Iowa Farmers and the Iowa Nutrient Reduction Strategy: Survey Results from the Missouri-Little Sioux Watershed

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Introduction

In 2013, the state of Iowa released the Iowa Nutrient Reduction Strategy (NRS) (www.nutrientstrategy.iastate.edu/). The NRS is a science- and technology-based approach to guide actions that reduce the amount of nutrients delivered to Iowa waterways and the Gulf of Mexico. The NRS was developed through a collaboration between Iowa State University (ISU), the Iowa Department of Agriculture and Land Stewardship (IDALS), and the Iowa Department of Natural Resources (IDNR). The strategy outlines opportunities and recommendations for voluntary efforts to reduce nutrients in surface water from both point sources, such as wastewater treatment plants and industrial facilities, and nonpoint sources, including farm fields and urban areas. The NRS is engaging diverse private and public stakeholders from many sectors of urban and rural society, with a primary focus on helping municipalities, industry, and agriculture to reduce flows of nutrients into waterways. This report focuses on the agricultural sector. The NRS goals for Iowa nonpoint sources, mainly agriculture, are a 41 percent reduction in nitrogen loss and a 29 percent reduction in phosphorus loss.

Measurement of progress toward these goals is a central objective of the NRS. The measurement process is guided by a program logic model approach (figure 1), which outlines measurable indicators of change. The domains in which changes are tracked are: inputs such as funding; the human actors whose actions can impact nutrient management such as farmers and private and public sector organizations; land use, nutrient management practices, and edge-of-field practices for nutrient load reduction; and, the load of nutrients in Iowa watersheds. Iowa NRS partners are tracking changes in inputs, human dimensions, landscapes, and water quality that move Iowa toward NRS goals.

This document reports a subset of results of a survey project that is focused on measuring changes in the human domain, mainly Iowa farmers' knowledge, attitudes, and behaviors related to reduction of nutrient losses from farmland. The results presented in this document are specific to the Missouri-Little Sioux hydrologic unit code-6 (HUC6) watershed. The survey project, which is funded by IDALS and conducted by the ISU College of Agriculture and Life Sciences, is a five-year effort to collect data that will help stakeholders measure progress toward NRS objectives and to inform outreach and engagement strategies. The survey has three main objectives: measure farmer knowledge, attitudes, and behavior related to nutrient management and nutrient loss into waterways; identify barriers to and facilitators of behavior change that reduces nutrient loss; and measure change in these over time. The survey data will help to gauge progress toward NRS goals and help stakeholders to adjust and refine strategies for outreach and engagement activities that promote nutrient loss reduction on Iowa farms.

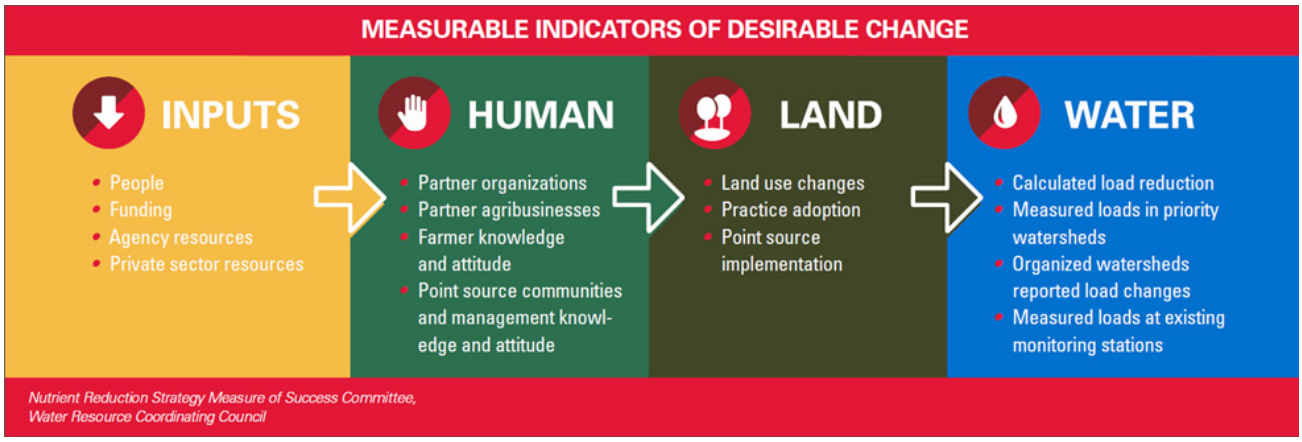


Figure 1. Iowa Nutrient Reduction Strategy program logic model.

Survey methodology

The farmer survey project is being implemented over a five-year period through an annual rotating longitudinal survey that will cover six hydrologic unit code six (HUC6) watersheds. Each HUC6 watershed contains at least one HUC8 watershed that is classified as a "priority watershed" by the Iowa Water Quality Initiative (WQI). The HUC6 watersheds and their priority HUC8 watersheds are listed in table 1.

The sample population is Iowa farmers who operated at least 150 acres of row crops in the year prior to the survey. A minimum acreage threshold was set because 1) nutrient reduction actions are most applicable to row crop farmers, and 2) operations that exceed 150 acres farm a majority of Iowa farmland. Samples for the survey are purchased annually from Survey Sampling International. Iowa State University's Center for Survey Statistics and Methodology (http://www.cssm.iastate.edu/) conducts the annual mail survey and data entry process, and assists with data analysis.

Farmers in the Missouri-Little Sioux HUC6 watershed (figure 2) received surveys in spring of 2015, and a subset of "repeat respondents" received the survey again in spring of 2016. Response rates in the Floyd HUC8 watershed, which is considered a priority watershed by the Iowa Water Quality Initiative, were 47 percent in 2015 and 73 percent in 2016 (table 2). Response rates in non-priority watershed areas were 41 percent in 2015 and 46 percent in 2016. In 2015, the non-priority surveyed area focused on the Big Papillion-Mosquito Boyer HUC8 watershed. In 2016, the non-priority area was expanded to survey all of the non-priority HUC8 watersheds within the Missouri-Little Sioux HUC6 watershed. In 2015, 357 surveys were completed and returned from the Big Papillion-Mosquito/Boyer HUC8, and 425 from the Floyd

Table 1. Surveyed HUC6 watersheds, and the priority HUC8 watersheds within the HUC6 watersheds

HUC6 Watershed	Priority HUC8 Watershed(s)
Iowa	Middle Cedar
Missouri-Little Sioux	Floyd
Upper Mississippi-Maquoketa-Plum	Turkey
Upper Mississippi-Skunk-Wapsi	South Skunk Skunk
Missouri-Nishnabotna	West Nishnabotna East Nishnabotna
Des Moines	Boone North Raccoon

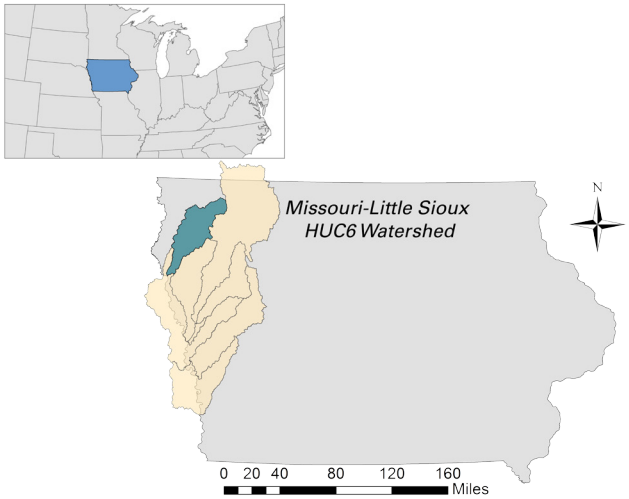


Figure 2. The HUC8 watersheds surveyed in the Missouri-Little Sioux HUC6 watershed with the Floyd HUC8 highlighted

Table 2. Response rates associated with each area of the Missouri-Little Sioux HUC6 watershed that was surveyed in 2015 and 2016.

HUC6	HUC8	Response Rate 2015	Response Rate 2016
Missouri-Little Sioux	Floyd	47%	73%
	Non-priority HUC8 watersheds	41%	46%
	Total	44%	53%

HUC8. In 2016, 352 surveys were completed and returned from the non-priority HUC8 watersheds (including the Big Papillion-Mosquito/Boyer), and 173 from the Floyd HUC8.

The following sections present survey results. First, the baseline results from all respondents surveyed in 2015 are reported. The subsequent section presents results from "repeat respondents" who were surveyed in both 2015 and 2016, reporting changes in survey responses among that subsample of respondents.

Baseline survey results from all respondents in 2015

Awareness of the Iowa Nutrient Reduction Strategy

The first objective of the survey was to measure farmers' awareness of the NRS. Prior to the first question, respondents were provided with the following introductory information:

> *The Iowa Nutrient Reduction Strategy is a plan to reduce the amount of nitrogen and phosphorus that enters Iowa's streams and rivers and eventually the Gulf of Mexico. It is designed to help reduce nutrients in surface water in a scientific, reasonable, voluntary, and cost-effective manner. The strategy sets goals for both "point sources" (e.g., water treatment plants) and "nonpoint sources" (e.g., agriculture) of nutrients. The goal for Iowa agriculture is that nutrient losses into waterways will be reduced by 41% for nitrogen and 29% for phosphorus.*

Immediately following that introductory text, respondents were posed the question, "Before reading the description above, how knowledgeable were you about the Iowa Nutrient Reduction Strategy?" and were asked to rate their knowledge on a five-point scale ranging from not at all knowledgeable to very knowledgeable. About six percent of respondents reported that they were very knowledgeable (figure 3), and 25 percent rated themselves as knowledgeable. The largest category, at 41 percent, was somewhat knowledgeable, while 21 percent and seven percent of farmers reported that they were slightly knowledgeable or not at all knowledgeable, respectively.

Information sources

The next question sought to better understand the information channels through which farmers have learned about the NRS. Respondents were provided introductory text stating, "Information about the Nutrient Reduction Strategy has been publicized through many sources. Please indicate whether or not you have learned about it from the sources listed below," and asked to check any of the sources that applied. Eighty percent of respondents reported they had learned about the NRS through the farm press (figure 4). Iowa State University Extension was the second most frequently cited source, at 64 percent, followed by the Natural Resource

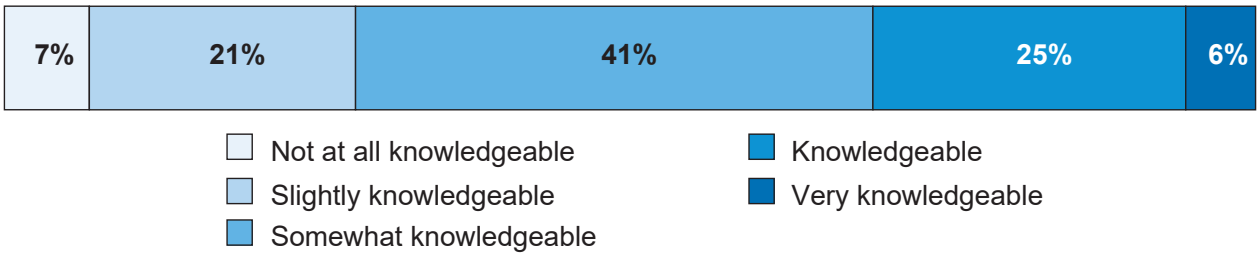


Figure 3. Farmer awareness of the Iowa Nutrient Reduction Strategy in 2015, in the Missouri-Little Sioux HUC6 watershed.

Conservation Service (NRCS) or Soil and Water Conservation Districts (SWCD), at 63 percent. The fewest respondents, at 31 percent, 22 percent, and 19 percent, had heard about the NRS from agricultural retailers, crop advisers, and seed companies, respectively. These results indicate that some information sources, particularly the farm press, had played a larger role in disseminating information about the NRS in the surveyed areas, while retailers and advisers played smaller roles.

Awareness of watershed management activities

The NRS takes a watershed-based approach to prioritizing areas that require increased efforts in implementing nutrient reduction practices. Water quality improvement projects in Iowa and across the Corn Belt region have shown that farmers' involvement and leadership in watershed projects can be crucial to their success. Thus, the survey sought to measure farmer awareness of and involvement in watershed management activities.

A series of four questions were posed about watershed management activities. Prior to the questions, the following text was provided for context and to ensure that all survey respondents had the same understanding of the concepts of "watershed" and "watershed management":

> A *watershed* is an area of land that drains into a common waterway or water body. Watersheds are often described as "nested" because smaller watersheds that drain into smaller waterways make up larger watersheds that drain into rivers and ultimately into the sea.
>
> *Watershed management* refers to planning and action focused on maintaining clean water and general environmental quality within a watershed.

Twenty-five percent of farmers stated that there was an active watershed management group in their respective watersheds, and 25 percent indicated that they themselves were involved in organized watershed management activities. Thirty-two percent reported that other local farmers were involved in organized watershed management activities, and eight percent reported that local non-farming residents were involved in such activities (table 3).

Also of interest for this research project were the negative and "Don't Know" responses to the

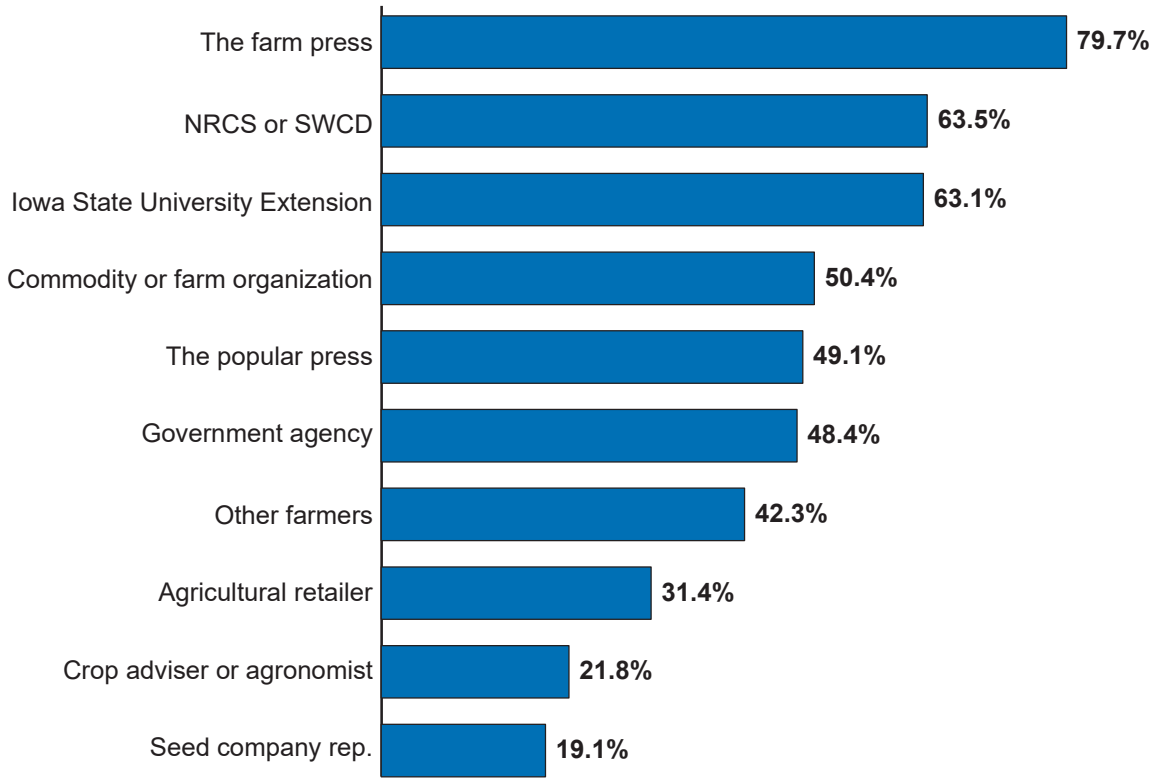


Figure 4. Sources from which respondents learned about the Iowa Nutrient Reduction Strategy in the Missouri-Little Sioux HUC6 watershed.

watershed management questions (table 3). Seventy-five percent of farmers reported either that there was no active watershed management group in their watershed (29 percent) or they were not aware of one (46 percent). Similar results were found for the questions about local farmers and non-farming residents. Overall, the responses indicate that most farmers in the surveyed watersheds were not aware of organized watershed management activities in their watersheds.

Attitudes toward the Iowa Nutrient Reduction Strategy

Another objective of the survey was to measure respondents' attitudes toward the NRS and water quality issues. Survey respondents were asked to report their level of agreement or disagreement with a variety of statements related to the NRS. The statements, listed in table 4, examine several general areas of farmers' perspectives, including: awareness of and concern about water quality problems; support for action; opinions about the efficacy of current nutrient management practices; and other topics such as concern about regulation.

The first category encompasses seven items that measured aspects of awareness and concern about agriculture's impacts on water quality, and support for action (table 4). Selected results include: 84 percent of farmers agreed or strongly agreed with the statement "I am concerned about agriculture's impacts on Iowa's water quality," and 77 percent agreed with the statement "I would like to improve practices on the land I farm to help meet the Nutrient Reduction Strategy's goals." Forty-five percent indicated they would be willing to have their farm operations' effectiveness in minimizing nutrient loss evaluated. Overall, results for these items showed that most respondents were concerned about agriculture's impacts on water quality and supportive of NRS goals.

The second category of statements represents self-assessment of nutrient management effectiveness. Sixty-one percent of farmers agreed that "The nutrient management practices I use are sufficient to prevent loss of nutrients into waterways" (table 4). Similarly, 50 percent agreed that "I am already doing all that I can to reduce nutrient loss from my farm into waterways." These results point to a sense of satisfaction with current nutrient management practices among a substantial proportion of surveyed farmers. Between 36 and 37 percent of farmers reported uncertainty associated with these statements.

The third category is comprised of items that measure other relevant perspectives associated with nutrient loss reduction. Eighty-nine percent of farmers agreed with the statement "I am concerned about potential water quality regulations targeting agriculture," and 44 percent agreed that "If society wants inexpensive, abundant food, people have to be willing to deal with some impacts on water quality" (table 4). Forty-four percent agreed that "Fertilizer and ag chemical dealers should do more to help farmers address nutrient losses into waterways." Finally, just 23 percent agreed with the statement "In general, landlords are willing to help farmers address nutrient loss from the farmland they rent," compared to 37 percent who disagreed.

Use of conservation practices

Tracking shifts in farmers' conservation behavior is a major survey objective. Following the question set measuring farmer perspectives regarding the NRS, the survey explored survey respondents' use of conservation practices that are employed to manage nutrients and otherwise improve soil and water conservation outcomes on agricultural lands.

Table 3. Involvement in watershed management activities in the Missouri-Little Sioux HUC6 watershed

	Yes	No	Don't Know
Is there an active watershed management group in the watershed?	24.9%	28.7%	46.4%
Are local farmers involved in organized watershed management activities?	31.6%	24.9%	43.5%
Are local non-farming residents involved in organized watershed management activities?	8.3%	31.3%	60.4%
Are you involved in organized watershed management activities?	24.8%	68.8%	6.5%

The survey asked participants to report whether they had used any of 20 practices in their farm operation (owned or rented land) in 2014. Respondents' use of practices fell into one of three categories: "Not used in 2014, no plans to use it," "Not used in 2014, might use it in the future," and "Used the practice in 2014."

Table 4. Farmer perspectives on topics related to the Iowa Nutrient Reduction Strategy in the Missouri-Little Sioux HUC6 watershed

	Strongly disagree	Disagree	Uncertain	Agree	Strongly agree
Awareness, concern, and support for action					
I am concerned about agriculture's impacts on Iowa's water quality	1.2%	4.8%	9.9%	65.4%	18.6%
I would like to improve conservation practices on the land I farm to help meet the Nutrient Reduction Strategy's goals	1.8%	2.4%	19.2%	61.3%	15.3%
Iowa farmers should do more to reduce nutrient and sediment run-off into waterways	0.3%	5.2%	19.9%	64.2%	10.4%
I am concerned about Iowa's contribution to water quality problems (e.g., hypoxia) in the Gulf of Mexico	1.3%	5.8%	33.1%	54.5%	5.4%
Helping to meet the Nutrient Reduction Strategy's goals is a high priority for me	0.9%	7.8%	37.9%	48.2%	5.3%
I would be willing to have someone help me evaluate how my farm operation is doing in terms of keeping nutrients out of waterways	4.3%	11.9%	39.0%	41.8%	3.0%
Nutrients from Iowa farms contribute to water quality problems (e.g., hypoxia) in the Gulf of Mexico	2.5%	12.5%	40.9%	37.5%	6.6%
Self-assessment of nutrient management					
The nutrient management practices I use are sufficient to prevent loss of nutrients into waterways	0.1%	2.8%	35.7%	51.4%	10.0%
I am already doing all that I can to reduce nutrient loss from my farm into waterways	0.4%	12.9%	37.1%	38.8%	10.8%
I don't know how well my farm operation is doing in terms of keeping nutrients out of waterways	11.2%	37.2%	31.5%	18.7%	1.4%
Other perspectives					
I am concerned about potential water quality regulations targeting agriculture	0.7%	1.3%	8.8%	55.3%	33.9%
Fertilizer and ag chemical dealers should do more to help farmers address nutrient losses into waterways	3.0%	18.9%	33.8%	37.6%	6.6%
If society wants inexpensive, abundant food, people have to be willing to deal with some impacts on water quality	2.1%	25.5%	28.8%	36.3%	7.3%
In general, landlords are willing to help farmers address nutrient loss from the farmland they rent	8.3%	28.4%	40.5%	21.7%	1.1%

Fertilizer management practices

Seven of the practices are related to fertilizer management, of which five are specifically recommended by the NRS Science Assessment (figure 5a). Of these, spring nitrogen (N) application was the most widely used, with 74 percent of farmers reporting that they employed this practice in 2014. Forty-one percent of farmers reported use of nitrogen stabilizers. Use of a maximum return to nitrogen (MRTN) calculator was reported by 30 percent of respondents, and 28 percent reported using variable rate nitrogen application methods. Growing season nitrogen application (i.e., side-dress) was reported by 14 percent of farmers. In addition, substantial proportions of farmers who reported that they did not use the practices in 2014 indicated that they might use them in the future: 23 percent for nitrogen stabilizers, 29 percent for MRTN, 26 percent for variable rate nitrogen, and 23 percent for growing season nitrogen application. These results signal potential openness to eventual adoption of these recommended practices.

Fall application of nitrogen, which is not generally a recommended practice, was reported by 39 percent of respondents (figure 5a). Manure application, a practice that may have a neutral impact or reduce nutrient loss when employed appropriately but may contribute to losses in other cases, was reported by 59 percent of respondents.

Tillage and cover crops

Farmers were asked to indicate which types of tillage practices they had used on at least some of the land they farmed in 2014. These practices included no-till (all years of rotation), intermittent no-till, conservation tillage, and strip till (figure 5b). Forty-seven percent reported using conservation tillage on at least some of their land, 47 percent used no-till, 24 percent had employed intermittent no-till, and three percent reported use of strip-till methods. Among farmers who were not using conservation tillage, no-till, intermittent no-till, or strip-till, 15 percent, 20 percent, 24 percent, and 18 percent, respectively, indicated that they might use the practice in the future. Cover crops, which have been promoted heavily by NRS partner organizations, were reported by 15 percent of respondents. A relatively high proportion of farmers—37 percent—indicated that they might use cover crops in the future (figure 5b).

Two practices that are uncommon, but exceptionally effective at reducing nutrient loss—cropland converted to perennial crops (e.g., hay, pasture, trees) and extended rotations (three or more crops over a 3–5 year rotation)—were also included in the list. Fourteen percent of farmers indicated that in 2014 they operated at least some cropland that had been converted to perennial crops, and 13 percent reported that they employed some kind of extended rotations in their farm operation (figure 5b). Similar proportions—11 and 16 percent, respectively—suggested they might use them in the future.

Structural practices

Structural practices—conservation practices that generally require some alteration to the landscape—and drainage practices were also explored in the survey (figure 5c). Tile drainage is prevalent among farmers in the surveyed watersheds, with 70 percent reporting that some form of drainage was employed on their land in 2014. Terraces were reported by 64 percent of farmers, and "buffers along streams or field edges to filter nutrients and sediment from runoff" were used by 49 percent of farmers. "In-field buffer strips (e.g., contour) to filter nutrients and sediment," ponds or sedimentation basins, and bioreactors were reported by 24, 18, and one percent, respectively.

Length of practice use

Because one of the objectives of the survey is to examine changes in conservation behavior over time, farmers who reported use of practices in 2014 were asked to indicate how long they had used the practice. Two response categories were used: "one to three years," and "over three years." The results of this question set are displayed in figure 6 as a percentage of those respondents who indicated they used the practice in 2014. Respondents who did not use the practice in 2014 were excluded from the results discussed below.

Fertilizer management practices

Figure 6a displays the length of time that farmers had used various fertilizer management practices. Of those who reported spring nitrogen application in 2014, 92 percent had practiced it for more than

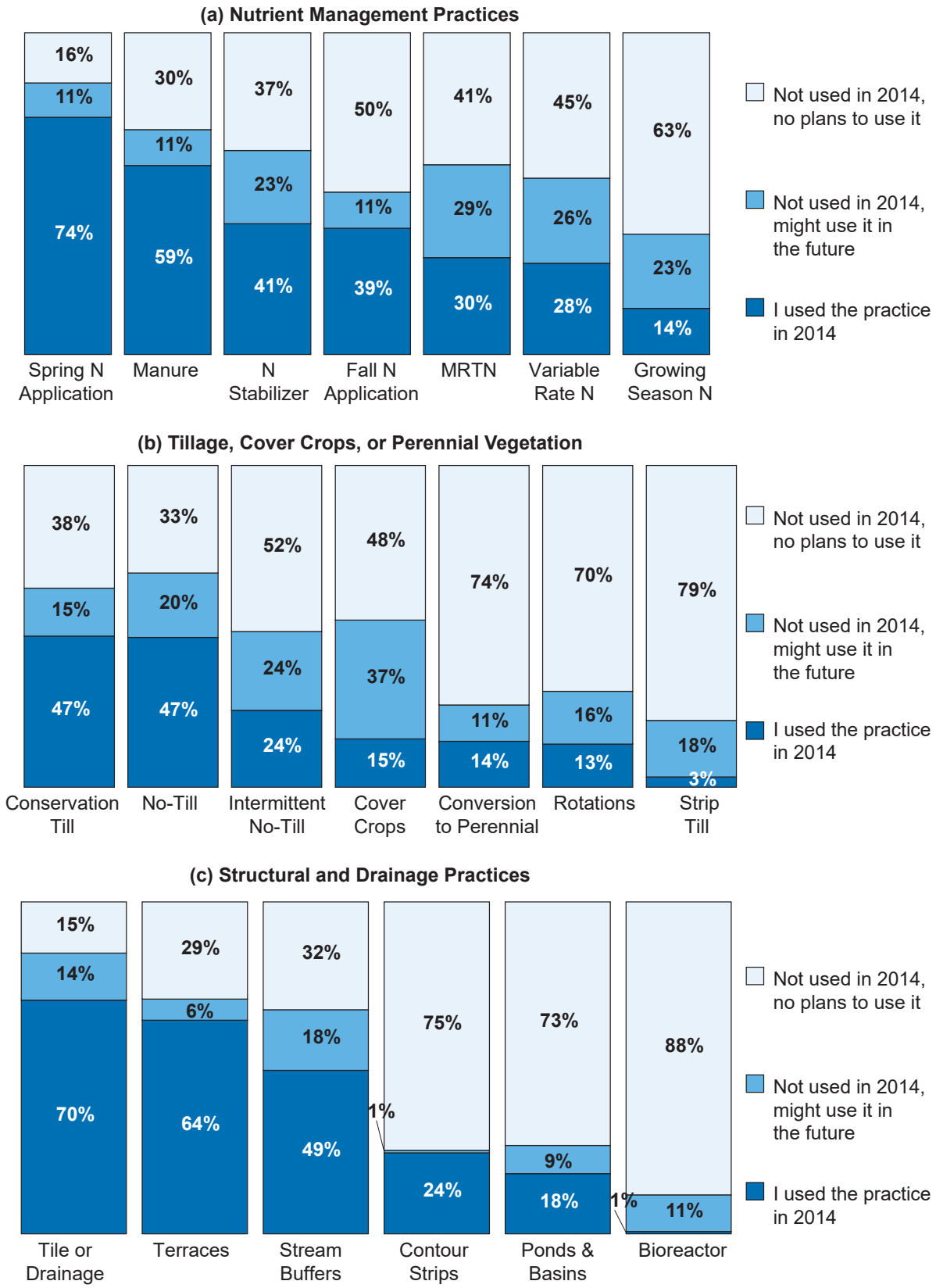


Figure 5. Percentage of farmers in the Missouri-Little Sioux HUC6 watershed who indicated that they had used selected a) nutrient management practices, b) tillage, cover crops, or perennial vegetation, or c) structural and drainage practices in 2014.

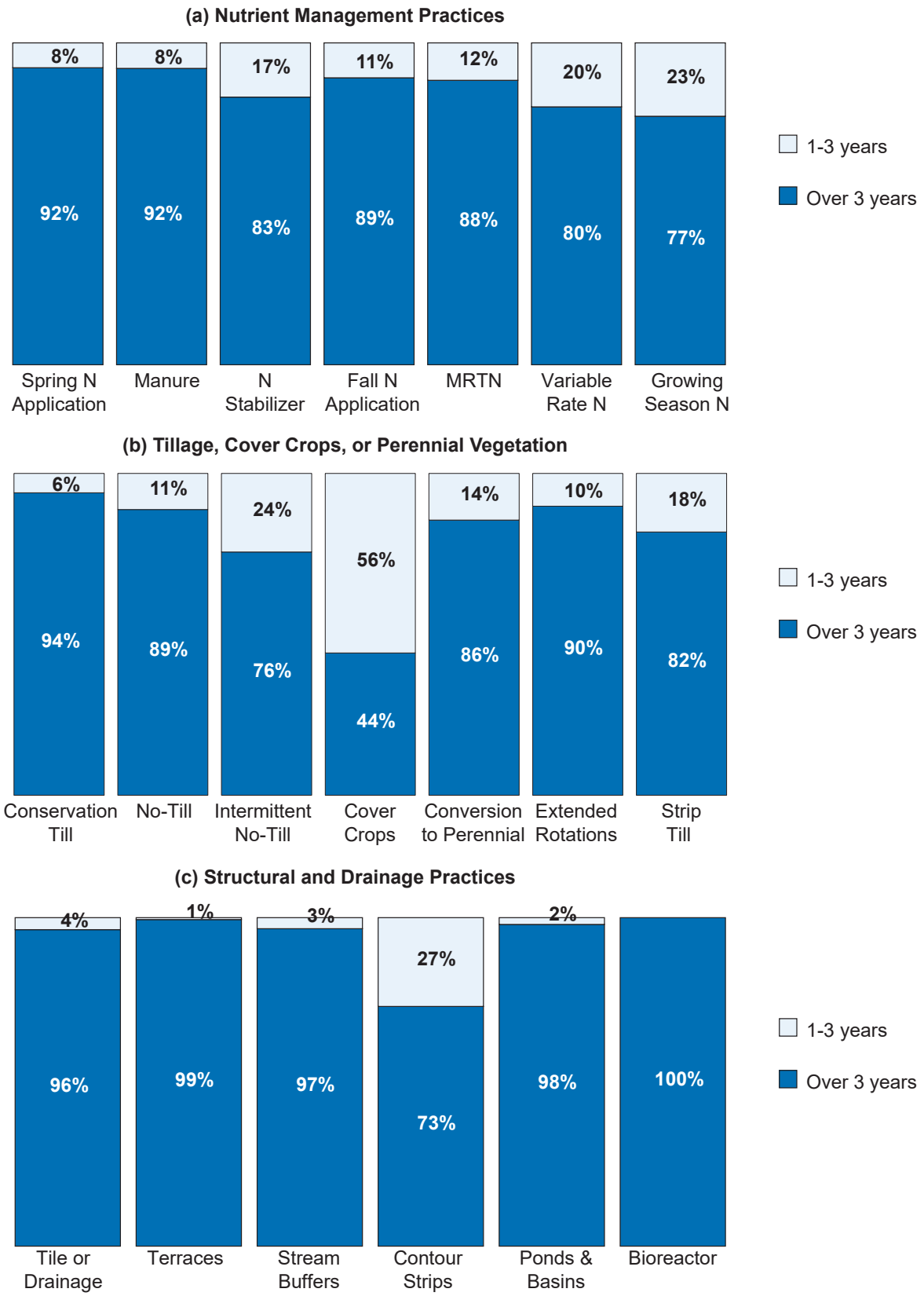


Figure 6. Percentage of farmers in the Missouri-Little Sioux HUC6 watershed that indicated they had used selected practices for one to three years or over three years: a) nutrient management practices, b) tillage, cover crops or perennial vegetation, c) structural and drainage practices.

three years and eight percent had practiced it for one to three years. Manure application had been used for over three years by 92 percent of users, and for one to three years by eight percent. Of those who had used nitrogen stabilizer, fall nitrogen application, and MRTN in 2014, 83, 89, and 88 percent had used these practices for more than three years, respectively. These practices had been adopted more recently by 17, 11, and 12 percent of farmers, respectively. Variable rate nitrogen application had been used by 80 percent for over three years and by 20 percent for one to three years. Finally, 77 percent had used growing season nitrogen application for over three years, and 23 percent had used this practice for one to three years.

Tillage and cover crops

Respondents also indicated the length of time they had used various practices related to tillage, cover crops, and perennial cover. Of those who had used conservation tillage in 2014, 94 percent had employed it for more than three years, and six percent for one to three years (figure 6b). No-till, intermittent no-till, and strip tillage had been used for more than three years by 89, 76, and 82 percent of users. These practices had been used for one to three years by 11, 24, and 18 percent. Cover crops had been used for over three years by 44 percent of those who had reported using them in 2014. Cover crops had the highest rate of recent adoption, with 56 percent reporting that they had used cover crops for one to three years

Structural practices

Finally, respondents reported the length of time that they had used various structural and drainage practices. Of the farmers in the surveyed watersheds who reported they had used tile or other drainage on their land in 2014, 96 percent had used this practice for over three years, and four percent had used it for one to three years (figure 6c). Terraces had been used for over three years by 99 percent, and one to three years by one percent. Stream buffers and contour strips had been used for over three years by 97 and 73 percent of farmers, respectively. These practices had been used by three percent and 27 percent of farmers for one to three years. Water and sediment control basins and ponds had been used by 98 percent for over three years while two percent had used these structures for one to three years. All of the bioreactors that were reported in 2014 had been in place for more than three years.

Barriers to conservation

Two question sets explored barriers to water quality improvement. First, farmers who did not use selected conservation practices were asked to indicate the barriers that prevented their use. Second, farmers reported their level of agreement with statements regarding various barriers to water quality improvement in Iowa.

Barriers to use of selected conservation practices among non-users

Following the question set about use of conservation practices, a follow-up question asked those respondents who had not used selected practices in 2014 about potential barriers to practice use. The questions were preceded by the text, “Some practices from the previous question are listed below. If you did not use a particular practice on your farm in 2014, please indicate the reasons why you did not use it.” Four potential barriers were provided: “risk to crop yield,” “cost too high compared to benefits,” “don’t know enough about it,” and “not appropriate for the farm’s soil or terrain.” Respondents were prompted to select all of the reasons that applied to them in the case of each practice.

Risk to crop yield was selected as a barrier by relatively few farmers. The most common practice under this barrier category was no-till, with 29 percent of farmers reporting that yield risk was a reason they had not adopted the practice (table 5). Fourteen percent of farmers indicated risk to crop yield was a barrier to use of spring nitrogen application, and 12 percent reported yield risk posed a barrier to their use of growing season nitrogen application.

High costs relative to potential benefits appears to be a more substantial barrier to adoption of several highly recommended practices. Forty percent of farmers indicated that this was a barrier to adopting nitrogen stabilizers, and 28 percent reported the same for cover crops (table 5). Twenty-six percent of farmers indicated high costs were a barrier to using extended rotations.

Substantial numbers of farmers reported that lack of knowledge served as a barrier to practice adoption.

Table 5. Barriers to implementation of selected conservation practices among non-users in the Missouri-Little Sioux HUC6 watershed in 2014

	Risk to crop yield	Cost too high compared to benefits	Don't know enough about it	Not appropriate for my farm's soil or terrain
Spring nitrogen application	14.3%	17.2%	15.1%	36.1%
Nitrogen stabilizer (e.g., N-SERVE)	1.6%	39.9%	37.7%	15.9%
Growing season nitrogen application (i.e., side-dress)	11.6%	25.1%	16.8%	37.5%
Nitrogen rate based on Corn nitrogen (N) rate calculator (MRTN)	5.6%	8.8%	67.8%	12.8%
Variable rate N application	6.4%	25.9%	37.3%	22.8%
No till (all years of rotation)	29.1%	9.4%	20.7%	35.9%
Strip tillage	5.9%	15.2%	31.4%	43.5%
Cover crops	7.0%	27.9%	43.1%	19.6%
Extended rotations (3 or more crops over a 3-5 year rotation)	9.8%	26.2%	28.6%	30.3%
Buffers along streams or field edges to filter nutrients and sediment from runoff	5.2%	23.2%	26.2%	41.3%
In-field buffer strips (e.g., contour) to filter nutrients and sediment	5.0%	18.0%	27.5%	45.3%
Bioreactor(s)	1.7%	10.8%	64.0%	24.8%

Nearly 68 percent of farmers selected "Don't know enough about it" as a barrier to adoption of MRTN (table 5). Sixty-four percent reported that lack of knowledge was a barrier to adoption of bioreactors, and 43 percent reported that their lack of knowledge about cover crops was a barrier to their use of the practice.

Finally, some practices were reported as not being appropriate to the respondents' soil or terrain. In-field buffer strips were reported as not being applicable by 45 percent of farmers. Forty-four percent of farmers indicated that contour strips were not applicable to their operation (table 5). This barrier was reported by 41 percent of farmers regarding the use of stream buffers.

General barriers to water quality improvement in Iowa

A question set asked farmers to report their level of agreement with various statements regarding impediments to improving Iowa's water quality more generally. The question set was preceded by the text, "The following are a number of potential barriers to water quality improvement in Iowa. Please indicate your disagreement or agreement with the following statements about these potential barriers," and farmers were provided a five-point scale from "strongly disagree" (1) to "strongly agree" (5). The statements covered five categories of barriers:

- Knowledge-related barriers
- Economic barriers
- Landlord-related barriers
- Farm management barriers
- Agronomic or structural barriers

Among the knowledge-related barriers to water quality improvement, "Farmers need help learning how to reduce nutrient loss more effectively" received the highest level of endorsement, with 64 percent of farmers indicating agreement (table 6). Similarly, thirty-six percent of farmers agreed that "Many farmers don't know how to further reduce nutrient losses from their farms" and less than half (48 percent) of farmers disagreed with the statement "I don't know how to further reduce nutrient losses from my farm." Although farmers perceived

knowledge-related barriers to action, most seemed to believe that lack of awareness is not the problem: 60 percent disagreed that "Many farmers are not aware that nutrients from agriculture can impact water quality."

The results also provided insights into farmer perceptions regarding potential economic barriers. The statement "Pressure to make profit margins makes it difficult to afford conservation practices," received agreement from 65 percent of farmers (table 6). However, in response to the statement "I can't afford to implement more conservation practices," responses were more evenly spread, with 34 percent disagreeing, 35 percent reporting

Table 6. Farmer perspectives on barriers to water quality improvement in Iowa

	Strongly Disagree	Disagree	Uncertain	Agree	Strongly Agree
Knowledge-related barriers					
Farmers need help learning how to reduce nutrient loss more effectively	2.2%	7.0%	26.4%	57.5%	6.9%
Many farmers don't know how to further reduce nutrient losses from their farms	2.9%	25.4%	35.7%	33.6%	2.5%
Many farmers are not aware that nutrients from agriculture can impact water quality	12.2%	47.6%	19.0%	19.5%	1.7%
I don't know how to further reduce nutrient losses from my farm	8.5%	39.3%	33.2%	17.2%	1.9%
Economic barriers					
Pressure to make profit margins makes it difficult to afford conservation practices	2.4%	14.8%	17.6%	52.8%	12.4%
There is not enough cost-share and other support available from government agencies	2.6%	12.7%	32.5%	40.7%	11.5%
Many farmers don't have the economic resources to adopt sufficient conservation practices	5.9%	28.5%	29.4%	30.7%	5.4%
I can't afford to implement more conservation practices	4.0%	29.9%	35.4%	26.7%	4.0%
Many conservation practices have negative impacts on yields	5.4%	37.5%	37.2%	18.1%	1.8%
Landlord-related barriers					
Landlords are unwilling to spend money on conservation	2.8%	12.4%	27.6%	42.9%	14.3%
Landlords don't want to change the way things are done	2.0%	14.3%	33.8%	37.9%	12.0%
Farm management barriers					
Farmers who are poor stewards of the land cause most of the water quality problems	3.7%	15.0%	33.4%	36.0%	11.9%
Farmers who have more run-off and erosion problems are less likely to seek conservation assistance	4.2%	25.6%	28.9%	33.7%	7.5%
Agronomic barriers					
Nutrient loss is difficult to avoid in corn-soybean production systems	5.8%	36.9%	28.9%	26.3%	2.1%
Nutrient loss is difficult to avoid in tile-drained fields	5.8%	27.3%	43.5%	21.4%	2.0%

uncertainty, and 31 percent agreeing. In other words, while profit margin pressure might make conservation investment more difficult, it was not necessarily unaffordable, at least in 2015 when the survey was conducted.

Substantial proportions of farmers agreed with statements related to potential landlord-related barriers. Fifty-seven percent agreed that "landlords are unwilling to spend money on conservation" (table 6). Similarly, 50 percent agreed that "landlords don't want to change the way things are done," and 34 percent were uncertain.

Technical and financial assistance for conservation

Respondents were also asked about their use of technical and financial assistance for conservation practices. Forty-five percent of the surveyed farmers had received conservation technical assistance from a state or federal agency in the previous five years (table 7). Only eight percent had received technical assistance from a non-governmental organization. Forty percent of respondents had received financial assistance in the form of cost-share.

Influence of information sources on nutrient management decisions

Farmers can turn to many organizations, agencies, and individuals for information to help them make decisions about nutrient management. A better understanding of which entities are most influential in nutrient management decisions can point to potentially effective information dissemination and outreach pathways. The survey provided a list of agricultural stakeholders and asked farmers to rate "how much influence the following sources of information have on your decisions about nutrient management practices and strategies." Responses were recorded on a five-point scale from "no influence" (1) to "very strong influence" (5). The results for each group are presented in table 8 from highest to lowest in level of reported influence.

The USDA Natural Resources Conservation Service or county Soil and Water Conservation District (federal and local conservation agencies that work together out of county-level USDA Service Centers) was the highest-rated source of information, with 33 percent of respondents reporting strong or very strong influence on nutrient management decisions (table 8). Iowa State University Extension was second, with 26 percent reporting at least strong influence. Twenty-two percent of respondents reported that family members had strong or very strong influence on nutrient management decisions.

Respondent demographics

The survey respondents were 97 percent male. They ranged from 26 to 92 years of age, with a mean age of 58 years. Thirty-eight percent reported a high school degree as their highest level of education, 30 percent reported some college, and 22 percent reported a bachelor's degree. The remaining ten percent reported having less than high school, some graduate school, a graduate degree, or an associate's degree.

Respondents reported an average of 776 acres of farmland. A mean of 740 acres was cropland (i.e., land in corn, soybeans, small grains, and/or fruit and vegetables), an average of 28 acres was pasture, and seven acres enrolled in the Conservation Reserve Program. On average, respondents reported 359 acres of owned cropland and 384 acres of rented cropland. Seventy-five percent rented some land. In 2014, 35 percent of the surveyed farmers raised livestock for sale or for milk production.

Farmers were asked to select a category that best represented their gross farm sales for 2014. Nineteen percent reported gross sales below $99,999. Twenty-

Table 7. Percentage of farmers who responded "Yes" to questions about the use of technical and financial assistance for conservation

In the last 5 years, have you received conservation technical assistance from a state or federal agency?	44.9%
In the last 5 years, have you received conservation technical assistance from a non-governmental organization (e.g., Soybean Association, Pheasants Forever)?	8.0%
In the last 5 years, have you received cost share to help you fund conservation practices?	39.6%

Table 8. Influence that different sources of information have on nutrient management decisions

	No Influence	Slight Influence	Moderate Influence	Strong Influence	Very Strong Influence
NRCS or county Soil and Water Conservation District	15.6%	18.9%	32.6%	25.9%	7.0%
Iowa State University Extension (e.g., field days, workshops, publications, videos)	18.1%	18.1%	37.9%	21.4%	4.4%
Family member	33.4%	20.7%	23.7%	18.9%	3.3%
Local agricultural retailer (e.g., fertilizer, agricultural chemical dealer, coop)	21.6%	24.3%	33.7%	18.0%	2.4%
Iowa Department of Agriculture and Land Stewardship	22.6%	25.4%	33.9%	14.9%	3.2%
Landlord/farm management firm	40.6%	17.8%	23.6%	16.3%	1.8%
Independent/private crop adviser/agronomist	44.8%	16.9%	22.8%	14.1%	1.3%
Other farmers	20.0%	28.2%	37.8%	13.1%	0.9%
Iowa Water Quality Initiative (WQI)	34.9%	25.7%	26.8%	10.2%	2.4%
Seed company	42.9%	25.8%	22.3%	8.0%	0.9%
Iowa Farm Bureau	46.6%	21.7%	23.3%	6.6%	1.9%
Iowa Corn Growers	45.5%	23.7%	22.4%	6.9%	1.5%
Iowa Soybean Association.	45.5%	24.1%	22.2%	6.8%	1.5%
Custom operator/applicator	52.4%	21.7%	18.9%	6.0%	1.1%
Conservation NGO (e.g., Pheasants Forever, etc.)	54.6%	23.0%	16.0%	5.2%	1.2%
Iowa Learning Farms	64.1%	16.5%	14.8%	3.8%	0.8%
Practical Farmers of Iowa	65.3%	17.6%	14.0%	2.2%	0.9%

eight percent reported gross sales of $100,000 to $249,000, and 24 percent reported $250,000 to $499,999. Fifteen percent reported between $500,000 and $999,999, and 14 percent exceeded $1 million.

Changes over time—Survey results from repeat respondents

To track changes in farmers' awareness, attitudes, and conservation behaviors over time, the NRS farmer survey project conducts two years of surveys in each HUC6 watershed. In 2016, the survey was mailed again to a subset of the original 2015 Missouri-Little Sioux HUC6 watershed sample. Respondents who completed the survey twice are referred to as "repeat respondents." Repeat responses allow for measurement of change, or the lack of change, between 2015 and 2016. In the Missouri-Little Sioux HUC6 watershed, repeat respondents completed the 2016 survey at a response rate of 74 percent. The 2016 survey was sent to 500 respondents that had completed the 2015 survey; 475 of these respondents were considered eligible. Of these, 350 repeat respondents completed the 2016 survey.

The following sections report the changes that occurred among repeat respondents from 2015 to 2016. Generally, only changes that were measured as statistically significant are reported, with corresponding levels of statistical significance (*p*-values) indicated in the results.

Awareness of and attitudes toward the Iowa Nutrient Reduction Strategy

The 2016 survey asked repeat respondents to report their knowledge of the NRS, with a question identical to that they had received in 2015 (page 9). There was no statistically significant change in NRS awareness from the first year to the next.

Similarly, repeat respondents indicated their levels of agreement with statements regarding their attitudes

toward the NRS and water quality. The statements were identical to those posed in the 2015 survey (table 4). There were no statistically significant changes in the levels of agreement with these items from the first to the second year.

Information sources

In both years the survey asked respondents to indicate whether they had learned about the NRS from a list of 10 potential information sources. The only statistically significant increase: the percentage of farmers was for commodity or farm organizations, such as the Iowa Soybean Association, the Iowa Corn Growers Association, and the Iowa Farm Bureau. In 2015, 48 percent of repeat respondents had learned about the NRS from a farm organization; in 2016, 54 percent reported learning about the NRS from this source ($p < 0.05$) (figure 7).

Awareness of watershed management activities

As shown in table 3, respondents were asked to indicate a "Yes", "No", or "Don't Know" response to the following questions concerning watershed management activities:

- Is there an active watershed management group in the watershed?
- Are local farmers involved in organized watershed management activities?
- Are local non-farming residents involved in organized watershed management activities?
- Are you involved in organized watershed management activities?

There was no statistically significant change in responses to these questions between 2015 to 2016.

Use of conservation practices

Nutrient management practices. Among the nutrient management practices that the survey asked about, most were practices that can reduce the loss of nutrients from fields when compared to conventional practices. However, the survey also included Fall N application, which can increase potential for nutrient loss. Respondents were asked to indicate whether they had used the practice in the prior year, did not use the practice but might use it in the future, or did not use the practice and had no plans to use it.

For the nutrient management practices, repeat respondents reported several statistically significant changes. Use of Fall N application fell from 43 percent to 33 percent, although the percentage of farmers who did not use the practice but might in the future increased from nine to 17 percent ($p < .01$). There were statistically significant increases in "potential future use" of growing season N application ($p < 0.001$), and variable rate N application ($p < 0.10$). In other words, the proportion of farmers who indicated that they might apply N during the growing season increased substantially while the proportion who did not use the practice and had no plans to use it decreased (from 61 to 49 percent). Potential users increased from 22 to 35 percent. Finally, variable rate N non-users

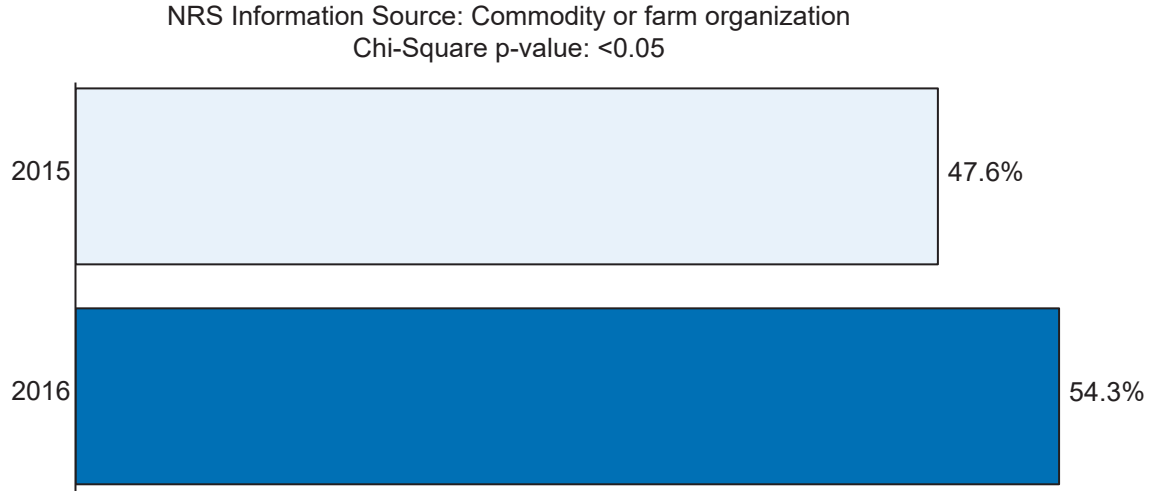


Figure 7. The percentage of repeat respondents in the Missouri-Little Sioux HUC6 watershed, in 2015 and 2016, who indicated that they had learned about the Iowa Nutrient Reduction Strategy from a commodity or farm organization.

decreased from 45 to 41 percent, while potential users increased from 25 to 33 percent. Users of variable rate N fell from 29 to 26 percent (figure 8). Overall, these results indicate that farmers in the watershed are moving away from non-recommended practices such as fall nitrogen application and toward more efficient practices such as growing season and variable rate application.

Land use practices. Among the land use practices, there was significant change in responses to the questions about conversion of row crops to perennial crops ($p < 0.05$) and in the use of extended rotations ($p < 0.05$). The statistically significant change was due to a shift from the "not using, no plans to use" category to the "potential use in the future category. For conversion to perennial crops, percentage of farmers reporting no plans to use the practice fell from 74 to 66 percent, and potential users increased from 11 to 18 percent. Similarly, for extended rotations the percentage of farmers in the "no plans to use" category fell from 74 to 68 percent and potential use rose from 14 to 21 percent (figure 9).

Structural practices. Among the structural practices, there was a statistically significant change in responses related to the use of ponds and sediment basins ($p < 0.05$) and of bioreactors ($p < 0.05$). From 2015 to 2016, non-users of ponds and basins fell from 72 to 68 percent of repeat respondents, and potential users rose from seven to 13 percent. Potential users of bioreactors rose from 10 to 17 percent, while non-users with no plans to use bioreactors decreased from 89 to 82 percent (figure 10).

Barriers to conservation

Comparisons of responses on the barriers to practice use questions showed a number of significant changes between 2015 and 2016. As reported above,

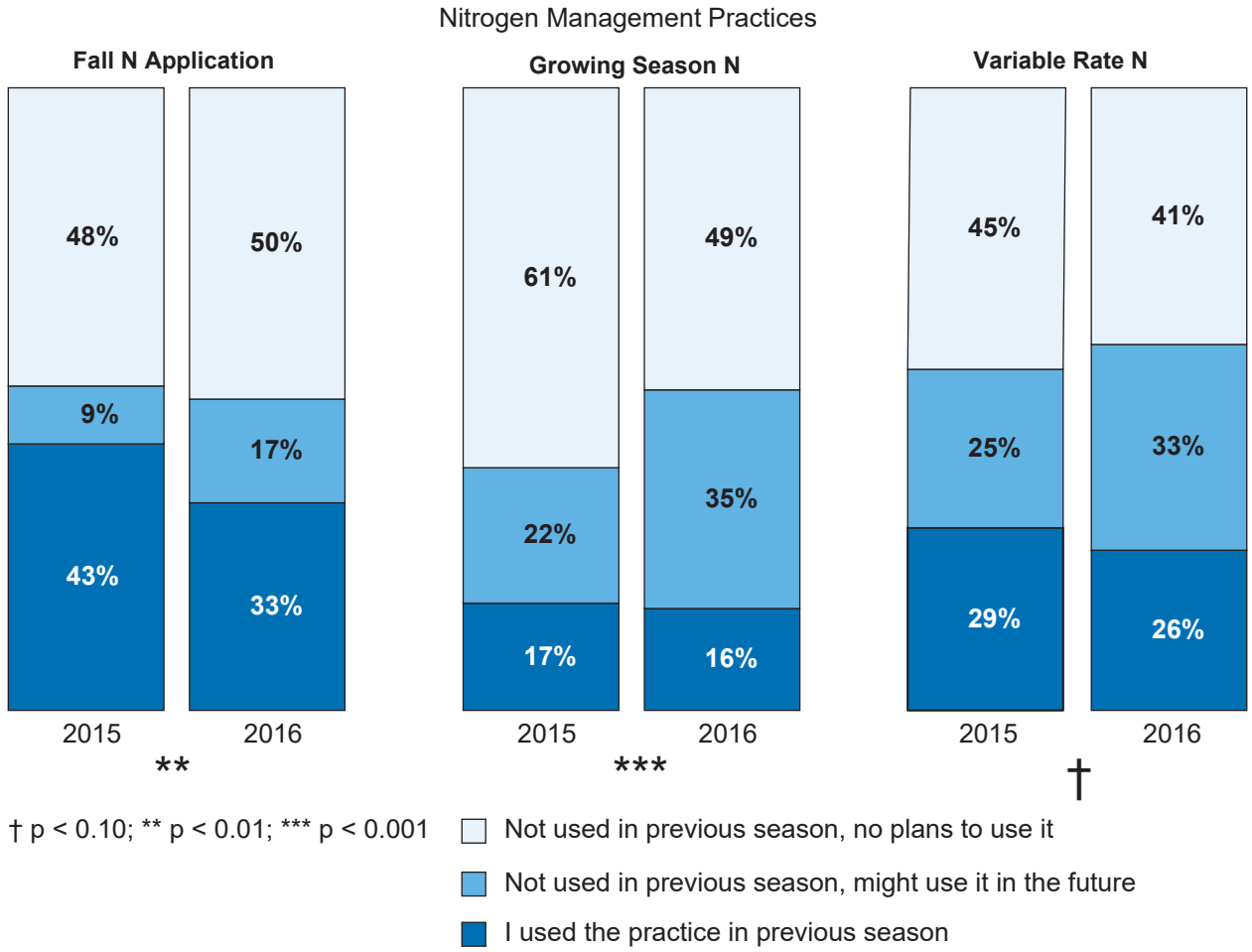


Figure 8. The percentage of repeat respondents in the Missouri-Little Sioux HUC6 watershed, in 2015 and 2016, who indicated that they used selected nutrient management practices in the prior season, that they might use the practices in the future, or that they have no plans to use the practices.

respondents who had not used a given practice were asked to check any of four potential barriers—"cost too high compared to benefits," "don't know enough about it," "not appropriate for my soil or terrain," and "risk to crop yield"—if the particular barrier applied to them (table 6). The percentage of non-users (i.e., those who had no plans to use the practice or those who might use it in the future) who checked each barrier are displayed in figure 11. Results are provided only for those practices that showed a statistically significant change between 2015 and 2016.

The percentage of farmers who cited cost as a barrier to conservation practice use increased for cover crops but declined for several other practices. The proportion of farmers citing cost as a barrier to cover crops use increased from 27 percent of non-users in 2015 to 35 percent in 2016 ($p < 0.05$) (figure 11a). On the other hand, the percentage of practice non-users citing cost as a barrier declined for the following practices: growing season N (24 to 14 percent ($p < 0.01$)), variable rate N (27 to 17 percent ($p < 0.05$)), N stabilizer (48 to 28 percent ($p < 0.01$)), and extended rotations (28 to 20 percent ($p < 0.05$)).

The percentage of non-users who perceived lack of knowledge as a barrier to practice use decreased significantly from 2015 to 2016 for a number of practices: cover crops, strip till, contour strips, stream buffers, bioreactors, and MRTN (figure 11b). The greatest decrease in knowledge as a barrier occurred for MRTN, which dropped from 70 percent of non-users to 55 percent ($p < 0.01$).

The percentage of non-users who indicated that a practice is "not appropriate for my soil or terrain" decreased significantly for each of the following practices: contour strips, stream buffers, bioreactors, spring N application, growing season N, variable rate N, MRTN, and extended rotations (figure 11c).

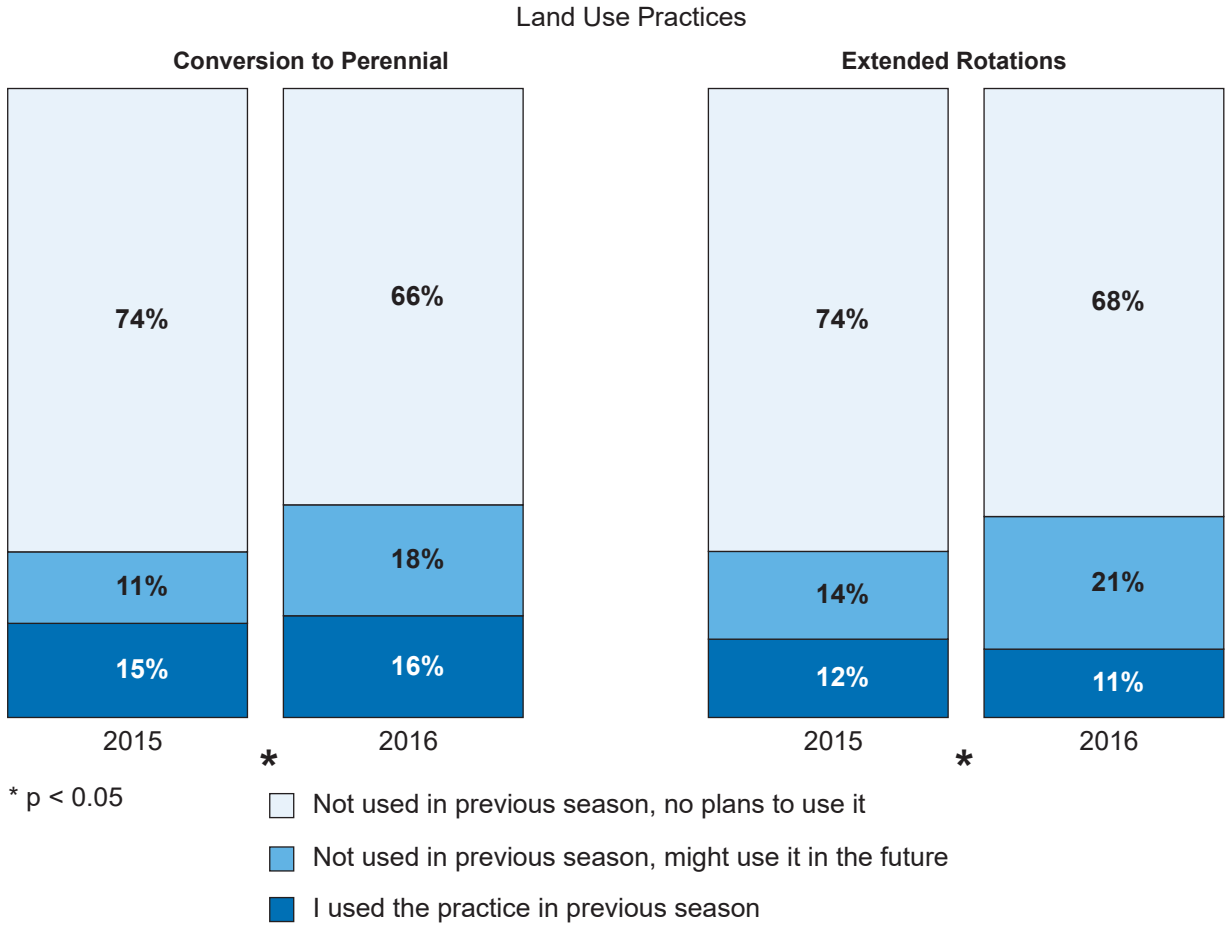


Figure 9. The percentage of repeat respondents in the Missouri-Little Sioux HUC6 watershed, in 2015 and 2016, who indicated that they used selected land use practices in the prior season, that they might use the practices in the future, or that they have no plans to use the practice.

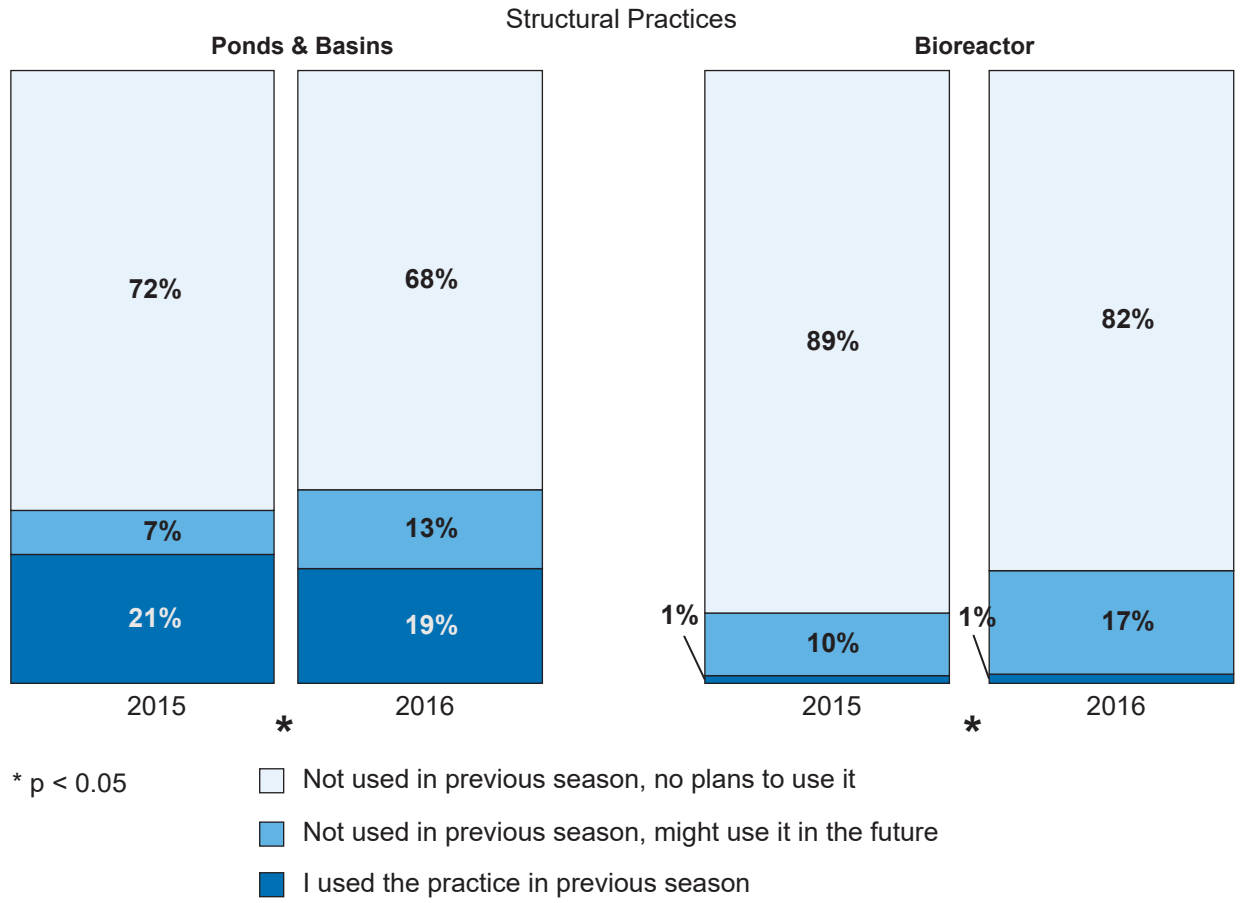


Figure 10. The percentage of repeat respondents in the Missouri-Little Sioux HUC6 watershed, in 2015 and 2016, who indicated that they used selected structural practices in the prior season, that they might use the practices in the future,or that they have no plans to use the practices.

The greatest decrease in "not applicable" as a barrier occurred in spring N application. This practice was considered not applicable by 39 percent of non-users in 2015 and 21 percent in 2016 ($p < 0.05$). It is likely that this barrier and lack of knowledge of practices are related. In other words, as farmers' knowledge of practice increases, their understanding of how a given practice might fit into their farm operations may also increase.

Finally, the percentage of farmers citing risk to crop yield as a barrier to practice use decreased significantly only for use of variable rate N. In 2015, eight percent of users indicated risk to crop yield as a reason for not using the practice; in 2016, this value had decreased to four percent of users ($p < 0.10$).

Comparisons of responses to statements related to potential barriers facing water quality improvement in Iowa (table 6) showed several statistically significant changes in responses between 2015 and 2016. There was an increase in agreement with the statement "Many farmers don't have the economic resources to adopt sufficient conservation practices" (figure 12). In 2015, 33 percent of repeat respondents agreed or strongly agreed with this statement; this proportion increased to 39 percent 2016. Disagreement and strong disagreement decreased from 37 to 32 percent ($p < 0.05$).

Overall agreement with the statement "Nutrient loss is difficult to avoid in corn-soybean production systems" also increased (figure 12). From 2015 to 2016, the percentage of repeat respondents who strongly disagreed decreased from six to three percent, while those who disagreed with the statement increased from 38 to 42 percent ($p < 0.1$).

There was an overall decrease in agreement with the statement "Landlords are unwilling to spend money on conservation" (figure 12). From 2015 to 2016, the percent of repeat respondents who agreed or strongly agreed decreased from 58 to 47 percent. Uncertainty increased from 28 to 36 percent, and disagreement or

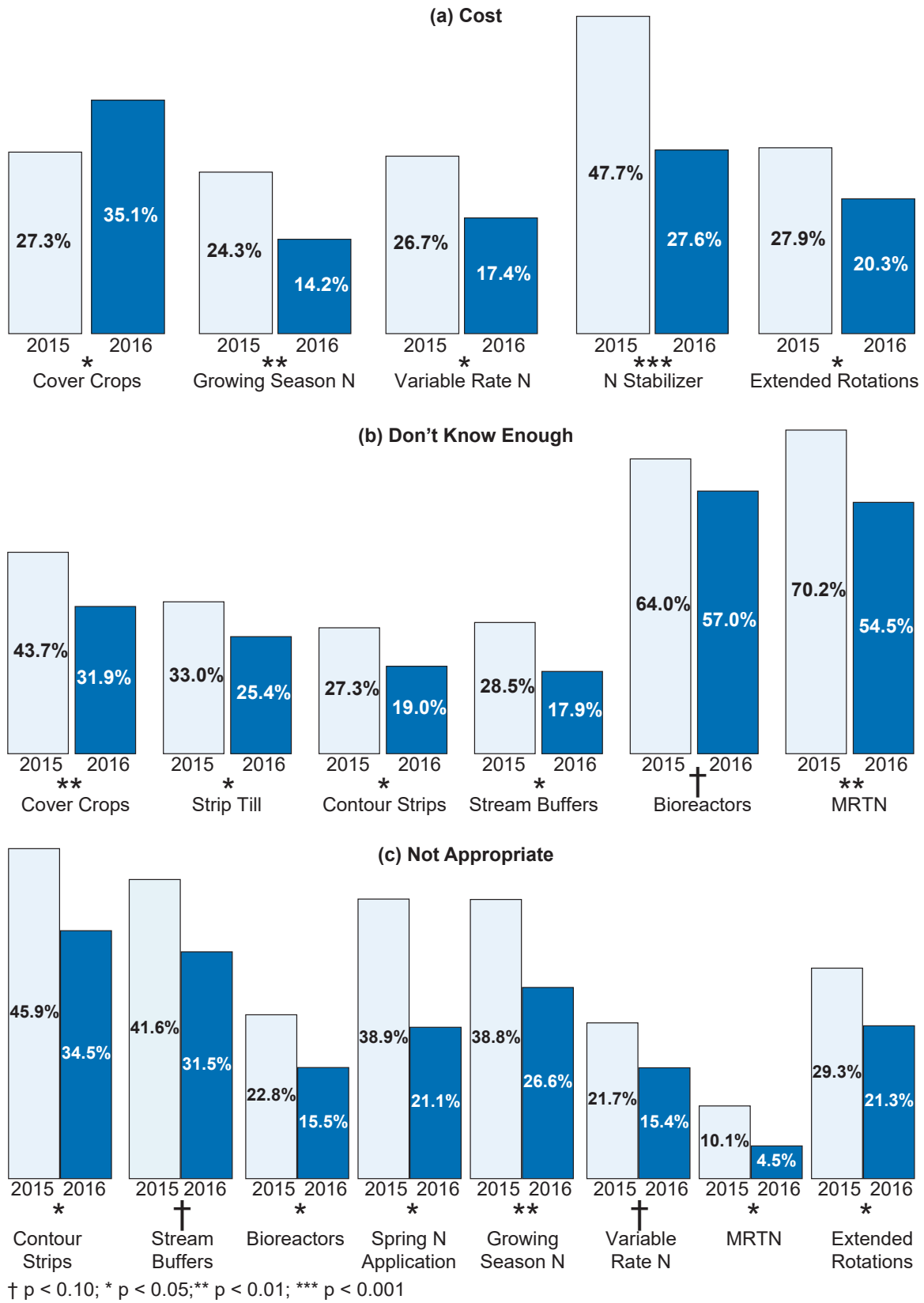


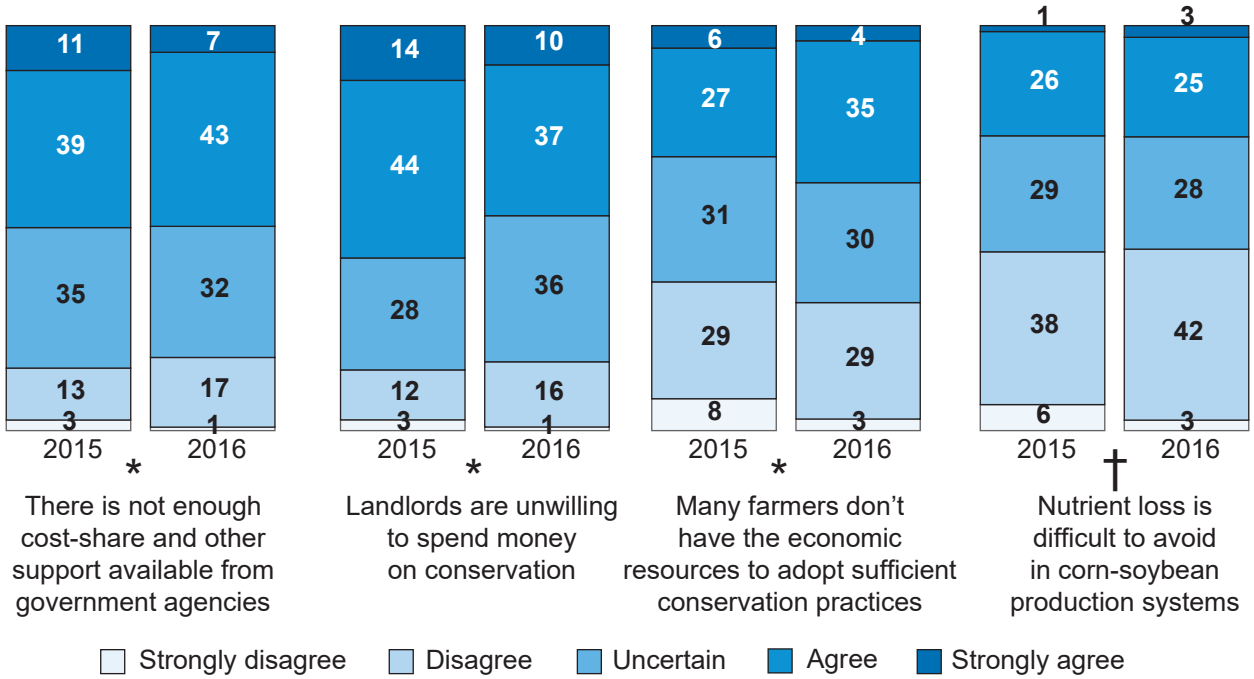
Figure 11. The percentage of repeat respondents in the Missouri-Little Sioux HUC6 watershed, in 2015 and 2016, who cited a) cost, b) knowledge, or c) "not appropriate for my soil or terrain" as barriers to using selected practices.

strong disagreement increased from 15 to 17 percent ($p < 0.05$).

Finally, the statement "There is not enough cost-share and other support available from government agencies" received a decrease in uncertainty—35 to 32 percent—and an increase in disagreement—13 to 17 percent ($p < 0.05$).

Technical and financial assistance for conservation

Repeat respondents indicated whether they had received cost-share and conservation technical assistance in the previous five years (table 9). Those who reported that they had received technical assistance in the last five years from a state or federal agency fell from 47 percent in 2015 to 34 percent in 2016 ($p < 0.001$). Those who had received technical assistance from an NGO fell from nine to six percent ($p < 0.05$). Finally, those who had received cost-share to help fund conservation practices fell from 39 to 25 percent ($p < 0.001$). These results suggest that a number of respondents who had received cost share in the five years previous to 2015 were no longer in that 5-year window in 2016.



† $p < 0.10$; * $p < 0.05$

Figure 12. The percentage of repeat respondents in the Missouri-Little Sioux HUC6 watershed, in 2015 and 2016, who indicated their level of agreement with selected statements regarding barriers to water quality improvement in Iowa.

Table 9. Percentage of repeat respondents who responded "Yes" to questions about the use of technical and financial assistance for conservation

	2015	2016	p-value
In the last 5 years, have you received conservation technical assistance from a state or federal agency?	46.5%	34.3%	$p < 0.001$
In the last 5 years, have you received conservation technical assistance from a non-governmental organization (e.g., Soybean Association, Pheasants Forever)?	9.2%	5.5%	$p < 0.05$
In the last 5 years, have you received cost share to help you fund conservation practices?	39.3%	25.1%	$p < 0.001$

Summary of key findings

Awareness and attitudes

- In 2015, 31 percent of farmers in the Missouri-Little Sioux HUC6 watershed reported that they were knowledgeable or very knowledgeable about the NRS. Twenty-eight percent reported slight or no knowledge.
- The farm press, ISU Extension and Outreach, and conservation agencies were the most common source of information about the NRS. Between 2015 and 2016, the percentage of farmers who had learned about the NRS from commodity or farm organizations increased significantly from 48 to 54 percent.
- Agricultural product and service providers were the least common source of NRS information.
- In general, Iowa farmers were aware of and concerned about agriculture's impacts on water quality. Most farmers were supportive of the NRS's goals.
- Nearly half of farmers would be willing to have their operations' nutrient management effectiveness evaluated.
- More than 60 percent of farmers believed their nutrient management practices were sufficiently effective, and nearly half reported that they are doing all they can to reduce nutrient losses. More than one-third of farmers were uncertain on these items.
- About 25 percent of farmers indicated that there was an active watershed group in their watershed, and 46 percent were not aware of one.
- Almost all farmers were concerned about potential regulations.
- Between 2015 and 2016, there was no significant change measured in items related to knowledge, awareness, or attitudes among farmers in the Missouri-Little Sioux HUC6 watershed.
- However, substantial proportions of farmers who were using innovative nutrient loss reduction practices had been using them for less than three years, suggesting an overall increase in practice use. Notable among these were cover crops and in-field buffer strips, with 56% and 27% of users, respectively, reporting that they had been using them for three years or fewer.

Conservation practice use

- Farmers in the Missouri-Little Sioux HUC6 watershed reported significant change in rates of conservation practice use or in intended future use from 2015 to 2016. Users of fall N application decreased by ten percent. Interest in using perennial crops, extended rotations, and bioreactors in the future increased.
- Between 2015 and 2016, there was no measured change in the use or potential future use of cover crops, reduced tillage, or N stabilizer.

Barriers to conservation

- Lack of knowledge is a major barrier to adoption of many conservation practices in 2015. In 2016, fewer farmers reported this barrier for a number of practices. This result suggests that farmers are learning more about practices, which is reducing the importance of lack of knowledge as a barrier.
- There was a significant increase in farmers reporting that cost is a barrier to adopting cover crops. Corn and prices declined substantially between the two surveys, likely contributing to this result.
- Pressure to make profit margins and lack of economic resources, including cost-share and lack of landlord willingness to invest in conservation, were increasingly cited as substantial barriers to conservation practice adoption.