, only three of fifteen practices were perceived as effective by more than 75% of respondents. Focus was, therefore, turned to further study what factors influence belief in CP effectiveness in the UIRW.

Unique models were specified for each of seven practices identified by producers, Conservation District and NRCS representatives (C. Dunigan and K. Lee, personal comms.) as important in the UIRW. These practices were also those that were generally adopted and/or perceived effective more than others. These practices are; 1) use of a comprehensive NMP, 2) filter strips, 3) prescribed grazing, 4) basing fertilizer applications on soil test results, 5) soil testing, 6) controlled grazing, and 7) pasture management. Each model had the same set of independent variables.

The dependent variable, belief in CP effectiveness, in each model, took on one of three possible values, "yes", "no", and "uncertain". Following convention, a Hausman Specification Test was used to test the Independence of Irrelevant Alternatives (IIA) (SAS Institute, 2010) in a multinomial logit model. The test for independence failed; the alternatives "no" and "uncertain" did not necessarily behave as unique options, and thus a multinomial probit model was adopted because it relaxes the IIA assumption (Greene).

The independent variables hypothesized to influence perception in the UIRW were those found in the literature. *Years* is years of operation in the watershed for the *i*th individual. As suggested by Litchenberg (2004), more year of experience should lead to more effective adoption of CPs and thus our hypothesis that years has a positive influence on perception of CPs. The perception of environmental issues has shown a mixed effect in the literature. Here, we hypothesis that the belief in water quality issues within the watershed (WQ_i) will positively influence perceptions of CP effectiveness. Enterprise type (*ET2, ET3 and ET4*, defined previously) and Acres ($Acres_i$) are used to investigate the influence of engagement in beef and poultry production and the total farm size in the watershed, respectively. Walters and Young (2011) and Reimer, Weinkauf, and Prokopy (2012) suggest farm size and type of production influence perceptions of CPs, and thus are included in our model. Finally, given the expected influence of formal and informal groups and information sources, NS_i is used to represent number of information sources used to gain CP information. Past studies from Darr and Pretzsch (2006), Knowler and Bradshaw (2007), Benham et al. (2007) and Tamini (2011) have shown that information and groups can influence perception of CPs, but have not yet been tested in the UIRW. These information sources include those presented in Figure 2. For all practices, the "yes" response is used as the base outcome, and the "no" and "uncertain" options are estimated as probabilities based off that outcome.

In addition, marginal effects were estimated for the five independent variables. The estimation is made only for the "yes" outcome, to understand the effect of various factors in increasing or decreasing the probability of responding yes.

Of the seven models developed, no model had more than four significant variables (of the seven variables tested) associated with either the "no" or "uncertain" response alternatives (Table 3). Models for the perceptions of comprehensive NMPs and for filter strips had the greatest number of significant variables, but the combination of variables that were significant differed across models. In all but the soil testing model, at least two variables were found to be significant in explaining difference between "yes and no" or "yes and "uncertain" perceptions of CPs.

The influence of individual variables is best interpreted through their marginal effects. In these models, marginal effects represent a change in the probability of believing a practice is effective, given a change in a given independent variable. Marginal effects are presented in Table 4. The coefficient for the variable belief in water quality issues was found to be significant in models for four (comprehensive NMP, prescribed grazing, soil testing and controlled grazing) (Table 3) and its marginal effect was significant and positive in three (all but soil testing) of those four models (Table 4). The marginal impact varied greatly across models. For example, believing that water quality issues existed increased the probability of finding NMPs effective by 0.1686 but increased the probability of finding prescribed grazing effective by 0.3711.

One or more type of enterprises was also found to be significant in six of the seven models (except soil testing) but its marginal effect was only significant in four of the equations. Where significant, being engaged in poultry, beef or both increased the probability of believing a practice was effective (as compared to those not engaged in those enterprises). The marginal impact of enterprise type was relatively large compared to other variables, ranging from 0.0944 to 0.2561 (Table 4). The coefficient for the number of sources utilized for information about CPs was significant in four models (comprehensive NMP, prescribed grazing, basing fertilizer off soil test results, and pasture management). The marginal effects, however, were only significant for three models (prescribed grazing was not significant), and were similar in magnitude, ranging from 0.0412 to 0.0525 (Table 4).

Total farm acreage was significant for three models (filter strips, basing fertilizer on soil test results, and pasture management), although the marginal effects were small: ranging from 0.0007 for pasture management to 0.0012 for basing fertilizer off soil test results (Table 4). The small effect is expected, since the change in the dependent variable (number of acres) is much smaller than the change in the three-choice independent variable.

Years in operation was only significant in influencing perception for controlled grazing and pasture management, but the only significant marginal effect was for pasture management, at 0.0047 (Table 4).

There were no significant negative marginal effects, across all variables and all models. While there were some negative, insignificant effects, the variables included in the models generally positively influence the perception of CP effectiveness in the watershed.

5. Discussion/Conclusion

The purpose of this study was to better understand adoption and perception of CPs in the UIRW, focusing on non-economic factors that may have implications for educational programs. In recent decades, certain factors have often been cited as important to adoption by researchers including perceptions of environmental issues, type of production operation, sources of information for CPs and perceptions of CPs themselves. Our study supports the literature, with the exception of number of sources. We conclude it isn't necessarily the number of sources that is important in adoption but more so the opinions the producer holds regarding environmental conditions and the ability of CPs to affect them.

Survey results showed that most respondents (84%) believe water quality issues exist within the watershed. But the perceptions regarding the effectiveness of CPs were much more mixed. Only nine of the 15 practices were perceived as effective by at least 50% of respondents; only 3 were deemed effective by at least 75% of the respondents. Moreover, in many cases the percentage of respondents reporting they were unsure of the effectiveness, was greater than the percentage who said no. Understanding what influences perceptions of CPs, is an important first step to changing perceptions that can lead to greater CP adoption.

Factors influencing perceptions of CPs were examined for seven CPs (that were important to the watershed, and more often adopted and perceived effective than the other eight examined) using multinomial probit models. Not surprisingly, factors' influences differed across models. The type of agricultural activities pursued was significant and positive in six of the models, with large marginal effects in three. Belief in water quality was significant and positive in four of the models, also with large marginal effects in three. Unlike in the adoption model, the sources of information about CPs was found to be significant in four of the models. Marginal effects were also significant in three models, but their influence was much smaller than that of enterprise type or belief in water quality issues. However, it is important to note that while the number of information sources may not directly influence CP adoption, it can influence the perceptions of CP which can then, in turn, influence adoption rates. Finally, acres and years were found to be significant in few models, and their marginal effects, though mostly significant in those models, were very small.

While substantial improvements have been made in the last decade to reduce excess nutrients in the waters of the UIRW, water quality problems remain. Point sources have greatly reduced their contributions and therefore, efforts turn towards nonpoint sources to make similar improvements. Research has determined that proper placement and timing of agricultural CPs can reduce water quality problems within a watershed. This study has identified factors that influence adoption and perceptions of CPs. Educational efforts that target different enterprise types and focus on providing information about effectiveness of CPs may lead to increases in adoption rates and improvements in water quality in the UIRW in the future.

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Table 1. Comparison of Survey Responses to 2012 Agricultural Census Farms

	2012 NASS Census[a]		Study Survey		
	Benton	*Washington*	*Benton*	*Washington*	p-value
Farm Size:					
1 - 9 acres	7.51	7.19	5.90	21.54	**0.0494***
10 - 49 acres	35.65	35.97	35.42	28.62	0.5195
50 - 179 acres	36.49	37.37	42.80	42.12	0.9004
180 - 499 acres	15.21	15.35	15.13	7.72	0.2300
500 - 999 acres	3.11	3.32	0.00	0.00	NA
1000 acres or more	2.04	0.80	0.00	0.00	NA
Principle Operator:					
Farming as primary job	47.75	42.29	53.51	54.02	0.6587
Other as primary job	52.25	57.71	45.39	44.37	0.6679
Type of production:					
Pasture Production	78.40	77.42	72.32	74.28	0.8643
Beef	71.67	65.99	73.06	67.20	0.9965
Hay Production	54.38	54.84	57.93	60.45	0.8976
Broilers + other poultry	18.22	17.15	37.27	32.80	0.8706
Vegetable production	1.25	2.16	0.74	2.89	0.6318
Swine	1.16	2.24	0.74	0.00	0.3027
Dairy	0.79	0.56	0.00	0.96	0.3555
Fruit production	0.37	1.28	1.48	1.93	0.6460
Other livestock	NA	NA	4.06	5.79	NA
Tree farming/logging	NA	NA	1.85	2.57	NA
Other agriculture	NA	NA	1.85	0.64	NA

Source: Nass Census data: USDA, NASS, 2012a, 2012b.
Notes: Values presented are percentages, except for p-values. Single, double, and triple asterisks (*, **, ***) represent p-values <0.1, <0.05, <0.01 respectfully

Table 2. Factors Influencing Number of CPs Adopted – Poisson Count Data Model: Marginal Effects

Parameter	dy/dx	Standard Error	z-score	P>|z|
WQ (belief in water quality issues)	0.8514	0.2380	3.5800	0.0000
NE (number of CPs believed effective)	0.0493	0.0242	2.0400	0.0420
NS (number of sources of information used)	-0.0287	0.0786	-0.3700	0.7150
Enterprise type				
Poultry Producers	0.7446	0.3216	2.3200	0.0210
Beef producers	1.6367	0.2088	7.8400	0.0000
Poultry and beef producers	1.8886	0.2956	6.3900	0.0000

Table 3. Factors Influencing the Perception of CP Effectiveness – Multinomial Probit Model Results

Practice		**Years**	**WQ**	**Enterprise Type**			**NS**	**Acres**
				Poultry	**Beef**	**Both**		
Use of comprehensive NMP	No	-0.0034	**-0.4776****	**-0.9615****	-0.0291	**-0.8950*****	**-0.2281*****	-0.0012
	Uncertain	0.0052	**-0.6560*****	**-0.4192****	**-0.4188****	-0.6277	**-0.1479****	0.0000
Filter strips	No	0.0029	0.0483	**-1.1453*****	**-0.6629*****	**-0.7017*****	-0.0729	**-0.0041*****
	Uncertain	-0.0083	-0.0334	**-0.9572*****	**-0.5666*****	**-1.0969*****	-0.0439	**-0.0030*****
Prescribed grazing	No	0.0129	**-1.0053*****	0.1140	0.1352	0.3019	**-0.1817****	-0.0001
	Uncertain	0.0080	**-1.5203*****	-0.0896	**-0.6482*****	-0.0769	0.0414	0.0002
Basing fertilizer off soil test	No	-0.0084	0.3756	-0.1642	-0.3594	**-0.6093***	**-0.3823*****	**-0.0065*****
	Uncertain	0.0029	-0.1894	**-0.8474***	**-0.6535****	-0.4389	-0.0517	**-0.0071*****
Soil testing	No	-0.0132	**0.8832****	-0.5285	0.4432	-0.0190	-0.1403	0.0008
	Uncertain	-0.0008	-0.0671	-0.1149	-0.0354	-0.4151	-0.0018	-0.0009
Controlled grazing	No	**-0.0172***	**-0.5963****	-0.1308	0.3827	0.4594	0.1296	-0.0008
	Uncertain	-0.0079	**-0.7618*****	**-0.8413****	**-0.5403****	**-0.5277***	0.0302	-0.0002
Pasture grass management	No	**-0.0210***	0.1292	-0.3129	**0.6458****	-0.3471	**-0.2820*****	-0.0021
	Uncertain	**-0.0198****	-0.3143	-0.2027	-0.1284	-0.2506	**-0.1645***	**-0.0035*****

Notes: Values presented are estimated coefficients, where single, double, and triple asterisks (*, **, ***) represent p-values <0.1, <0.05, <0.01 respectively

Table 4. Factors Influencing the Perception of CP Effectiveness – Marginal Effects

Practice	**Years**	**WQ**	**Enterprise Type**			**NS**	**Acres**
			Poultry	**Beef**	**Both**		
Use of comprehensive NMP	-0.0004	**0.1696*** **	**0.1740** **	0.0691	**0.2067*** **	**0.0525*** **	0.0002
Filter strips	0.0008	-0.0017	**0.2993*** **	**0.1823*** **	**0.2561*** **	0.0163	**0.0010*** **
Prescribed grazing	-0.0029	**0.3711*** **	0.0065	**0.0950* **	-0.0161	0.0155	0.0000
Basing fertilizer off soil test	0.0006	-0.0163	0.0840	**0.0944** **	**0.0989* **	**0.0412*** **	**0.0012*** **
Soil testing	0.0015	-0.0629	0.0461	-0.0449	0.0347	0.0154	0.0000
Controlled grazing	0.0027	**0.1754*** **	**0.1258** **	0.0459	0.0354	-0.0169	0.0001
Pasture grass management	**0.0047*** **	0.0389	0.0493	-0.0382	0.0582	**0.0486*** **	**0.0007*** **

Notes: Values presented are estimated coefficients, where single, double, and triple asterisks (*, **, ***) represent p-values <0.1, <0.05, <0.01 respectively

Figure 1 Adoption of Conservation Practices, by Percentage of Respondents

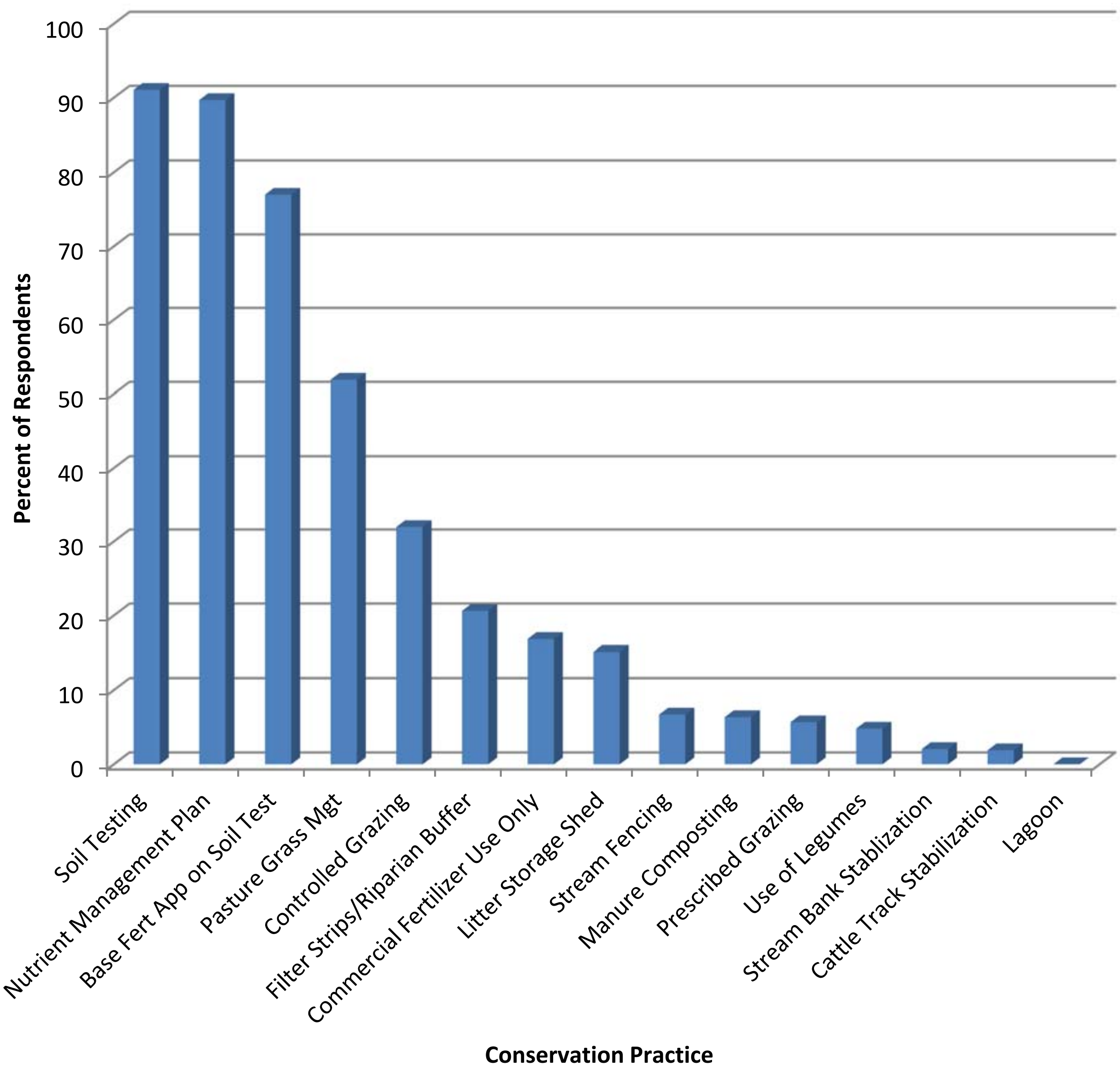

Figure 2 Sources of Information Used Regarding Conservation Practices, by Percentage of Respondents

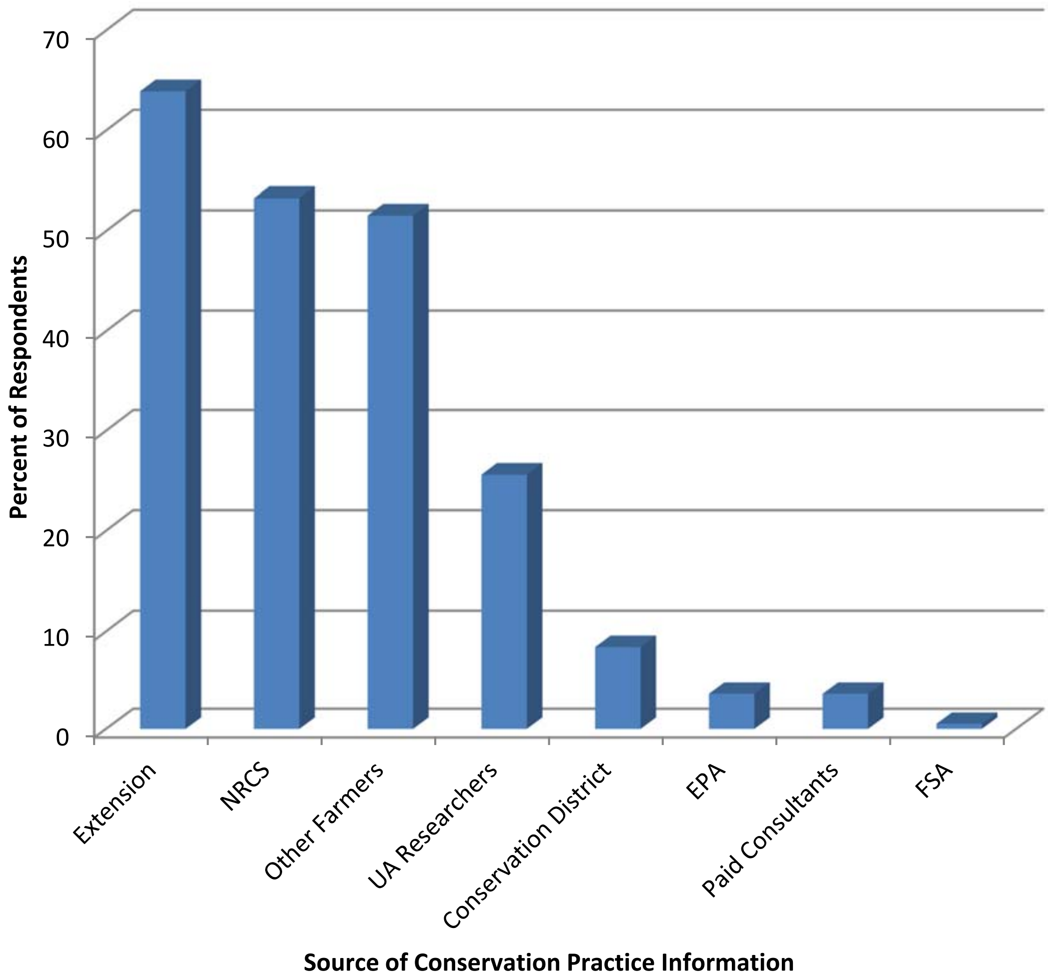

Figure 3 Belief in Effectiveness of a Conservation Practice, by Percentage of Respondents