REAP

Researching the Effectiveness of Agricultural Programs: Evaluating Survey Data in the Maumee and Saginaw Watersheds

Task 4a: Aggregating Existing Farmer Survey Data

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Executive Summary

Key Findings

The objective of the data analysis presented here was to compare farmer adoption of conservation practices between two GLRI priority watersheds using existing survey data. The results of the analysis are meant to identify ways to improve future investments that better account for the needs of the local farming populations, and the unique motivations and constraints.[1] Our results are limited to two priority watersheds, Saginaw and Maumee, due to data availability and comparability. With this data we aimed to answer three specific research questions:

(1) How do priority watersheds differ in their farm characteristics, beliefs, and conservation adoption?

(2) What socio-psychological factors are driving adoption of recommended practices?

(3) What is the impact of GLRI programs on key drivers of adoption?

How do the priority watersheds differ?

- Concerning the characteristics of the participants in our analysis, a majority of farmers are male with less than 10% female respondents in both watersheds. On average, Maumee farmers are slightly younger than Saginaw farmers (57 vs 63, respectively), while the majority of famers in both watersheds have some college education, but no degree. More respondents in the Maumee watershed identified as multi-generation farmers with their farm being previously owned and/or operated by a family member (88% vs. 75%, respectively).
- In terms of motivations, Maumee farmers have higher perceptions of risk related to local water quality but farmers in both watersheds "agree" that it is their personal responsibility to protect water quality. Both sets of respondents also possess the same level of moderately high perceived confidence that recommended best management practices protect water quality.
- In terms of barriers, Maumee farmers perceived the barriers to cover crop use as greater than those in the Saginaw, although on average farmers in both watersheds believe that barriers to cover crops limit their ability a little. In terms of general cost and time barriers related to BMPs, cost barriers are perceived are more problematic in both watersheds compared to time barriers.
- In terms of BMP adoption, approximately twice as many Saginaw farmers were using cover crops compared to Maumee farmers (51% vs. 26%, respectively). In terms of reduced tillage, more farmers in the Saginaw have adopted this practice compared to the Maumee (59% vs. 42% respectively). However, a much higher percentage of Saginaw farmers are enrolled in farmer

[1] The analysis informed the following *REAP project output*: future directions to support water quality improvements

incentive programs including EQUIP, CRP, and CSP (65% compared to 26% in the Maumee), despite the relatively higher use of nutrient trapping practices in the Maumee (using filter strips, saturated buffers, grass waterways). Maumee farmers also had higher adoption rates of right time (i.e., avoiding application before rain event, choosing spring over fall or winter) and right rate (i.e., application rates based on soil testing) practices. This may be due to the level of outreach done by the 4R Nutrient Stewardship Program in the Maumee watershed.

What factors drive adoption?

Our analyses indicate that the following factors explain adoption of the BMPs that are often the focus of GLRI investments.

- RIGHT TIME: The individuals *more likely to be applying fertilizers at the right time* were those who were younger, more educated, more concerned about water quality, perceived greater responsibility for water quality, and with more farming experience (for the Maumee only).
- COVER CROPS: The individuals *more likely to be using cover crops* were those with more education, who were already using reduced tillage and who were less concerned about cover crop barriers (i.e., issues related to the time required to implement cover crops, the cost, lack of equipment, uncertain long-term payback). This held true for both watersheds with the exception of education that was only significant for the Saginaw.
- RIGHT RATE: The individuals *more likely to be applying fertilizer at rates informed by soil tests* were younger farmers already using reduced tillage. For the Saginaw, right rate practices also increased with greater confidence in BMPs, while in the Maumee, right rate practices decreased with greater concern about cost-related barriers.
- REDUCED TILLAGE: The individuals *more likely to be using reduced tillage* were older farmers, while in the Maumee reduced tillage was also more common among those with higher water quality risk perception. Farmers in the Saginaw were also less likely to use reduced tillage as their perception of cost barriers increased.
- NUTRIENT TRAPPING: The individuals *more likely to have installed nutrient trapping practices (e.g., filter strips)* were those participating in incentive-based programs, while in the Saginaw nutrient trapping practices were more common among those that were confident that recommended management practices protected water quality.

What is the impact of GLRI programs?

Overall, we find evidence from two specific GLRI projects, that GLRI investments in farmer engagement and outreach do increase farmer knowledge about recommended practices, as well as confidence in some cases (for cover crops and no-till in particular). However, such events did not increase concern about the issues in general, and there is some evidence that outreach events are more meaningful for the non-farming public as a means of increasing their understanding of the issues and the role of agriculture. Despite these short-term positive impacts on farmer knowledge and beliefs, we do not see evidence that future intentions to use recommended practices increase as a result of participating in GLRI programming. The one exception to this is for cover crops, where these programs do seem to increase positive intentions. However, the best predictor of future use of a practice is past use.

Recommendations

- Future GLRI investments should recognize that each priority watershed is different, and the needs of the farming population will vary, as will the type of practices that are needed to decrease nutrient loss and improve water quality.
- Younger and more educated farmers have a tendency to be using a suite of recommended practices more often, indicating that older farmers with less education are in greater need of education and assistance.
- Applying fertilizer at the right time, both within and between seasons, is the one set of recommended practices that seems dependent on concern about water quality and feeling personally responsible for water quality issues. This would be an appropriate focus for future outreach, education and engagement through GLRI.
- Confidence in the recommended practices as a feasible and effective solution to nutrient loss and water quality issues is critical to promoting adoption, this could be a key focus of GLRI funding in the future (demonstrating effectiveness through demonstration farms and support for trial adoption of practices).
- Incentive based programs seem to be critical for nutrient trapping practices, which makes sense given the collective benefit nature of such approaches.
- Current outreach and engagement through the GLRI may be having a short-term impact on farmer beliefs and knowledge, but there is less evidence that it is leading to long-term change.
- There is evidence that concerns about the costs associated with recommended practices is a significant barrier, point to the need for well-designed incentive programs where the cost is prohibitive, as well as education to correct misperceptions about costs over time.

Introduction

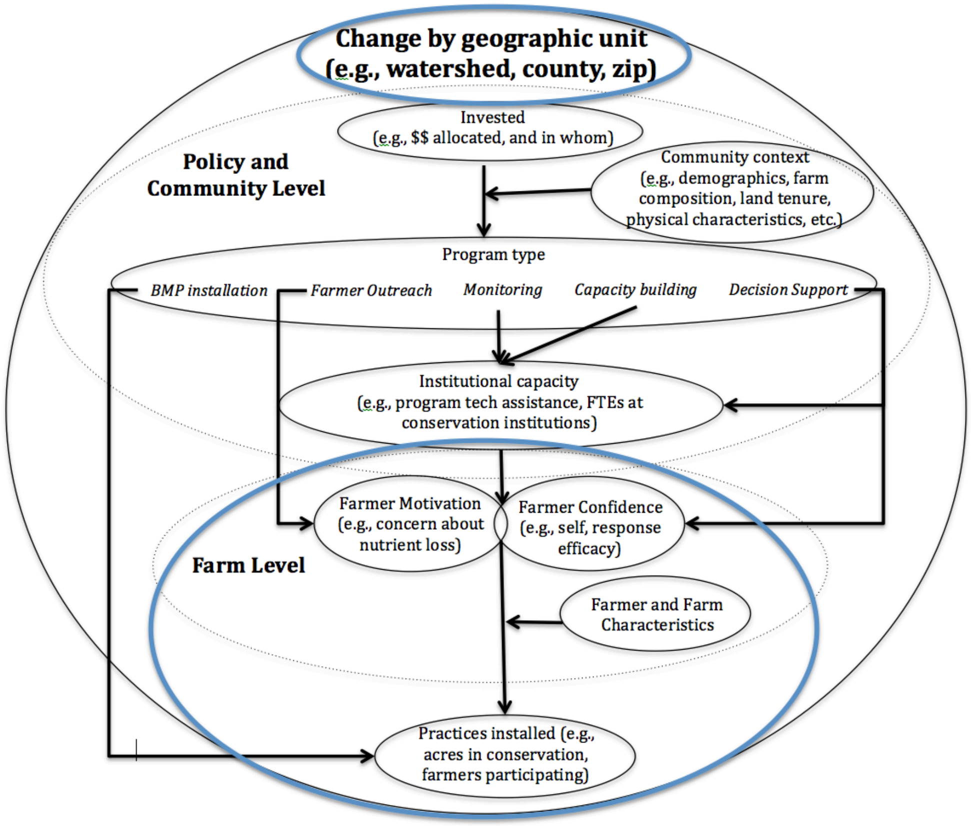
Project Background

Researching the Effectiveness of Agricultural Programs

Agricultural producers in the Great Lakes Basin have received over $100 million from the Great Lakes Restoration Initiative for agricultural conservation practices intended to influence on-farm decision making and improve water quality. The data presented in this report is one component of a GLRI-funded project using socio-economic analytics to evaluate the effectiveness of those federal (and selected state) incentives, using multiple indicators of success to better understand obstacles and opportunities for enhancing on-farm decision-making to improve water quality (see Fig. 1). The goal of the analysis presented here is to compare farmer adoption of conservation practices between two priority watersheds using existing survey data. The hope is that such an analysis can identify ways to improve future GLRI investments that better account for the needs of the local farming populations, and the unique motivations and constraints. A follow-up survey in four priority watersheds will further quantify these findings.

Specifically, the analysis addresses *why* changes in adoption occur through a set of correlational analyses, and *what* tangible benefits may result from GLRI investments at the farm level through a case study analysis of a pre-post survey data for two particular GLRI projects. The expected outcomes include: (1) an assessment of current knowledge, beliefs, intentions etc. at the farm level, and (2) an assessment of differences between the Saginaw and Maumee watersheds. These outcomes are reflected in Fig. 1, which demonstrates where this particular analysis (i.e., Task 4a) fits into the broader project. Specifically, in this task we are considering how farmer motivations, such as risk perception related to local water quality and confidence in BMPs, may influence BMP adoption at the farm level. We are also interested in how adoption may be influenced by other characteristics of the farm or farmer (e.g., farm size and farmer education), and how these relationships vary at different spatial scales (between priority watersheds and within priority watersheds by county or sub-watershed) (see Fig. 1).

Figure 1. REAP conceptual model highlighting the components of the analysis in Task 4a (blue circles)



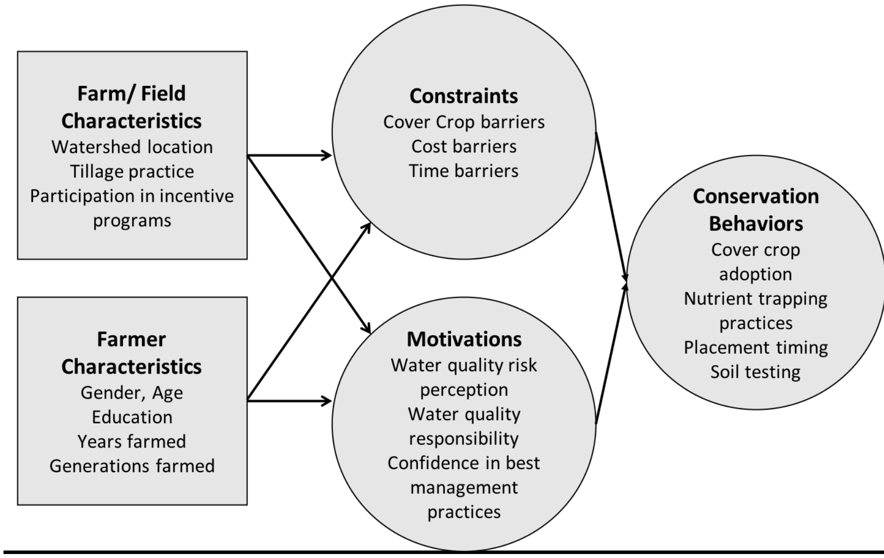
Using the existing survey data that we collected and aggregated for the Saginaw and Maumee watersheds (see Fig. 2), this analysis serves to answer 3 specific research questions:

(1) How do priority watersheds differ in their farm and farmer characteristics, beliefs, and conservation adoption?

(2) What socio-psychological factors are driving adoption of recommended practices?

(3) What is the impact of GLRI programs on key drivers of adoption?

Figure 2. Overlapping existing data in the Saginaw and Maumee Watershed



Methodology

Step 1: Identify existing survey instruments

Initially, a total of twenty-three survey instruments were identified that could be used to investigate farmer and farm characteristics, farmer motivation, confidence and practice adoption across the Saginaw, Maumee, and Lower Fox watersheds. No prior surveys were located for the Genessee watershed. Of the three surveys located in the Lower Fox, two were determined to have duplicate data so one was removed from consideration. Six of the Saginaw watershed surveys originated from the Social Indicators Database Management and Analysis system (SIDMA). Two of such survey instruments from Genesee County and South Branch Flint River were unobtainable. An additional four SIDMA surveys were taken out of consideration because they were not included in the priority watersheds (e.g., western Lake Erie basin but not Maumee). Two surveys were unable to be geolocated in terms of watershed but were suspected they included respondents in the Maumee and/or Saginaw watersheds One of such surveys instruments however, was unobtainable. From the six survey instruments identified in the Maumee watershed, one was unobtainable and one was taken out of consideration because recent data was still being processed. As a result, the following survey instruments were collected for further consideration (see Table 1).

Table 1. Initial survey instruments

Watershed	Survey Instrument	Institutions
Lower Fox	Brown and Outagamie Counties' Land and Water Conservation Department Questionnaire	Alliance for the Great Lakes
	View on Lower Fox and Green Bay Water Resources: Responses from Dairy Farmers	University of Wisconsin
Saginaw	Your View on Local Water Resources	Purdue University, MABA, IWR/ Michigan State University
	Sediment Reduction in the Sebewaing Watershed 2012	Social Indicators Database Management and Analysis systems
	Sediment Reduction in the Sebewaing Watershed 2015	Social Indicators Database Management and Analysis systems
	Sediment Reduction in the Swartz Creek Watershed 2012	Social Indicators Database Management and Analysis systems
	Sediment Reduction in the Swartz Creek Watershed 2015	Social Indicators Database Management and Analysis systems
Maumee	2014 Nutrient Management in the Maumee Watershed	Ohio State University, Purdue University, Michigan State University
	2012 Farmer BMP Survey	Ohio State University
	Blanchard River Demonstration Network Farm Evaluation Survey	Ohio State University, USDA, OFB
	2016 4R Nutrient Stewardship in the WLEB	Ohio State University, TNC, USDA, IPNI
Saginaw/ Maumee	Crop Management and Stewardship Practices	Michigan State University

Step 2: Combine survey instruments, grouping variables and identifying overlap

We began by creating a database listing all survey instruments and specific survey questions included in each instrument. The database was examined and sorted to identify "groupings" of questions that we determined addressed the same type of variable (e.g., identifying all questions that sought to measure the variable "water quality risk perception"). Variable "groups" were then created that represented the variable that several survey instrument questions were aiming to measure.

An early version of the database identified the following potential variable groups (each variable group contained several survey instruments with various prompts and scales of measurement):

> *Watershed familiarity, familiarity of agricultural and environmental issues, social connections, social trust, water quality knowledge, water quality control, nutrient loss control, water quality risk perception, nutrient loss risk perception, BMP efficacy, 4R awareness, management/ economic concern, legal concern, prioritization of conservation, farmer identity, risk attitude, location, farming experience, generations farming, off-farm job, income, acreage, livestock, and current practices on farm/field.*

Survey instruments were then further analyzed to see what could be feasibly grouped into the same category. Emerging patterns were noted and recorded such as the observation that across multiple surveys, questions regarding the use of grassed waterways, filter strips, and riparian buffers could be combined into a measure of "nutrient trapping" practices. The variable groups were then examined to see where they overlapped in terms of survey and watershed. For a variable group to be identified as overlapping, it needed to exist in at least one survey dataset per watershed. A new database was then created with the following shorter list of overlapping variable groups:

> *Specific practices (4Rs, crop rotation, livestock practices etc), use of crop advisor, barriers to specific practices, broad barriers (cost, time, knowledge), social connections, social trust, information frequency, farmer conservation identity, field and farm acreage, program participation, demographics, risk perception, efficacy, and income*

We then identified where overlap occurred on a watershed level, meaning that the variable group exists in at least one of the survey datasets per watershed. Variables where overlap occurred in all three watersheds was highlighted and presented in a similar manner to Table 2.

Table 2. Variable overlap in Lower Fox, Saginaw, and Maumee Watersheds

Variables	Lower Fox	Saginaw	Maumee
Gender	X	X	X
Age	X	X	X
Education level	X	X	X
Location of farm	X	X	X
Nutrient trapping practice	X	X	X
Drainage water management	X	X	X
Tillage practice	X	X	X
Cover crops practice	X	X	X
Nutrient management plan	X	X	X
Future intention of nutrient soil trapping	X	X	X
Future intention of cover crops	X	X	X
Barriers to broad management practices	X	X	X
Information source preference	X	X	X
Water quality risk perception	X	X	X
Water quality responsibility	X	X	X
Water quality control	X	X	X
Acreage of specific crop/ use	X	X	X
Livestock on farm	X	X	X
Decision making on farm	X	X	X
Family-owned farm	X	X	X

Step 3: Request data on specific variables from researchers

With this initial refined list of potential overlap, we were able to request the raw data from researchers. Two options were given to either 1) share their entire dataset or 2) provide for us only the specific survey instrument questions we identified as potentially overlapping and needed for analysis. A document was created listing each of the specific survey instrument questions needed from each survey to inform what data to ask for from each survey owner. Researchers were given the opportunity to send datasets from early April to the end of July. Multiple reminder emails were sent to researchers who had not yet replied, or replied and had not yet sent data, including a final email sent in July that stated we would be accepting datasets until the end of the month. Table 3. displays the final list of surveys for which we received data.

Table 3. List of surveys received in data request

Watershed	Survey Instrument	Institutions
Lower Fox	Brown and Outagamie Counties' Land and Water Conservation Dept Questionnaire	Alliance for the Great Lakes
Saginaw	Your View on Local Water Resources	Purdue University, MABA, IWR/ Michigan State University
	Sediment Reduction in the Sebewaing Watershed 2012*	Social Indicators Database Management and Analysis systems
	Sediment Reduction in the Swartz Creek Watershed 2012*	Social Indicators Database Management and Analysis systems
Maumee	2014 Nutrient Management in the Maumee Watershed	Ohio State University, Purdue University, Michigan State University
	2012 Farmer BMP Survey	Ohio State University
	Blanchard River Demonstration Network Farm Evaluation Survey	Ohio State University, USDA, OFB
	2016 4R Nutrient Stewardship in the WLEB	Ohio State University, TNC, USDA, IPNI

*Note: Sebewaing 2015 and Swartz 2015 were removed from analysis due to too small of sample size

Step 4: Combine variable-specific data into database for analysis

Because only one Lower Fox survey was received variable overlap between the three watersheds narrowed, as the one Lower Fox survey did not have as much comparable data. Thus, the focus then shifted to comparing the Saginaw and Maumee Watershed. This increased overlap in a few cases in which variables overlapped for Saginaw and Maumee watersheds but not the Lower Fox. A final database was created with the combined raw data of overlapping variables for each survey included in the analysis.

While details on specific-variable recoding is included in the statistical analysis section of the report, broadly speaking, final variable overlap was based on whether or not survey instrument questions were 1) clearly intending to measure the same concept, and 2) the scales used for measurement could be accurately transformed and/or combined while retaining the meaning and integrity of the data. Through this process, the inclusion of certain questions and instruments shifted due to discovering that they could not be accurately combined into one shared scale. The final overlap of variables by surveys is displayed in Table 4. Information on which specific instruments informed each variable, and how each question was recoded is included in the analysis and results section of the report. For the remainder of the report, the following survey codes will be used to refer to the original source of the data:

Survey Name	**Survey Code**
Sediment Reduction in the Sebewaing Watershed 2012	1
Sediment Reduction in the Swartz Creek Watershed 2012	2
Your View on Local Water Resources	3
2016 4R Nutrient Stewardship in the WLEB	4
2014 Nutrient Management in the Maumee Watershed	5
2012 Farmer BMP Survey	6

Table 4. Overlap of existing variables by survey and watershed

Variable	Survey 1	Survey 2	Survey 3	Survey 4	Survey 5	Survey 6
Gender	X	X	X	X	X	X
Age	X	X	X	X	X	X
Education	X	X	X	X	X	X
Years farmed	X	X		X	X	
Generation farmer	X	X				X
Reduced tillage	X	X	X	X	X	X
Water quality risk perception	X	X	X	X	X	
Water Quality Responsibility	X	X	X	X		
Confidence in practices	X	X	X		X	X
Cover crop barriers	X	X	X	X		
Cost barriers	X	X	X	X		
Time barriers	X	X	X	X		
Cover crop adoption	X	X	X	X	X	X
Right rate adoption	X	X	X	X	X	X
Right time adoption	X	X			X	X
Nutrient trapping adoption	X	X	X			X
Program Participation			X		X	X

Survey Instruments and Methodology

Surveys 1 & 2

Scientists across the Midwest developed the Social Indicators Data Management and Analysis (SIDMA) instrument to measure the social outcomes of water projects as indictors of environmental progress (Prokopy et al., 2009). The system includes core and supplemental indicators along with the process of how to collect and use such indicators. Surveys 1, 2 and 3 utilized for the survey instrument and methodology. We are awaiting more details on the project-specific details for survey 1 and 2.

Survey 3

The "Your Views on Local Water Resources: Saginaw Bay Watershed" survey was distributed to farmers in the Saginaw Bay watershed by the Natural Resource Social Science Lab at Purdue University (Eanes et al,. 2017a) The survey was released as part of a multi-phased, five-year study evaluating the effectiveness and impact of the Saginaw Bay Regional Conservation Program. The population targeted included agricultural producers and non-farming landowners of the Saginaw Bay (only those who identified as agricultural producers were used for the purpose of this analysis). A Freedom of Information Act request for names and addresses of individuals, businesses, and organizations resulted in a sampling frame of those who previously received funding from the Farm Bill. Geocoding six priority sub-watersheds, removing duplicate names and addresses, and a random selection led to a final sample size of 3,000 potential participants randomly divided into two lists of 1,500. Following a five-wave protocol, survey distribution started with two versions of an advance letter. One letter included a $2 inventive sent of 1,500 potential respondents while the other letter included no incentive. The letters contained a website address with a unique access code and a statement of an incoming paper survey for those who wished to not take the survey online. A total of 1,459 responses were recorded with a response rate of 49.5% including refusals (Eanes et al., 2017b).

Survey 4

The "4R Nutrient Management in the Western Lake Erie Basin" survey from The Ohio State University's College of Food, Agriculture, and Environmental Sciences served to study farmers perception around recommended nutrient management practices, the extent to which current research and education was impacting farmers, and to what extent retailer certification was influencing farmer decision making. The survey specifically investigated farmers' perceived barriers to adopting practices on their fields. Survey questions centered on perceived nutrient run-off in their area, perceived efficacy of recommended practices, characteristics of their farm, current management and nutrient application practices, farmer demographics, and a choice experiment examining how farmers make decisions to hire

Nutrient Service Providers. A sample of 3,272 names and mailing addresses for farmers in the Maumee Watershed was obtained from Farm Market ID (http://www.farmmarketid.com). This sample was divided and stratified by farm size with a final sample similar to census data for farms over 50 acres. The implementation process used the Tailored Design Method (Dillman, 2000) Of the 2,574 farmers contacted, 748 responses were used with an adjusted response rate of 29.1% (Prokup et al., 2017)

Survey 5

The "Farmers, Phosphorus and Water Quality" survey was conducted by The Ohio State University's College of Food, Agriculture, and Environmental Sciences School of Environment and Natural Resources. The survey served to investigate farmer decision-making to understand the prevalence of Best Management Practices in the Maumee Watershed, identify the reasoning behind farmers adopting certain BMPs, and investigate their motivation or willingness to adopt additional practices on their farm. The sample included corn and soybean farmers of the Maumee watershed and was purchased from Farm Market ID. The survey administration followed Dillman's Tailored Design (Dillman, 2000). The final round of cover letters included an incentive. Of the 2000 farmers initially targeted, 701 were used for potential analysis with those who did not operate a farm sorted out. The final response was 652 surveys (Wilson et al., 2013).

Survey 6

The "Farmers, Phosphorus and Water Quality: Part II" survey served to better understand the prevalence of various Best Management Practices in the Maumee Watershed, identity why farmers adopt specific BMPS, and identify the motivation behind farmer willingness to adopt additional practices. Of the approximately 12,000 addresses of corn and soybean farmers identified in the Maumee watershed by a private sampling firm, a random sample of 2500 for each of three survey versions was taken. This survey was conducted by researchers from The Ohio State University College of Food, Agricultural and Environmental Sciences and College of Arts and Sciences. The survey included questions over field-specific management practices relating to fields of particular crop productivity. Survey administration followed the Dillman's Tailored Design method (Dillman, 2000). Of the 75000 potential respondents, 3,234 were included in the potential analysis with an adjusted response rate of 43.12%. However, after those no longer farming were removed along with responses with insufficient questions answered, 2,764 were used in analysis (Burnett et al., 2015).

Analysis

The statistical analysis included in this report was created using the Statistical Program for the Social Sciences. To answer the first research question of how priority watersheds differ, we analyzed frequency distributions, measures of central tendency (mean, medium, mode) and valid percentages. The valid percentages were derived from a case-by-case deletion of missing data from each variable analyzed. The resulting data, respective to each watershed, was tested using a T-Test or Mann-Whitney U Test to determine whether or not these characteristics examined differed statistically between watershed. To examine the second research question of what socio-psychological factors are driving adoption of recommended practices, a binary logistic model was used to estimate the likelihood of adoption given a set of predictor variables (the characteristics examined in the first research question). To examine the third research question, about the impact of specific GLRI programs on farmer beliefs and rates of adoption, we used a series of pre-post test analysis (paired samples t-tests) to assess a change in beliefs or intentions following participation in a GLRI program. We also used correlational analyses to assess the extent to which particular changes in beliefs covaried with future intentions (e.g., does an increase in knowledge about cover crops positively correlate with an increase in future intentions to use cover crops?)

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Research Question 1: How do the watersheds differ?

The first research question we set out to answer was the following: how do the priority watersheds differ in their farm and farmer characteristics, beliefs, and conservation adoption? In the following sections we summarize the descriptive results from our analysis comparing the Saginaw and Maumee watersheds using the aggregated data described previously.

Farm and Farmer Characteristics

Gender & Age

Across all surveys, farmers were prompted to identify their gender as "male" or "female". To create a consistent code, gender data in survey 4 and 5 was recoded from [0-male, 1-female] to [1-male, 2-female]. Gender and age data is displayed in Table 5. The majority respondents in Saginaw and Maumee were male (91.4% and 97.1%). In both watersheds, less than 10% of respondents were female (8.6%, 2.9%). For Saginaw, the average age was 62.6 ranging from 28-97. On average, Maumee respondents were slightly younger with a mean age of 57.4 ranging from 18-86. In both watersheds, the most frequent age was 60. The demographics for gender and age was statistically different between the Saginaw and Maumee watershed, where the Saginaw had older farmers and more women (z= -8.326 , p=.000[2] and t= 9.659, p=.000[3] respectively).[4]

Table 5. Respondent gender and age

	Saginaw				**Maumee**			
Farmer Demographics	***N***	***Valid %***	***Mean***	***Std. Deviation***	***N***	***Valid%***	***Mean***	***Std. Deviation***
Male	1042	91.4	-	-	4024	97.1	-	-
Female	1042	8.6	-	-	4024	2.9	-	-
Age	944	-	62.6	13.4	3987	-	57.4	12.5

Education & Farming Experience

All surveys shared corresponding measures of education level coded on the same 1-6 categorical scale. Table 6. summarizes the distribution of education level across respondents in the Saginaw and Maumee watershed. For both watersheds, the category most often selected was a high school degree or

[2] Based on an independent samples Mann-Whitney U Test
[3] Based on an independent samples T-Test
[4] When reporting all significance level for T-Test and M-W U Test, it was considered whether or not equal variances were assumed

equivalent. On average however, farmers in the Saginaw and Maumee have an education level of "some college", with the majority reporting some college or less education. Although both groups of respondents have the same average level of education, Saginaw respondents are slightly more educated with a mean response of 3.14 compared to 3.04 for Maumee, reflecting the greater proportion of individuals with some college versus just a high school degree in the Saginaw relative to the Maumee ($z= -2.983$, $p= .003$)[5]. Farming experience was determined by self-reported years farmed. This value did not differ significantly between the watersheds with an average 35 years farmed for Saginaw and 38 for Maumee ($t= -1.332$, $p= .183$).[6]

Table 6. Respondent's highest level of education (Saginaw n= 1025, Maumee n= 3989)

Watershed	Saginaw	Maumee
Education Completed	***Valid %***	***Valid %***
Some high school	3.4	1.7
High school degree or equivalent	38.2	48.7
Some college, no degree	24.6	18.6
Associate's degree	14.4	11.2
Bachelor's degree	13.8	14.2
Graduate or professional degree	5.6	5.6

Generation Farmer

The variable generation farmer is used to describe whether or not a farmer owns/ operates farmland previously own/operated by family members. For surveys 1 and 2 in the Saginaw watershed, this question was phrased, "did any family member own and operate this farm before you did" with the options "no" or "yes". For surveys 5 and 6 in the Maumee watershed, the question was phrased, "how many generations has your family been farming some portion of your current operation" with options to checkmark whether or not the respondent was a first, second, or third generation farmer. Data from both phrasings of the question was recoded to simply answer whether or not the respondent was a multi-generation farmer. The recoded data on whether or not the respondent was a multi-generation farmer was given the value of [0- no, 1- yes]. On average, respondents in both watersheds were multi-generation

[5] Based on an independent samples Mann-Whitney U Test
[6] Based on an independent samples T-Test

farmers. Table 7 shows the percentage of farmers who identified as multi-generation farmers. More respondents in the Maumee watershed reported being multi-generation farmers ($z= -4.250$, $p= .000$).[7]

Table 7. Percentage of multi-generation farmers by watershed

Watershed	N	Label	Valid Percent
Saginaw	111*	Not multi-generation farmer	25.2
		Multi-generation farmer	74.8
Maumee	3283	Not multi-generation farmer	11.8
		Multi-generation farmer	88.2

*Small sample size due to variable only being represented in surveys 1 & 2

Current Reduced Tillage

We define reduced tillage as any form of tillage that leaves greater than 30% of the crop residue on the soil surface (e.g., conservation tillage, no-till, strip tillage, ridge tillage, etc). Varying measures of tillage practice across all six surveys were consolidated to represent a categorical variable of [0- Conventional tillage, 1- Reduced tillage] practice on farm. For surveys 1 and 2, only a measure of experience with “no-till” was measured. Because the practice of no-till is included in the category of reduced tillage, we proceeded to include this question in the combined variable of reduced tillage for Saginaw. The concept of no-till was presented as “planting seeds into narrow tilled strips in soil previously untilled by full-width inversion implements to reduce soil erosion” The respondent was asked to report familiarity with practice on a scale of 1-4 with [1- Never heard of it, 2- Somewhat familiar with it, 3- Know how to use it, not currently using it, 4- Currently using it, 9- Not relevant]. The “not relevant” option was coded out as we wanted to measure tillage-use among farmers whom it applied to as best as possible. Options 1-3 were coded as [0- conventional tillage] and option 4 was coded [1- reduced tillage].

Survey 3 measured reduced tillage through the prompt, “reduced-tillage: (e.g., no-till, strip-till, ridge-till). Reduced tillage is a practice that leaves crop residue from the previous year on the fields, while limiting soil distributing activities to only those necessary to place nutrients, condition residue and plant crops.” Respondents were asked to select an option that best described their experience with reduced tillage including [1- Not relevant, 2- Never heard of it and not willing to try it, 3- Never heard of it, but might be willing to try it, 4- Heard of it and not willing to try it, 5- Heard of it and might be willing to try it, 6- Used it in the past and not willing to try it again, 7- Used it in the past and might be willing to try it

[7] Based on an independent samples Mann-Whitney U Test

again, 8- Currently use it] As in surveys 1 and 2, "not relevant" was coded out. Options 2-7 were used as indicators that farmer was not using reduced tillage practice and recoded as [0- conventional tillage] and option 8 was recoded as [1- reduced tillage].

Surveys 4 and 5 had the exact same question measuring reduced tillage practice. This question was phrased, "What type of tillage was last used in this field based on crop residue after planting?" Options included [1-Conventional (<30% residue), 2- Conservation (30-90% residue), 3- No-till (>90% residue)] To measure those practicing reduced tillage, option 1 was coded as [0- conventional tillage] while 2 and 3 were [1- reduced tillage]. The option existed to use a different phrasing of the question in survey 5, which stated, "across your total farm operation, what % of your planted acreage was in each type of tillage this past year?" However, the question in survey 5 that was identical to the tillage question in survey 4 was used to keep consistency when possible.

Survey 6 gave respondents the opportunity to circle a number indicating how often they engaged in "No-till (90% or more post-planting residue)" and "Conservation tillage (30-90% post-planting residue). The response options included [0- Never, 1- Sometimes, 2- Always]. This frequency measure was recoded to inform the [no, yes] usage variable by determining that [1- Sometimes, 2- Always] represented a [1- reduced tillage] as *sometimes* still indicates engagement.

As seen in Table 8, farmers in the Saginaw watershed had more adoption of reduced tillage ($z= -9.912$, $p= .000$).[8]

Table 8. Percentage of farmers who practice reduced-tillage by watershed

Label	Watershed	N	Valid Percent
Practice some form of reduced tillage	Saginaw	782	59.1%
	Maumee	3901	42.2%

Motivations

Water Quality Risk Perception

Across surveys 1-5, survey questions or items were chosen that were intended to measure farmer water quality risk perception (e.g., measures of concern, problem severity, and perception of pollutants, sources, consequences and quality of local water bodies and Lake Erie). Table 9. displays the scope of prompts merged under the water quality risk perception. An attempt was made to remain as objective as possible when measuring risk perception and avoid prompts such as, "How concerned are you about your

[8] Based on an independent samples Mann-Whitney U Test

farm contributing to algal blooms in lake Erie?" (Survey 4), as a question like this brings into consideration whether or not the farmer believes their farm is contributing to water quality risks. It would not be valid to compare this question against the questions in surveys 1-3 that are not specific to the consideration of one's farm.

Surveys 1-3 used the same response scale which included [1- not a problem, 2- slight problem, 3- moderate problem, 4- severe problem, 5- don't know] option [5- don't know] was coded out and not included in the scaled measure of risk perception. Survey 4 prompted the respondent to circle a number that best represented how concerned they were on a level from [0- not at all concerned, to 6- extremely concerned]. This question was recoded to match the 4-option scale from surveys 1-3 because it was more logical to condense a 6-point scale to a 4-point scale than to stretch the 4-point scale. [0- not at all concerned] was recoded to represent a [1- no water quality risk perception], [1,2] on the concern scale was recoded to represent [2- slight water quality risk perception], [3,4] on the concern scale was recoded to represent [3- moderate water quality risk perception], and [5,6] on the concern scale was recoded to represent [4- severe water quality risk perception].

Survey 5 included three types of questions with three separate scales. The first question asked the respondent to rate overall water quality locally and in Lake Erie. This was coded on a scale of [-3- very bad, 0- neither good nor bad, 3- very good]. [-3- very bad] was recoded as [4- severe water quality risk perception], [-2, -1] rating was recoded as [3- moderate water quality risk perception], [0, 1, 2] rating was recoded as [2- slight water quality risk perception] and [3-very good] was recoded as [1- no water quality risk perception]. The next question was similar to the concern question in Survey 4 with an identical scale of [0- not at all concerned, to 6- extremely concerned]. The only difference was the specification of concern in western Lake Erie as opposed to Lake Erie in survey 4. This question was recoded in the same manner as in survey 4. The final question was an indication of how serious respondents felt the negative consequences of nutrient loss would be in western Lake Erie. This question included a scale of [0- not at all serious, 1- slightly serious, 3-serious, 4- moderately serious, 5- extremely serious]. [0- not at all serious] was recoded to [0- no water quality risk perception], [1, slightly serious] was recoded to [2- slight water quality risk perception], [3- serious, 4- moderately serious] was recoded to [3- moderate water quality risk perception], and [5- extremely serious] was recoded to [4- severe water quality risk perception].

Table 10. illustrates the average level of water quality risk perception. Overall, respondents in the Maumee watershed possess higher water quality risk perception than respondents in the Saginaw (z= -9.912, p= .000).[9] For Saginaw farmers, the most frequent response indicated "slight water quality risk

[9] Based on an independent samples Mann-Whitney U Test

perception" while the most frequent response for the Maumee watershed indicated "moderate water quality risk perception".

Table 9. Measures of water quality risk perception in surveys 1-5

Survey			Water Quality Measure
Saginaw	How much of a problem are the following…	1	water impairments in your area? (sedimentation in the water, nitrogen, phosphorus)
			sources in your area? (soil erosion from farm fields, soil erosion from shorelines/ streambanks, excessive use of lawn fertilizers etc. *3 more sources listed)*
			issues in your area? (loss of desirable fish species, reduced beauty of lakes or streams, reduced quality of water recreation activities, excessive aquatic plants or algae)
		2	water impairments in your area? (sedimentation in the water, nitrogen, phosphorus)
			sources in your area? (soil erosion from farm fields, soil erosion from shorelines/ streambanks, excessive use of lawn fertilizers etc. *4 more sources listed)*
			issues in your area? (loss of desirable fish species, reduced beauty of lakes or streams, reduced quality of water recreation activities, excessive aquatic plants or algae)
		3	pollutants in the Saginaw Bay watershed? (sedimentation, nitrogen, phosphorus, bacteria, muck)
			sources in the Saginaw Bay watershed? (discharges from industry into streams and lakes, discharges from wastewater, soil erosion from farm fields, etc. *10 more sources)*
			issues in the Saginaw bay watershed? (contaminated drinking water, contaminated fish, loss of desirable fish species, etc. *7 more issues)*
Maumee		4	Please circle the number that best represents how concerned you are about the following issues: the negative impacts of nutrient loss on Lake Erie
			How would you rate the overall quality of the water in the rivers, streams, and lakes the water in lake Erie How would you rate the overall quality of the water in Lake Erie?
		5	Please circle the number that indicates how serious you feel the negative consequences of nutrient loss in western lake Erie are to (you and your family, your local community, communities on and around lake Erie, plants and animals in local streams, plants and animals in Lake Erie)

Table 10. Average water quality risk perception

Watershed	N	Mean	Std. Deviation
Saginaw	925	2.4	.65
Maumee	3530	2.8	.64

Water Quality Responsibility

Surveys 1, 2, and 3 contained the exact wording, “it is my personal responsibility to help protect water quality” and were measured on a scale of [1- strongly disagree, 2- disagree, 3- agree nor disagree, 4- agree, 5- strongly agree]. Survey 4 asked, “it is my personal responsibility to help protect local water quality” and was measured on a scale of [-2- strongly disagree, -1- disagree, 0- neither disagree nor agree, 1- agree, 2- strongly agree]. This scale was recoded to match the 1-5 scale of surveys 1, 2, and 3. As seen in Table 11., the majority of respondents in both Saginaw and Maumee agree that, “it is my personal responsibility to help protect water quality”. There was so significant difference in perceived water quality responsibility between watersheds (t= .856, p= .392).[10]

Table 11. Distribution of farmers agreeing with personal responsibility to protect water quality

Survey	N	Strongly disagree (%)	Disagree (%)	Agree nor disagree (%)	Agree (%)	Strongly Agree (%)
Saginaw	985	.7%	.5%	8.7%	60.9%	29.1%
Maumee	2768	.1%	.9%	8.3%	64.9%	25.8%

Confidence in Best Management Practices

Surveys 1-3 measured confidence in best management practices with the same prompt and scale of, “Using recommended management practices on farms improves water quality” [1- strongly disagree, 2- disagree, 3- neither agree nor disagree, 4- agree, 5- strongly agree]. Survey 4 asked, “To what extent can the widespread adoption of these practices improve water quality in western lake Erie”. Such best management practices included “avoiding broadcasting when the forecast predicts a 50% or more chance of at least 1 inch of total rainfall in the next 12 hours”, “avoiding surface application of phosphorus on frozen ground”, “incorporating broadcast fertilizer (via tillage)”, “subsurface placement of fertilizer (via banding or in-furrow with seed)”, “determining rates based on regular soil testing once within the rotation (or every three years” and “incorporating winter wheat or cereal rye cover into rotation”. These prompts were coded on a scale of [0- not at all, 1- a little, 2- somewhat, 3- a good deal, 4- to a great extent] and

[10] Based on an independent samples T-Test

recoded to represent a 1-5 scale matching the confidence measures of surveys 1-3. It was determined that "not at all" was synonymous with "strongly disagree (that adoption of practices improve water quality)" and the labels were adjusted accordingly to now fit a 1-5 scale of agreement with the prompt statement. The six best management practices were then combined and calculated to find the average confidence level across all management practices. Survey 6 measured confidence with the question, "to what extent do you agree or disagree that nutrient management practices (like filter strips and cover crops) improve water quality". The scale spanned [-2- strongly disagree, -1- disagree, 0- neither disagree nor agree, 1- agree, 2- strongly agree]. Because this scale was already a 5-point scale, the numbers were recoded to range from [-2-2] to [1-5].

Table 12. displays the average level of confidence that best management practices improve water quality. On average, farmers in both the Saginaw and Maumee agree that using best management practices improve water quality. There is no significant difference between confidence in BMPs between farmers in each watershed (t= .891, p= .373).[11]

Table 12. Confidence that best management practices improve water quality

Watershed	N	Mean	Std. Deviation
Saginaw	986	4.0 (Agree)	.74
Maumee	1334	4.0 (Agree)	.85

[11] Based on an independent samples T-Test

Constraints

Cover Crop Barriers

Questions were identified in surveys 1-4 that specifically identified barriers to adopting cover crops. While each dataset varied on the specific prompt, all barriers relating to cover crop adoption was consolidated to represent a broad sense of the level of perceived barriers existing to cover crop adoption in each watershed. Table 13 illustrates the range of barriers included in the overall cover crop adoption barrier variable. Questions for surveys 1, 2, and 3 were coded to answer how much the following factors limited one's ability to implement cover crops by [1- not at all, 2- a little, 3- some, 4- a lot, 5- don't know]. Option 5 was coded out as it did not support the measure for level of perceived barriers. The scale from surveys 1-3 was used as the final scale that survey 4 was recoded to match. Survey 4 asked to what extent the respondent agreed or disagreed with each statement scaled [-2- strongly disagree, -1- disagree, 0- neutral, 1- agree, 2- strongly agree]. [-2 strongly disagree] was recoded to [1- limit your ability not at all], [-1 disagree, 0- neutral] was recoded to [2- limit your ability a little], [1- agree] was recoded to [3- limit your ability some] and [2- strongly agree] was recoded to [4- limit your ability a lot]

The average perceived barriers to cover crop adoption are low in both watersheds (i.e., barriers limit your ability a little), but greater in the Maumee ($t= -6.978$, $p=.000$).[12]

[12] Based on an independent samples T-Test

Table 13. Specific barriers to cover crop adoption

Watershed	Survey	Barrier to Cover Crop Adoption
Saginaw	1 & 2	Don't know how to do it
		Time required
		Cost
		The features of my property make it difficult
		Insufficient proof or water quality benefit
		Desire to keep things the way they are
		Hard to use with my farming system
		Lack of Equipment
	3	Don't know how to do it
		Time required
		Cost
		Hard to use with farming operation
		Lack of equipment/ technology
		My agronomist/ crop advisor has never mentioned this practice
		My agronomist/ crop advisor suggest not doing this practice
Maumee	4	The profit margins for winter wheat are too small
		Establishing winter cover crops is too difficult due to uncertain planting window
		The risks of winter cover crops interfering with spring planting are too great
		The near term cost of cover crops is too great for the uncertain long-term payback

Table 14. Average perception of level at which barriers limit cover crop adoption

Watershed	N	Mean*	Std. Deviation
Saginaw	700	2.2	.84
Maumee	729	2.5	.57

*[1- not at all, 2- a little, 3- some, 4- a lot, 5- don't know]

Cost and Time Barriers

The method behind choosing and recoding data to represent cost and time barriers was replicate to that of cover crop barriers resulting in a prompt and scale of "how much the following factors limited one's ability to implement cover crops" [1- not at all, 2- a little, 3- some, 4- a lot]. Instead of choosing a wide range of barriers associated with cover crop practices, the cost and time barriers associated with a wide range of practices were combined to create a variable of broad cost barriers to implement recommended practices.

For survey 1, the cost variables associated with residue retention, cover crops, and filter strips were chosen along with two cost prompts included in a measure of broad barriers to change management practices. These two cost prompts read, "personal out of pocket expense" and "lack of government funds". Survey 2 contained identical variables and prompts with the exception of adding one more cost variable for soil tests. Survey 3 included cost barriers associated with cover crops, reduced tillage, and nutrient management plans. Survey 4 included cost barriers associated with nutrient placement, soil tests, and cover crops.

For survey 1, time barriers associated with no-till, residue retention, cover crops, and filter strips were consolidated to create the broad barrier of time to engage in adoption. Survey 2 time barriers came from soil tests, no-till, cover crops, and filter strips. Survey 3 included time barriers connected to cover crops, reduced tillage, and nutrient management plans. Survey 4 had time barriers associated with alternatives to broadcasting.

As seen in Table 15., on average, cost barriers are perceived as slightly higher than time barriers in both the Saginaw and Maumee watersheds. Cost and time barriers were similar among watersheds, but farmers in the Maumee perceived the barriers as slightly higher. The difference in cost and time barriers were significantly different between the two watersheds (t= -3.701, p=.000 and -6.511, p= .000, respectively).[13]

[13] Based on an independent samples T-Test

Table 15. Average perception of the degree to which cost and time barriers limit practice adoption

Barrier	Watershed	N	Mean	Std. Deviation
Cost Barrier	Saginaw	911	2.3	.94
	Maumee	729	2.4	.46
Time Barrier	Saginaw	895	2.1	.94
	Maumee	727	2.3	.64

*[1- not at all, 2- a little, 3- some, 4- a lot, 5- don't know]

Practices

Cover Crop Adoption

Current cover crop adoption was measured across all surveys in the form of [0- no cover crop, 1- yes cover crop]. Surveys 1 and 2 included a measure for current cover crop adoption in the question "how familiar are you with this (cover crop) practice?". Options ranged from [1- never heard of it, 2- somewhat familiar with it, 3- know how to use it; not using it, 4- currently using in, 9- not relevant]. Option 9 was coded out, while options [1-3] were coded as [0- no cover crop] and option [4] was coded as [1- yes cover crop].

Survey 3 measured cover crop adoption through the prompt, "Cover crops are planted for erosion production, soil improvement, and water quality improvement." Respondents were asked to select an option that best described their experience with cover crops including [1- Not relevant, 2- Never heard of it and not willing to try it, 3- Never heard of it, but might be willing to try it, 4- Heard of it and not willing to try it, 5- Heard of it and might be willing to try it, 6- Used it in the past and not willing to try it again, 7- Used it in the past and might be willing to try it again, 8- Currently use it]. As in the surveys 1 and 2, [1- Not relevant] was coded out. Options 2-7 were used as indicators that the farmer was not using crops and recoded as [0- No cover crop] and option 8 was recoded as [1- Yes cover crop].

Survey 4 asked, "was a cover crop planted on this field after the 2015 harvest?" on a [0- No, 1- Yes] scale. There was an option to use the prompt, "in the last three years I have used cover crop/ have not used cover crop" however, a time scale of three years gave a less accurate depiction of current cover crop practice. Survey 5 had a similar prompt and scale to survey 4 with a slight change of wording, "was a cover crop planted on this field after the most recent crop". These questions from surveys 4 and 5 gave the most accurate depiction of current cover crop adoption as possible.

Survey 6 asked whether respondents planted cover crops after row crop harvest never, sometimes, or always. Sometimes and always were chosen to represent the [1- Yes cover crop]. This was the result of a decision that *sometimes* still implied adoption.

As seen in Table 16., 51% of Saginaw farmers reported having adopted cover crops while only 26.2% of Maumee farmers reported using cover crops. The adoption rate of cover crops in the Saginaw is statistically different to that of the Maumee (z= -13.827, p= .000)[14]

Table 16. Percentage of farmers reporting current cover crop use on their farm

Watershed	N	Value	Valid %
Saginaw	760	No cover crop use	48.8
		Yes cover crop use	51.2
Maumee	4199	No cover crop use	73.8
		Yes cover crop use	26.2

Right Time Practices

We define the "right time" as choosing to be precise in the timing of fertilizer application, whether that is considering the best timing within (e.g., avoiding application before a rain event) or between seasons (e.g., choosing spring over fall or winter). As with cover crop adoption, current right time practices were coded into two categories [0- No right time] and [1- Yes right time]. For each survey, the right time variable included any or all of the practices that fall under the broad 4R "Right Time" management category (https://www.nutrientstewardship.com/4rs/). For surveys 1, 2, and 6, these practices included, "avoid fall application of manure or nitrogen fertilizer." Survey 4 similarly contained "avoiding fall/winter application of phosphorus" and also included "avoiding winter or frozen ground surface application of phosphorus" and "delaying broadcasting when the forecast predicts a 50% or more chance of at least 1 inch of total rainfall in the next 12 hours".

Table 17. displays the percentage of right time adopters vs. non-adopters in the Saginaw and Maumee watersheds. Maumee farmers have a higher adoption rate at 58.5% than Saginaw farmers with an adoption rate of 50.5% (z= -1.510, p= .131).[15] The strong presence of 4R Nutrient Stewardship in the Maumee watershed supports this trend of higher right time adoption rate as "Right Time" is included in the 4-Rs of right source, right time, right rate, and right place, a campaign that is very prevalent in the western Lake Erie basin (https://www.nutrientstewardship.com/4rs/).

[14] Based on an independent samples Mann-Whitney U Test
[15] Based on an independent samples Mann-Whitney U Test

Table 17. Percentage of farmers adopting right time practices

Watershed	N	Value	Valid %
Saginaw	91*	No right time use	49.5
		Yes right time use	50.5
Maumee	3459	No right time use	41.5
		Yes right time use	58.5

*Small sample size due to variable only being represented in surveys 1 & 2

Right Rate Practices

We define “right rate” practices as an attempt to determine application rates based on soil testing. Expanding the same methodology to calculate cover crop and right time adoption, right rate adoption was identified through the combination of any/all variables associated with 4R right rate adoption. Survey 1 included the practice, “conduct regular soil tests for pH, phosphorus, and nitrogen and potassium”. Survey 1 along with survey 2 included, “follow university recommendations for fertilizer rates”. Survey 3 contained the practices, “variable rate application of phosphorus” and “regular soil testing.” Similarly, the measure for right rate adoption in survey 4 read, “do you use soil testing to inform your nutrient management decisions?” Survey 5 had the most practices listed including, “do you use soil testing on this field to inform your nutrient management decisions?”, “grid soil sampling for variable rate application”, “determining rates based on regular soil testing once within the rotation (or every three years), and “following soil test trends to maintain the agronomic range for phosphorus in the soil”. Survey 6 included, “regular soil testing”, “grid (zone) sampling or variable rate fertilizer application”, and “one-year of fertilizer per year on a corn crop”.

Table 18. contains the percentage of farmers adopting right rate practices. Out of all the practices included in this analysis, right rate practices have the highest adoption rate in both the Saginaw and Maumee. Maumee has a higher percentage adoption of right rate practices than the Saginaw, which further aligns with the high presence of 4R Nutrient Stewardship programs in the Maumee Watershed (z= -11.749, p= .000).[16]

[16] Based on an independent samples Mann-Whitney U Test

Table 18. Percentage of farmers adopting right rate practices

Watershed	N	Value	Valid %
Saginaw	950	No right rate use	28.0
		Yes right rate use	72.0
Maumee	4222	No right rate use	12.7
		Yes right rate use	87.3

Trapping Practices

We define trapping practices as any practice meant to provide a collective benefit to water quality by trapping the soil and water that may leave the field during rain events (e.g., filter strips, saturated buffers, grass waterways, etc). Adoption of nutrient trapping practices appeared in surveys 1, 2, 3, and 6. Surveys 1 and 2 included filter strips. In addition to filter strips survey 1 included residue retention practices. Survey 3 included grass/tree riparian buffers or filter strips, saturated buffers, grassed waterways, winder breaker/shelterbelt establishment, conservation cover, treatment wetland, and grade stabilization structures. Survey 6 included grass waterways, filter strips, and lagoon/wastewater system.

As with right rate and right time practices, nutrient trapping practices have a higher adoption rate in the Maumee watershed as compared to the Saginaw (z= -5.069, p= .000).[17] Table 19. demonstrates the percent adoption of nutrient trapping practices, showing that nutrient trapping practices are used more often than right time practices, but less often than right rate practices in both watersheds.

Table 19. Percentage of farmers adopting nutrient trapping practices

Watershed	N	Value	Valid %
Saginaw	956	No nutrient trapping use	31.1
		Yes nutrient trapping use	68.9
Maumee	680	No nutrient trapping use	19.9
		Yes nutrient trapping use	80.1

[17] Based on an independent samples Mann-Whitney U Test

Program Participation

Incentive-based program participation was included in surveys 3, 5, and 6 and was coded on a basis of [0- no participation] and [1- yes participation]. Overall participation in any program was calculated, with the most common programs being CSP, CRP, and EQUIP. Any other program or participation in an “other” option was also included. As seen in Table 20. describing overall program participation, farmers in the Saginaw watershed indicate a much higher rate of program participation (z= -21.629, p= .000).[18]

Table 20. Overall program participation

Watershed	N	Value	Valid %
Saginaw	838	No program participation	34.7
		Yes program participation	65.3
Maumee	3508	No program participation	74.0
		Yes program participation	26.0

[18] Based on an independent samples Mann-Whitney U Test

Second Research Question: What factors explain adoption?

To answer the second research question, "What socio-psychological factors are driving adoption of recommended practices", we examined the extent to which the variables that overlapped between data sets could explain adoption rates of recommended practices. Specifically, we were able to investigate predictors to current right time, right rate, reduced tillage, cover crops, and nutrient trapping practices. Regression analysis was used to analyze the relationship between adoption of a particular practice (the dependent variable) and one or more predictors (the independent variables). Because the dependent variables were categorical on the basis of [0- no adoption, 1- yes adoption], logistic regression was chosen as the best statistical technique to answer the research question. We ran two regressions for each management practice to compare how the predictors of adoption may vary between the two priority watersheds.

In order to determine which variables would be chosen to test predictive impact on practice adoption, we had to consider the available overlap of independent and dependent variables at a survey level. Table 4 can once more be used as a visual to examine the existence of variables by survey. Binary logistic regression treats missing data with "listwise deletion". When listwise deletion occurs, only cases that do not contain any missing data for any of the chosen analysis will be included in the test. Therefore, we could not calculate the predictive potential of a wide range of independent variables at a watershed level due to the fact that there were no surveys that possessed all of the listed variables. As a result, the methodology for choosing how many independent variables from which survey to explain adoption rates was based on which combination of surveys could be used to explain adoption of recommended practices with the most available factors. Table 21 displays the surveys and variables used to predict each adopted practice. The most inclusive combination of surveys and independent variables was used to test influence on the dependent practice variables.

Table 21. Independent and dependent predictor variables and survey data used in analysis

Dependent variable	Survey	Independent variable
Right time adoption	1, 2, 5	Gender, Age, Education, Water quality risk perception, Water quality responsibility, Years farmed, Generations farmed
Cover crop adoption	1, 2, 3, 4	Gender, Age, Education, Reduced tillage, Water quality risk perception, Confidence, Cover crop barriers
Right rate adoption	1, 2, 3, 4	Gender, Age, Education, Reduced tillage, Water quality risk perception, Confidence, Cost barriers, Time barriers
Reduced tillage adoption	1, 2, 3, 4	Gender, Age, Education, Water quality risk perception, Confidence, Cost barriers, Time barriers
Nutrient trapping adoption	3, 5	Gender, Age, Education, Confidence, Program participation

Right Time Adoption

The model for applying fertilizer at the "right time" included eight independent variables (gender, age, water quality risk perception, water quality responsibility, years farmed, generation farmer, education). Education was recoded into three categories [1- some high school, 2- high school degree, 3- higher education].

For the Saginaw watershed, the model was not significant ($p > .05$); as a result these results will not be presented. However, the model including all predictors was statistically significant for the Maumee watershed (chi-square (8, N= 2517) = 143.0, $p < .000$), indicating the model could distinguish between respondents who adopted and did not adopt right time practices. The entire model explained between 5.5% (Cox and Snell R square) and 7.4% (Nagelkerke R squared) of the variance in adoption and correctly classified 62.7% of cases. As displayed in Table 22, five of the independent variables made a unique statistically significant contribution to the model (age, education, water quality risk perception, water quality responsibility, years farmed). The odds ratio of .97 inversely indicates that as age increases, the odds of adopting right time practices decreases by 1.03. For education, the odds ratio of 2.14 indicates that compared to having some high school education, those with continued education past high school increase their odds of adopting right time practices by 2.14. The odds ratio for water quality risk perception suggests that each point increase of perceived water quality risk increases the odds of adopting right time practices by 1.70. For each point increase in perceived water quality responsibility, odds of adopting right time practices increase by 1.28. Finally, increasing the number of years farmed increases the odds of adopting right time practices by 1.01. Overall, these results indicate that the likelihood of applying fertilizer at the right time to minimize nutrient loss increases with an education beyond high school, concern about water quality, perceived responsibility for water quality, farming experience, while it decreases with age.

Table 22. Predicting likelihood of adopting "right time" practices in the Maumee

Independent Variable	*B*	S.E	Wald	*df*	*p*	Odds Ratio	95% C.I for Odds Ratio Lower	Upper
Gender	-.33	.31	1.16	1	.28	.72	.39	1.31
Age	-.027	.005	23.58	1	.00	.97	.96	.98
Water quality risk perception	.531	.09	35.43	1	.00	1.70	1.43	2.03
Water quality responsibility	.24	.08	10.70	1	.00	1.28	1.10	1.48
Years farmed	.01	.01	7.73	1	.01	1.01	1.00	1.02
Generation farmer	-.05	.14	.01	1	.73	.953	.73	1.25
HS degree	.27	.33	.70	1	.40	1.32	.69	2.49
Higher education	.76	.33	5.37	1	.02	2.14	1.12	4.07

Cover Crop Adoption

The model explaining cover crop adoption included seven independent variables (gender, age, education, reduced tillage, water quality risk perception, practice confidence, and cover crop barriers). Education was recoded into three categories [1- some high school, 2- high school degree, 3- higher education].

For respondents in the Saginaw Watershed, the model including all predictors was statistically significant (chi-squared (8, N= 517) = 33.51, p < .000), indicating the model could distinguish between respondents who adopted and did not adopt cover crops. The entire model explained between 6.3% (Cox and Snell R square) and 8.4% (Nagelkerke R squared) of the variance in adoption and correctly classified 71.5% of cases. As displayed in Table 23, only three of the independent variables made a unique statistically significant contribution to the model (education, reduced tillage, and cover crop barriers). The odds ratio of .72 inversely indicates that for each point increase on the scale of perceived cover crop barriers, the odds of adopting cover crops decreases by 1.39. As compared with some high school education, a higher education degree increased the odds of adopting cover crops by 8.99. Almost significant but slightly above a *p* value of .05 at .06, having a high school degree compared to some high school education increased the odds of adopting cover crops by 7.41. With an odds ratio of 1.50, if a farmer had currently adopted reduced tillage practices, their odds of adopting cover crops increased by 1.5. Overall, this indicates that cover crop use is more likely among those with more education, and those who are already using reduced tillage practices. Adoption is lower among those who perceived the barriers to cover crop use as greater.

The model for the Maumee watershed including all predictors was statistically significant (chi-squared (8, N= 649) = 79.55, p < .000), indicating the model could distinguish between respondents who adopted and did not adopt cover crops. The entire model explained between 11.5% (Cox and Snell R square) and 16.5% (Nagelkerke R squared) of the variance in adoption and correctly classified 74.1% of cases. As displayed in Table 24, only two of the independent variables made a unique statistically significant contribution to the model (reduced tillage and cover crop barriers). Farmers already engaging in reduced tillage were twice as likely to use cover crops, increasing odds by a ratio of 1.84. While a one-unit increase in perceived barriers decreased the odds of adopting cover crops by 4.08. Overall, this indicates that as seen in the Saginaw, those using reduced tillage practice are more likely to adopt cover crops and adoption is lower among those who perceive the barriers to cover crop use as greater.

Table 23. Predicting likelihood of adopting cover crop practice in the Saginaw

Independent Variable	*B*	S.E	Wald	*df*	*p*	Odds Ratio	95% C.I for Odds Ratio	
							Lower	Upper
Gender	-.91	.61	2.22	1	.14	.41	.12	1.33
Age	-.01	.01	1.44	1	.23	.99	.98	.1.00
HS degree	2.00	1.07	3.50	1	.06	7.42	.91	60.47
Higher education	2.20	1.07	4.24	1	.04	8.99	1.11	72.72
Reduced tillage	.37	.19	3.93	1	.05	1.45	1.00	2.09
Water quality risk perception	-.28	.16	3.09	1	.08	.76	.55	1.03
Broad Efficacy	.11	.14	.65	1	.42	1.12	.85	1.47
Cover Crop Barriers	-.329	.11	8.32	1	.00	.72	.58	.90

Table 24. Predicting likelihood of adopting cover crop practice in the Saginaw

Independent Variable	*B*	S.E	Wald	*df*	*p*	Odds Ratio	95% C.I for Odds Ratio	
							Lower	Upper
Gender	.75	.61	1.51	1	.22	2.11	.64	6.97
Age	-.01	.01	1.14	1	.29	.99	.98	1.00
HS degree	20.18	22834.91	.00	1	1.00	581329406	.00	-
Higher education	20.49	22834.91	.00	1	.99	793749863	.00	-
Reduced tillage	.61	.24	6.42	1	.01	1.84	1.15	2.95
Water quality risk perception	.08	.13	.32	1	.58	1.08	.83	1.40
Broad Efficacy	-.05	.13	.17	1	.68	.95	.73	1.22
Cover Crop Barriers	-1.41	.20	47.45	1	.00	.25	.17	.37

Right Rate

The model for the use of soil tests to inform fertilizer application rates included eight independent variables (gender, age, education, reduced tillage, water quality risk perception, practice confidence, cost barriers, time barriers). Education was recoded into three categories [1- some high school, 2- high school degree, 3- higher education].

Overall, the model for the Saginaw watershed including all predictors was statistically significant (chi-squared (9, N= 584) = 59.69, $p < .000$), indicating the model could distinguish between respondents who adopted and did not adopt right rate practices. The entire model explained between 9.7% (Cox and Snell R square) and 15.3% (Nagelkerke R squared) of the variance in adoption and correctly classified 80.5% of cases. As displayed in Table 25, five of the independent variables made a unique statistically significant contribution to the model (gender, age, reduced tillage, water quality risk perception, confidence in practices). The odds ratio of .18 inversely indicates that being a female farmer compared to a male farmer decreases the odds of adopting right rate practices by 5.55.[19] The odds ratio of age was .978 inversely indicating that as age increases, the odds of adopting right rate practices decreases by 1.02. Farmers practicing reduced tillage were 1.85 times more likely to be using right rate practices compared to those using conventional tillage. Despite was intuition might suggest, water quality risk perception was inversely related to adoption of right rate practices. Each point increase of water quality risk perception halved the odds of adopting right rate practices. The odds ratio of practice confidence implied that increasing confidence in the efficacy of suggested management practices by one additional point on our scale increased the odds of adopting right rate practices by 1.38. Overall, these results indicate that the likelihood of using right rate practices increases among male farmers (versus female), and those who have confidence in BMPs and are already using reduced tillage practices. Inversely, the likelihood of using right rate practices decreases with age, and concern about local water quality.

The model for the Maumee watershed including all predictors was statistically significant (chi-squared (9, N= 642) = 19.51, $p < .021$), indicating the model could distinguish between respondents who adopted and did not adopt right rate practices. The entire model explained between 3.0% (Cox and Snell R square) and 6.2% (Nagelkerke R squared) of the variance in adoption and correctly classified 89.7% of cases. As displayed in Table 26., two of the independent variables made a unique statistically significant contribution to the model (age, reduced tillage) with one variable (cost barriers) having a nearly significant contribution ($p= .057$). The inverse odds ratio for age suggests that as age increases, odds of adopting right rate practices decrease by 1.03. Farmers who already implement reduce tillage double their

[19] Due to very few female respondents (n=28) analysis of gender differences is not included in suggestions

odds of adopting right rate practices. As perceived cost barriers increase, the odds ratio of .55 display that the odds of adopting right rate practices are halved. Overall, farmers who practiced reduced tillage were more likely to adopt right rate practices. Older farmers and those with high perceived cost barriers decreased their odds of adopting right rate practices.

Table 25. Predicting likelihood of adopting right rate practices in the Saginaw

Independent Variable	*B*	S.E	Wald	*df*	*p*	Odds Ratio	95% C.I for Odds Ratio	
							Lower	Upper
Gender	-1.70	.44	14.67	1	.00	.18	.08	.44
Age	-.02	.01	6.19	1	.01	.98	.96	1.0
HS degree	.44	.67	.43	1	.51	1.55	.42	5.70
Higher education	.20	.65	.09	1	.76	1.22	.34	4.39
Reduced tillage	.62	.23	7.35	1	.01	1.85	1.19	2.88
WQ risk	-.66	.19	12.49	1	.00	.52	.36	.74
Practice Confidence	.32	.16	4.32	1	.04	1.38	1.02	1.87
Cost Barriers	.05	.16	.11	1	.74	1.01	.77	1.45

Table 26. Predicting likelihood of adopting right rate practices in the Maumee

Independent Variable	*B*	S.E	Wald	*df*	*p*	Odds Ratio	95% C.I for Odds Ratio	
							Lower	Upper
Gender	-1.05	.71	2.17	1	.14	.35	.09	.20
Age	-.03	.01	5.56	1	.02	.97	.95	.20
HS degree	1.42	1.28	1.22	1	.27	4.12	.33	50.99
Higher education	1.43	1.28	1.24	1	.27	4.18	.34	51.76
Reduced tillage	.77	.29	7.14	1	.01	2.15	1.23	3.77
WQ risk perception	.04	.17	.06	1	.81	1.04	.74	1.47
Practice confidence	.03	.16	.04	1	.85	1.03	.75	1.42
Cost barriers	-.59	.31	3.63	1	.06	.55	.30	1.02
Time barriers	.37	.23	2.63	1	.11	1.45	.93	2.28

Reduced Tillage

The model explaining reduced tillage practices included seven independent variables (gender, age, education, water quality risk perception, practice confidence, cost barriers, time barriers). Education was recoded into three categories [1- some high school, 2- high school degree, 3- higher education].

For respondents in the Saginaw watershed, the model including all predictors was statistically significant (chi-squared (8, N= 598) = 37.13, p < .000), indicating the model could distinguish between respondents who adopted and did not adopt right rate practices. The entire model explained between 6.0% (Cox and Snell R square) and 8.2% (Nagelkerke R squared) of the variance in adoption and correctly classified 64.2% of cases. As displayed in Table 27, only two of the independent variables made a unique statistically significant contribution to the model (age, cost barriers). Contrary to the relationship between age and right rate adoption, the odds ratio of 1.02 indicates that as age increases, the odds of adopting reduced tillage slightly increases by 1.02. Cost barriers produced an odds ratio of .72, which inversely interprets as the odds of adopting reduced tillage decreasing by 1.4 as cost barriers increase by a point. Overall, these results indicate that the likelihood of having reduced tillage practices in place is greater among older farmers, and those who are concerned about cost-related barriers to general BMP use.

The model for the Maumee watershed including all predictors was statistically significant (chi-squared (8, N= 648) = 15.84, p < .045), indicating the model could distinguish between respondents who adopted and did not adopt right rate practices. The entire model explained between 2.4% (Cox and Snell

R square) and 3.7% (Nagelkerke R squared) of the variance in adoption and correctly classified 77.2% of cases. As displayed in Table 28, only two of the independent variables made a unique statistically significant contribution to the model (age, water quality risk perception). As seen in the Saginaw, as farmer age increases, the odds of adopting reduced tillage increases by 1.02. The odds ratio of 1.32 interprets as the odds of adopting reduced tillage increasing by 1.32 as water quality risk perception increases a point on the scale. Overall, older farmers in the Maumee as in the Saginaw have a greater likelihood of implementing reduced tillage. Farmers with higher water quality risk perception increase the probability of implementing reduced tillage.

Table 27. Predicting likelihood of adopting reduced tillage practice in the Saginaw

Independent Variable	*B*	S.E	Wald	*df*	*p*	Odds Ratio	95% C.I for Odds Ratio	
Gender	-.34	.43	.65	1	.42	.71	.31	1.64
Age	.02	.01	10.25	1	.00	1.02	1.01	1.04
High school education	-.18	.60	.09	1	.77	.84	.26	2.74
Higher education	.06	.60	.01	1	.92	1.06	.33	3.44
Water quality risk perception	-.17	.15	1.30	1	.26	.85	.63	1.13
Practice confidence	.06	.13	.23	1	.63	1.06	.83	1.37
Cost Barriers	-.33	.13	6.92	1	.01	.72	.56	.92
Time Barriers	-.19	.12	2.30	1	.13	.83	.65	1.06

Table 28. Predicting likelihood of adopting reduced tillage practice in the Maumee

Independent Variable	*B*	S.E	Wald	*df*	*p*	Odds Ratio	95% C.I for Odds Ratio	
Gender	-.30	.69	.19	1	.66	.74	.19	2.84
Age	.02	.01	8.55	1	.00	1.02	1.01	1.04
High school education	-20.04	22987.34	.00	1	1.0	.00	.00	-
Higher education	-19.90	22987.34	.00	1	1.0	.00	.00	-
Water quality risk perception	.28	.13	4.87	1	.03	1.32	1.03	1.69
Practice confidence	.027	.12	.05	1	.82	1.03	.81	1.30
Cost Barriers	-.01	.22	.00	1	.98	.09	.64	1.54
Time Barriers	-.08	.16	.25	1	.62	.93	.68	1.26

Nutrient Trapping

The model for nutrient trapping practices included five independent variables (gender, age, education, practice confidence, program participation). Education was recoded into three categories [1- some high school, 2- high school degree, 3- higher education].

Overall, the model for the Saginaw watershed including all predictors was statistically significant (chi-squared (6, N= 693) = 173.49, p < .000), indicating the model could distinguish between respondents who adopted and did not adopt right rate practices. The entire model explained between 22.1% (Cox and Snell R square) and 31.0% (Nagelkerke R squared) of the variance in adoption and correctly classified 76.3% of cases. This model had the strongest explanation of variance. As displayed in Table 29., three of the independent variables (education, practice confidence, program participation) made a unique statistically significant contribution to the model. Farmers with an education level greater than high school compared to those with some high school experience increased odds of adopting nutrient trapping practices by 3.25. With each point increase in confidence in the positive impact of suggested practices on water quality, the odds of adopting nutrient trapping practices increases by one and a half. Program participation was the strongest predictor of nutrient trapping adoption and had an odds ratio of 8.68. Participating in a program such as CRP, CSP, and EQUIP increased the odds of adopting nutrient trapping practices by almost 9 times. Overall, these results indicate that trapping related practices are more likely among those who enroll in conservation-based incentive programs, and those who believe in the effectiveness of BMPs at improving water quality.

The model for the Maumee watershed including all predictors was statistically significant (chi-squared (6, N= 576) = 70.57, p < .000), indicating the model could distinguish between respondents who adopted and did not adopt right rate practices. The entire model explained between 11.5% (Cox and Snell R square) and 18.2% (Nagelkerke R squared) of the variance in adoption and correctly classified 80.6% of cases. This model had the strongest explanation of variance. As displayed in Table 30., only two of the independent variables made a unique statistically significant contribution to the model (gender, program participation). Male farmers as compared to female farmers inversely increase odds of adopting nutrient trapping practices by three times.[20] Participating in programs such as CRP, CSP, and EQUIP increased the odds of adopting nutrient trapping practices by 5.66. Overall, male farmers as compared to women and those who participated in conservation-based incentive programs are more likely to engage in nutrient trapping related practices.

Table 29. Predicting likelihood of adopting reduced nutrient trapping in the Saginaw

Independent Variable	*B*	S.E	Wald	*df*	*p*	Odds Ratio	95% C.I for Odds Ratio	
Gender	-.34	.36	.85	1	.36	.72	.35	1.46
Age	-.01	.01	1.85	1	.17	.99	.98	1.00
HS degree	1.00	.61	2.69	1	.10	2.72	.82	8.99
Higher education	1.18	.61	3.75	1	.05	3.25	.99	10.73
Practice confidence	.42	.13	10.61	1	.00	1.52	1.18	1.95
Program participation	2.16	.19	128.03	1	.00	8.68	5.97	12.61

[20] Due to very few female respondents (n=29) analysis of gender differences is not included in suggestions

Table 30. Predicting likelihood of adopting reduced nutrient trapping in the Saginaw

Independent Variable	*B*	S.E	Wald	*df*	*p*	Odds Ratio	95% C.I for Odds Ratio	
Gender	-1.13	.43	6.80	1	.01	.32	.14	.76
Age	.00	.01	.24	1	.62	1.00	.99	1.02
High school degree	.40	.67	.36	1	.55	1.50	.40	5.59
Higher education	.62	.68	.83	1	.36	1.86	.49	7.08
Practice confidence	.11	.15	.46	1	.50	1.11	.82	1.50
Program participation	1.73	.25	46.76	1	.00	5.66	3.44	9.30

Third Research Question: What is the specific impact of GLRI?

To answer the third research question, "what is the impact of GLRI programs on key drivers of adoption (e.g., risk perception, confidence, etc.)", data were analyzed from the Blanchard Valley Demonstration Farms in which farmers completed a survey before and after a field demonstration event. We also analyzed data from another GLRI project conducted in the Sebewaing Watershed (Sediment Reduction in the Sebewaing River Watershed). In this project, participants completed a survey at the beginning of the project (2012) and again at the end of the project (2015). The pre and post-test data for these two GLRI projects were evaluated as a case study to identify the impact of specific GLRI programs on key drivers of adoption at a farm level. The key drivers included in the demonstration farm data included knowledge, concern, confidence (self-efficacy) and satisfaction with current management. We assessed any changes in these drivers after attending the tour or participating in the program (paired samples t-tests), and we also assessed the correlations between these changes for the BVDF tours and future intentions to adopt conservation practices.

Survey Instrument and Methodology

Pre- and post surveys were conducted as a means of evaluating the Blanchard Valley Demonstration Farm Tour, partially funded by the GLRI in partnership with USDA NRCS and the Ohio Farm Bureau. In this survey, the goal was to help the Blanchard Valley Demonstration Farm network determine if their educational objectives were being met. Their objectives included increasing knowledge and behavioral intentions around monitoring phosphorus levels in the soil, improving soil health through cover crops and no-till, placing fertilizer beneath the surface of the soil to decrease nutrient loss, and modifying how and where water flows in and around fields. A set of survey questions was created by researchers at The Ohio State University to focus on these four objectives, specifically assessing potential changes in knowledge about these four practices, confidence in one's ability to implement them, and current behavior and future intentions. Post-test surveys were completed immediately after the tour ended. There were 48 surveys completed from the Blanchard Valley Demonstration Farm Tours, which occurred between the spring and fall of 2017. Participants were those who opted in to attending the farm tour, with a version of the survey for farmers and one for non-farmers (e.g., county commissioners, FFA students, the media, etc).

Pre- and post surveys were conducted as a means of evaluating the Sebewaing Watershed project. The details on the survey population, participants, and administration are provided earlier in the report (see page 18).

Key Findings

Overall, the results indicate that attending the BVDF demonstration farmer tour did have a significant impact on several of the measures of interest among the farmer attendees (see Table 31). Specifically, farmers reported higher levels of knowledge across all the categories of interest (e.g., soil testing, cover crops, subsurface placement, modifying water flows, and knowing what steps to take) (in the range of moderate to well informed, $p < .05$). However, attending the event did not increase levels of concern about nutrient loss, soil health, or water quality ($p > .05$). However, farmers concern was already pretty high, in the range of moderately to very concerned. In terms of confidence, farmers indicated increased confidence in their ability to implement cover crops as a result of attending ($p < .05$), but their confidence for the other practice categories did not increase ($p > .05$). Overall, confidence was mid-range indicating there is room to improve confidence further.

Table 31. Evaluation of the impact of attending the Blanchard Valley Demonstration Farm tour using a pre-post analysis of change in farmer knowledge about conservation practices, concern about the problems, confidence in their ability to implement practices, and satisfaction with current management on his/her farm

Category	Variable	Pre-test (n=42)	Post-Test (n=42)	Different?*
Knowledge[1]	Soil test informed rates	3.14	3.83	Yes
	Cover crops/ no-till	3.48	3.76	Yes
	Sub-surface placement	3.35	3.83	Yes
	Modifying water flows	3.25	3.78	Yes
	About what steps to take	.978	.587	Yes
Concern[2]	Nutrient loss on farm	3.45	3.52	No
	Soil health on farm	3.81	3.62	No
	Water quality lake Erie	3.67	3.76	No
Confidence[3] (…in my ability to use)	Soil informed rates	.24	.32	No
	Cover crops/ no-till	.18	.38	Yes
	Sub-surface placement	.37	.61	No
	Modifying water flows	.44	.85	No
Satisfaction[3]	With current management	.53	.82	No

[1]On a scale from 1 (not at all informed) to 5 (extremely well informed)
[2]On a scale from 1 (not at all concerned) to 5 (extremely concerned)
[3]On a scale from -2 (strongly disagree) to 2 (strongly agree), where 0 (neither disagree nor agree)
*Based on a paired samples t-test with $p < .05$

In terms of the non-farmer attendees, those attending the tour indicated that their knowledge about conservation practices and the steps agriculture was taking to address nutrient loss was relatively high (they were “moderately informed”) (Table 32). However, knowledge did increase (participants reported being “very well informed” after the tour, $p < .05$). Participants were already very concerned about nutrient loss, soil health and water quality, and only water quality concern increased as a result of attending the tour ($p < .05$). Finally, in terms of beliefs about agriculture, participants started out largely neutral on each issue (indicating neither agreement nor disagreement). However, participants reported stronger agreement with several statements after attending the tour, namely that 1) agriculture was taking responsibility, 2) nutrient loss can be reduced, 3) water quality issues can be solved, 4) there is no silver bullet that works for every farm, and 5) they know what steps farmers need to take to reduce nutrient loss and improve soil health ($p < .05$).

Table 32. Evaluation of the impact of attending the Blanchard Valley Demonstration Farm tour on non-farmers using a pre-post analysis of change in knowledge about conservation practices, concern about the problems, and assorted beliefs about agriculture

Category	Variable	Pre-test (n=~130)	Post-Test (n=~130)	Different?*
Knowledge[1]	Soil test informed rates	2.53	3.91	Yes
	Cover crops/ no-till	2.97	3.80	Yes
	Sub-surface placement	2.79	4.05	Yes
	Modifying water flows	2.71	4.03	Yes
	The steps ag is taking	2.79	4.21	Yes
Concern[2]	Nutrient loss on farm	3.62	3.76	No
	Soil health on farm	3.71	3.89	No
	Water quality lake Erie	3.76	4.00	Yes
Beliefs about Agriculture[3]	Ag is taking responsibility	.85	1.43	Yes
	Water issues can be solved	.71	1.28	Yes
	Nutrient loss can be reduced	1.09	1.52	Yes
	There is no silver bullet practice	1.11	1.54	Yes
	There is a silver bullet practice	-.63	-.63	No
	It is difficult to grow food & protect envt	-.33	-.10	No
	The costs of action outweigh benefits	-.51	-.49	No
	I know what is needed to reduce nutrient loss	-.05	.95	Yes
	I know what is needed to improve soil health	.02	.97	Yes

[1]On a scale from 1 (not at all informed) to 5 (extremely well informed)
[2]On a scale from 1 (not at all concerned) to 5 (extremely concerned)
[3]On a scale from -2 (strongly disagree) to 2 (strongly agree), where 0 (neither disagree nor agree)
*Based on a paired samples t-test with $p < .05$

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Comment [1]: If we'd want to put these as footnotes we could probably squeeze this table on the page above but since it cut off half of the notes I put it on its own page

The results for the Sebewaing project also indicate positive changes (Table 33). Specifically, participants in the project reported an increase in their belief that 1) using recommended practices improves water quality, 2) quality of life in their community depends on good water quality, and 3) water quality impacts are problematic ($p < .05$). Finally, they reported less overall concern about two common barriers to using no-till, specifically the time it takes and knowing how to do it ($p < .05$).

Table 33. Evaluation of the impact of participating in the Sebewaing GLRI Watershed Project on farmers using a pre-post analysis of their change in beliefs from the beginning to end of the project

Variable		2012 pre-test (n=~90)	2015 post-test (n=~60)	Different?*
[1]Using recommended practices improves water quality.[1]		4.16	4.37	Yes
The quality of life in my community depends on good water quality in local streams, rivers, lakes.[2]		4.02	4.25	Yes
How much of a problem is reduced…[3]	…beauty of lakes or streams	2.60	3.65	Yes
	…quality of water recreation activities	2.90	3.85	Yes
	…excessive aquatic plants or algae	3.56	4.51	Yes
No-till barriers[4]	Don't know how to do it	4.17	3.39	Yes
	Time required	4.11	3.35	Yes

[1]On a scale from 1 (strongly disagree) to 5 (strongly agree)
[2]On a scale from 1 (strongly disagree) to 5 (strongly agree)
[3]On a scale from 1 (not a problem) to 4 (severe problem)
[4]On a scale from 1 (not at all) to 4 (a lot)
*Based on a paired samples t-test with p <.05

Overall, when looking at the future intentions of the farmer attendees at the BVDF event, we do not see much evidence that attending the event would increase the intentions of those not using the practices (Table 34). For example, those farmers who attended that were already using each practice were significantly more likely to report an intention to continue using it, than those who would be classified as potential new adopters (p > .05). The only exception to this was for blind inlets, where the future intentions of the two groups did not differ, but that may be a function of there being very few individuals already using this practice. The hope would be that such an event would be an equalizer, where perhaps the future intentions of the two groups would be similar.

Table 34. Future intentions of management practices by those already vs. not using the practice

Practice	Already Using it %	Already Using it Future intentions (mean)	Not Using it %	Not Using it Future intentions (mean)	Mean Different?*
Subsurface placement (injection/banding)	35	4.25	65	3.04	Yes
Grid sampling and VRT	39	4.57	61	3.45	Yes
Cover Crops (not winter wheat)	57	4.3	43	3.00	Yes
Drainage Mgmt Structures	33	4.10	67	2.88	Yes
P Filter Beds	0	N/A	100	2.71	N/A
Blind Inlets	6	3.50	94	2.81	No

*Based on an independent samples t-test comparing future intentions by those already using vs not using the practice
Note: Intentions measured on a scale from 1 (will never use it), 2 (am unlikely to use it), 3 (am unsure if I will use it), 4 (I am likely to use it), and 5 (will definitely use it)

Finally, we looked at the future intentions to use each recommended practice as a function of one's change in beliefs after attending the event (Table 35). Specifically, we calculated the change in one's perceived ability to use a particular practice, one's overall concern about nutrients and water quality, and one's knowledge about the particular practice. We then looked at correlations between these change variables as well as the farmer's age, owned and rented acres, prior use of the practice, and whether or not the BVDF made them think differently about the issues. Unfortunately, we do not see much evidence that the event is increasing one's intention to use any particular practice. Specifically, we find that some practices are more likely among larger farms (e.g., subsurface placement, grid sampling, drainage water management and blind inlets). The changes in knowledge, confidence, concern and satisfaction did not correlate with future intention for any of the practices, with a few exceptions. Participants' intentions to use cover crops were greater among those who reported a greater change in knowledge about cover crops and greater overall concern about the problems ($p < .05$). Farmers who reported being less satisfied with their current practices also reported greater intentions to use cover crops, as well as drainage water management and P filter beds ($p < .05$). Having already used the practice in the past had the highest correlations with future intentions, indicating that past experience was a better predictor of future intentions than having attended the BVDF tour and experienced a change in beliefs.

Table 35. Correlations between a variety of variables in the BVDF survey and future intentions to adopt a particular practice (significant correlations in bold)

	Subsurface Placement	Grid Sampling	Cover Crops	Drainage Water Mgmt	P Filters	Blind inlets
Age	*NS*	*NS*	*NS*	*NS*	*NS*	*NS*
Owned acres	**.430**	**.355**	*NS*	**.385**	**.397**	**.398**
Rented acres	**.448**	**.483**	*NS*	.400	*NS*	**.409**
Δ Knowledge	*NS*	*NS*	**.453**	*NS*	*NS*	*NS*
Δ Confidence	*NS*	*NS*	*NS*	*NS*	*NS*	*NS*
Δ Concern	*NS*	*NS*	**.508**	*NS*	*NS*	*NS*
Δ Satisfaction	*NS*	*NS*	**.463**	**.437**	**.354**	*NS*
Δ Knowing steps to take	*NS*	*NS*	*NS*	*NS*	*NS*	*NS*
Tour made me think different	*NS*	*NS*	*NS*	*NS*	*NS*	*NS*
Prior use of the practice	**.612**	**.564**	**.611**	**.594**	*No results*	*NS*

Note: NS indicates there was no significant relationship between the two variables; all numbers indicate the correlation value between the two variables for significant relationships