

# **Nitrogen Use and Determinants of Best Management Practices**

**A Study of Rush River and Elm Creek Agricultural Producers**



Final Report  
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Creek Watershed Agricultural Producers**

A final technical report prepared for the  
Minnesota Pollution Control Agency

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## **Executive Summary**

This report describes a study of the perspectives of farmers and resource professionals in the Rush River and Elm Creek watersheds, Minnesota. The study was conducted as part of a larger project entitled “Nitrogen Budget Assessment to Determine Nitrogen Loadings, Sources, and Pathways to Minnesota Surface Water” funded by the Minnesota Pollution Control Agency. This study was led by the Department of Forest Resources in collaboration with the Department of Soil, Water and Climate, and the Department of Applied Economics at the University of Minnesota. The purpose of the study is to assist watershed planners, commodity groups, and resource professionals in better understanding the determinants of nitrogen best management practices. Specific study objectives were to (1) explore farmer perspectives on farming and water resources, (2) examine the decision making process associated with nitrogen use on farms, and (3) identify drivers of and constraints to on-field and off-field nitrogen best management practice adoption. Data were gathered through a series of in-depth, personal interviews with 30 agricultural producers and two focus groups of water resource professionals in the Rush River and Elm Creek watersheds. The findings of this study are organized in response to eight research questions and are separated into two major sections: interview findings and focus group findings. A brief synopsis of study findings is highlighted below. Full findings in tabular form are presented in Appendix I.

### ***Farmer Interview Findings***

#### ***I. Who are participants and what are the characteristics of their farms?***

- The average age of participants was 59. Of the 30 participants, all were white, 28 were male, and more than one-third from both watersheds (40%) had attained at least a college degree.
- Participants have lived in their communities for an average of 52 years and reported farming for an average of 37 years. Farms had been in the participants’ families for an average of 85 years.
- The average distance from home to farmland was 4 miles.
- Ten (33%) participants operate 500 acres or fewer, 10 (33%) participants operate 501 to 1000 acres, and 10 (33%) participants operate over 1001 acres.
- Of the 30 participants, 21 (70%) own and manage their own land and rent from another and 22 (73%) relied on their land for more than 50% of their income.
- Of the 30 participants, 16 reported a total household income higher than \$100,000.

#### ***II. What are participants’ perspectives on farming and water resources?***

Participants were asked a series of questions concerning their perspectives on farming including what their farm means to them, what concerns them about farming today, and what they might change about farming. They were also asked about their connection to water resources in the area, their perspectives on water quality, and who should be responsible for keeping water resources healthy.

- In general, independence, overcoming challenges, raising a family, and production of crops emerged as predominating themes in what participants from both watersheds like most or find most meaningful in farming.

- Financial constraints and risk, potential government regulations, increasing farm size, and negative public perceptions of farming appeared to concern participants from both watersheds the most when asked to describe what they dislike or what worries them about farming.
- Participants in the Rush River watershed described their connection to the area's water resources along four general themes: wildlife, recreation, consumption, and conservation. Elm Creek watershed participants expressed their connection to water resources in three similar themes: recreation, production, and conservation.
- Participants' perceptions of the quality of local water resources diverged. Nine of the 15 Rush River watershed participants and 10 of the 15 Elm Creek watershed participants characterized local water resources as being of good quality.
- When asked whose responsibility it is to keep water resources healthy, the vast majority of farmers acknowledged a shared responsibility for water resource health.

### *III. How do participants manage their farms?*

Participants were asked questions about their ownership and management arrangements, decision-making process on the farm, the success of their farm, and changes in farm management.

- The majority of Rush River and Elm Creek watershed farmers who have rental agreements do so on a cash rental basis. The duration of most agreements was one year and nearly all agreements were from one to three years.
- In the Rush River and Elm Creek watersheds, economics and stewardship emerged as two predominating themes of what influences decision making on the farm
- When asked if they consult others when making decisions, farmers in the Rush River watershed identified cooperatives and agronomists, other farmers, and published sources of information as three primary contacts. Participants in the Elm Creek watershed reported consulting with financial resources and resource managers in addition to cooperatives and agronomists.
- Rush River watershed participants characterized the success of their farm in terms of three major themes: financial, production, and health. Producers in Elm Creek also characterized their farms' achievements in terms of financial and production success as well as land stewardship, livestock health, and social contributions.
- Common challenges to farmers in both the Rush River and Elm Creek watersheds were price volatility, high demand for land, weather, and regulations.
- The majority of participants in the Rush River watershed responded that they had changed the way they farmed in the past five years in three major realms: operations, equipment, and crop inputs. Farmers interviewed in the Elm Creek watershed noted changes concerning aspects of field operations ranging from tillage to plant density and business operations.

### *IV. How do participants use nitrogen on their farms and what influences their nitrogen use?*

Participants were asked about what they consider when applying nitrogen, how they apply nitrogen (including source, timing, method, and rate), and manure use. Participants also were asked how they determined nitrogen application rates, the importance of maximizing nitrogen efficiency, and the importance of minimizing potential impacts of nitrogen on the natural environment.

#### Factors that influence nitrogen application:

- Two themes emerged from participants' responses to what they considered when applying nitrogen: cost and precision. Elm Creek watershed farmers added minimizing leaching as an important goal as well.

#### Nitrogen application:

- Of 15 Rush River watershed participants, 9 applied nitrogen in the fall and 6 applied nitrogen in either the spring or a split application. Of 15 Elm Creek watershed participants, 4 applied nitrogen in the fall and 11 applied nitrogen in either the spring or a split application.
- Of 15 Rush River watershed participants, 10 applied anhydrous ammonia, 3 applied liquid (28% or 32%) nitrogen, and 2 applied urea. Of 15 Elm Creek watershed participants, 11 applied anhydrous ammonia and 4 applied liquid (28% or 32%) nitrogen.
- Of 15 Rush River watershed participants, 11 used manure as a nitrogen source on their lands. Of 15 Elm Creek watershed participants, 10 used manure as a nitrogen source on their lands.
- Of 15 Rush River watershed participants, nitrogen application rates ranged from 100lbs of spring applied liquid nitrogen to 200lbs of fall anhydrous on corn following corn. Of 15 Elm Creek watershed participants, nitrogen application ranged from 130lbs of spring applied anhydrous ammonia to 215lbs of fall applied anhydrous ammonia.

#### Determining nitrogen rates:

- All participants reported using nitrogen levels from soil samples to determine application rates for the following year.

#### Maximizing farm efficiency:

- Rush River watershed participants regarded economics and environmental concern as two important themes for maximizing the efficiency of nitrogen use. Participants in the Elm Creek watershed expressed the importance of maximizing the efficiency of nitrogen use in terms of economics and ensuring sufficient nutrients for the crop.

#### Minimizing impacts to the natural environment:

- Rush River watershed participants expressed concern about impacts to groundwater, ecological impairments, and future regulations when asked about the importance of minimizing potential impacts of nitrogen on the natural environment. Elm Creek watershed participants' discussions converged around the human benefits of healthy water resources.

#### *V. What are participants' perspectives on nitrogen best management practices?*

To generate discussion around what factors drive and constrain the adoption of best management practices (BMPs), participants were asked to describe their use of BMPs, their perceptions of BMPs, and factors that influence their decisions around the use of BMPs on their farms.

- Of the 10 BMPs listed for participants, the most commonly used BMPs overall were planting buffer or filter strips (80%) and following the University of Minnesota recommendations for nitrogen application (53%). The least commonly used BMPs were installing a two-stage ditch and planting alternative energy crops, neither of which was used by any of the study participants.

- Two-stage ditches and bioreactors were the BMPs with which farmers were least familiar. Eleven farmers (37%) reported hearing about two-stage ditches. Twenty (66%) farmers reported hearing about bioreactors.
- In participants' discussion of the BMPs, seven primary categories of constraints to adoption emerged: economics, knowledge, autonomy, market/demand, farm/landscape suitability, weather sensitivity, and effectiveness
- In participants' discussion of the drivers of best management practice adoption, three primary categories emerged: land management, economics, and responsibility.
- Planting buffers or filter strips was most popular among participants primarily because of familiarity/tradition and incentive payments received for low-producing soils.
- Installing a two-stage ditch and planting alternative energy crops were the least popular BMPs. Constraints to two-stage ditch installation were land requirements for implementation, cost of construction/maintenance, and lack of familiarity. Constraints to growing alternative energy crops were concerns regarding replacing nutrients harvested, lack of a market, and competing commodity prices.

### ***Resource Professional Focus Group Findings***

#### ***I. What are participants' perceptions of water resources and best management practices?***

Participants were asked to complete a fixed-choice survey addressing their concerns about the impact of nitrogen on different watershed scales. They were also asked their opinions about specific BMPs including the BMP's effectiveness at reducing nitrogen impacts on water resources and the likelihood the BMPs would negatively affect yield and profitability.

- Overall, participants reported being the most concerned (moderately to very concerned) about the impact of nitrogen on water resources within the Minnesota River Basin.
- Overall, variable rate technology, wetlands, and following University of Minnesota recommendations for nitrogen were rated the three most effective BMPs at reducing the impacts of nitrogen on water resource.
- Constructing a two-stage ditch and planting cover crops were rated as the least effective nitrogen BMPs.
- Overall, wetlands and planting alternative energy crops were rated the most likely to negatively affect yield and profitability.
- Using variable rate technology and University of Minnesota recommendations for nitrogen application were judged to be least likely to negatively impact yield and profitability.

#### ***II. What barriers exist to nitrogen best management practice adoption?***

Focus group participants were asked "What do you see as the biggest barriers to increasing BMP adoption in the [Elm Creek or Rush River] watershed and the surrounding area?"

- Overall, six primary categories of constraints emerged in these discussions: economics, farm culture, education, agency limitations, farmer values, and lack of enforcement.



- The economics of BMP implementation was the number one barrier identified in both focus groups. This involved the cost of BMP implementation and the corresponding loss of crop production.
- Landowner education and absenteeism were also cited as critical barriers in adoption of BMPs.

### *III. What are strategies for increasing best management practice adoption?*

Participants were asked to list ways to increase best management adoption in their respective watersheds and the surrounding areas.

- Overall, five primary categories of strategies emerged including education, farmer-tailored programs, showing results, identifying innovators, and regulation.
- Strategies for increasing BMP adoption were much more varied than constraints. Fourteen strategies were listed as possibilities for improving BMP adoption rates. The top three strategies were identification of local innovators, prioritized community meetings, and making programs/practices easier to follow.

## **Project Background**

This report describes the findings of a study of farm practices and farmer perspectives in the Rush River and Elm Creek watersheds, Minnesota. The study was conducted as part of a larger project entitled “Nitrogen Budget Assessment to Determine Nitrogen Loadings, Sources, and Pathways to Minnesota Surface Water” funded by the Minnesota Pollution Control Agency. This study was conducted by the Department of Forest Resources in collaboration with the Department of Soil, Water and Climate, and the Department of Applied Economics at the University of Minnesota. The purpose of the study is to assist watershed planners, commodity groups, and resource professionals in better understanding agricultural producers’ perspectives on farm management and in particular, nitrogen best management practices. Specific study objectives were to (1) explore farmer perspectives on farming and water resources, (2) examine the decision making process associated with the nitrogen use on farms, and (3) identify drivers of and constraints to on-field and off-field nitrogen best management practice adoption. This study adopted a qualitative research approach to “describe, understand and explain” agricultural producers’ perspectives on nitrogen management (Wagenet 2007, pg. 805). Thirty in-depth interviews were conducted with a sample of farmers and two focus groups were facilitated with resource professionals in the Rush River and Elm Creek watersheds.

The information provided in this report is intended to inform, enhance, and facilitate future programs designed to promote best management practice adoption among agricultural producers. This study and similar social science research (Davenport and Pradhananga, 2012) should serve as a companion to biophysical research and economic assessments in watershed planning initiatives across the state. Resolving water resource problems in agricultural communities requires an understanding of farmers’ perspectives—why they farm, what challenges they face, what influences their decision making, and how they perceive certain farm management practices. Study findings reported here are grounded in the values, beliefs, and every day experiences of 30 farmers and 15 resource professionals working in the study watersheds. Study recommendations will be useful for designing and implementing communication, education, and outreach programs that both respond to farmer needs and enhance water resources.

## **Research Design and Methods**

Thirty in-depth interviews were conducted with agricultural producers in the Rush River and Elm Creek watersheds, Minnesota. The Rush River watershed, a subwatershed of the Minnesota River, stretches across Le Sueur and Nicollet Counties (Appendix A). The Elm Creek watershed, a subwatershed of the Blue Earth River, stretches across primarily Martin and Jackson Counties (Appendix A). The interviews engaged participants in one-on-one dialogue about their farms, water resources, and nitrogen management. A semi-structured interview format fostered candid, individual reflection, as well as focused discussion around specific nitrogen best management practices. The interviews were conducted from January through March 2012. In addition to the interviews, two focus groups were facilitated with resource professionals working in the two study watersheds. A qualitative approach such as this preserves richness and detail in the descriptions and attitudes of those interviewed but does not attempt to be statistically representative of the opinions of a broader population. Thus, this study represents the opinions of only those interviewed.

A stakeholder inventory was conducted to generate a list of agricultural producers within the Rush River and Elm Creek watersheds. Resource professionals and other agricultural community experts such as representatives from the Soil and Water Conservation District, Natural Resource Conservation Service, Minnesota Pollution Control Agency, Board of Water and Soil Resources, Minnesota Farm Bureau, Minnesota Department of Agriculture, and a non-profit group were consulted to identify potential study participants. Twenty-eight farmers were contacted in the Rush River watershed, 15 of whom agreed to an interview. Nine farmers were unable to be reached despite repeated attempts and four declined an interview. Thirty-one farmers were contacted in the Elm Creek watershed; 15 agreed to an interview. Twelve farmers were unable to be reached despite repeated attempts and four declined an interview.

Data were collected through in-depth, semi-structured interviews lasting one to two hours. Interviews were conducted in participants' homes or places of business. Participants were recruited by telephone and by the "snowball" method of asking participants to recommend other potential interviewees. A recruitment script (Appendix B) was followed which described the purpose of the study, the participation process, and how the data would be used. Each participant signed an informed consent form (Appendix C). An interview guide (Appendix D and E) was developed and adopted after three pilot interviews, as well as approval of the study protocol by the University of Minnesota Institutional Review Board. Participants were also asked to complete a short survey consisting of basic sociodemographic and farm characteristics questions (Appendix F). Field notes were taken onsite to help provide context and procedural documentation. Focus group participants were asked to respond to questions regarding their concerns about the impact of nitrogen on different watershed scales (Appendix G). They were also asked their opinions about specific BMPs including the BMP's effectiveness at reducing nitrogen impacts on water resources and the likelihood the BMPs would negatively affect yield and profitability (Appendix H).

Interviews were transcribed verbatim using Olympus DSS Player Standard Transcription Module Version 1.0.2.0. Interview data were analyzed for underlying themes relevant to the guiding research objectives. Researchers used standard qualitative analysis methods adapted from Corbin and Strauss (2008), Krueger and Casey (2000), and Charmaz (2006) to code and organize the data, identify predominant themes, and explore relationships and patterns among themes. Qualitative data were analyzed using QSR NVivo 9.0. Quantitative statistics were analyzed using Statistical Package for Social Sciences (SPSS release 17.0)

### **Study Findings**

Findings reported here are based on in-depth, personal interviews with 30 agricultural producers and two focus groups of water resource professionals in the Rush River and Elm Creek watersheds. The findings are organized in response to eight research questions and are separated into two major sections: interview findings and focus group findings.

## ***Interview Findings***

Study findings reported here are based on 30 in-depth interviews conducted with farmers in the Rush River and Elm Creek watersheds. The findings are organized to respond to five questions:

1. Who are participants and what are their farm characteristics?
2. What are participants' perspectives on farming and water resources?
3. How do participants manage their farms?
4. How do participants use nitrogen on their farms and what influences their nitrogen use?
5. What are participants' perspectives on nitrogen best management practices?

### **1. Who are participants and what are their farm characteristics?**

The 30 interview participants were asked a series of basic sociodemographic questions, as well as questions about their farm operation.

#### ***Rush River watershed***

Most participants have lived and farmed in their communities for several decades, averaging 50 and 35 years, respectively (Table 1). On average, participants' families have owned their farm for 90 years. Participants reported living 2 miles from their farms, on average. The majority of farmers interviewed (60%) owned and managed their own land while also renting land from another party (Table 2). Property owned ranged from 120 to 2000 acres and averaged 755 acres in size (Table 3). The vast majority of participants were male (Table 4) and average age was 58 (Table 5). The highest level of formal education reported ranged from high school graduates to graduate degrees (Table 6). A majority of participants (60%) reported deriving more than 50% of their income from their land (Table 7) with over half reporting an annual household income of \$100,000 or greater from all sources before taxes in 2010 (Table 8).

#### ***Elm Creek watershed***

Elm Creek watershed participants reported having lived and farmed in their communities an average of 54 and 38 years, respectively (Table 1). On average, participants' families have owned their farm for 81 years and live 6 miles from their farms. Most farmers interviewed (80%) owned and managed their own land while also renting land from another party (Table 2). Property owned ranged from 280 to 6400 acres and averaged 1427 in size (Table 3). The vast majority of participants were male and average age was 61 years of age (Table 4 and 5). Highest formal education level reported ranged from high school graduates to graduate degrees (Table 6). A majority of participants (87%) reported deriving more than 50% of their income from their land (Table 7) with over half reporting an annual household income of \$100,000 or greater from all sources before taxes in 2010 (Table 8).

### **2. What are participants' perspectives on farming and water resources?**

Participants were asked a series of questions concerning their perspectives on farming including what their farm means to them, what concerns them about farming today, and what they might change about farming. They were also asked about their connection to water resources in the area, their perspectives on water quality, and who should be responsible for keeping water resources healthy.

### *Rush River watershed*

In general, independence, overcoming challenges, raising a family, and production of crops emerged as predominating themes in what participants like most or find most meaningful in farming (Table 9). Independence was a theme referred to by every participant interviewed. As one farmer described, “You realize at the end of the day, the farmer is the boss and he makes the decisions.” Another stated, “Self-employment...you don’t have a boss and you live and die by your own decisions.” Overcoming the challenges presented by farming was also a theme expressed by Rush River watershed participants: “One thing’s for sure, there are never going to be two years alike, and I enjoy that.” Raising a family in a rural environment was also a strong theme. “The rural environment is a great place to raise a family. Great for my kids, they’re involved in 4H, they take their animals to the fair,” a participant responded. Another pleasure expressed by farmers was the production of crops. Said one farmer, “[I’m] doing something that’s productive, that I can feel something physical coming off the land from my efforts, my management. There’s always the thrill of putting the seed in the ground and managing it until you harvest your crop.”

Financial constraints and risk, government regulations, increasing farm size, and negative public perceptions of farming appeared to concern participants the most when asked to describe what they dislike or what worries them about farming (Table 10). Financial constraints concerning land, commodity, and input prices all worried participants for both economic and social reasons:

It’s highly competitive right now. Landlords can name their price and have somebody snatch up your land in an instant. We’re down 300 acres this year already. It’s almost cutthroat out there. Not like it used to be like with a handshake and a nod and you could run the farm for years and years and years. It’s different now.

Some participants viewed potential government regulations as constraints on their own autonomy and the productivity of their farms. One farmer admitted, “I worry about EPA putting out regulations that will inhibit our ability to produce. We have been told that we have to increase yields to feed the world. I’m ready, willing, and able, but I don’t want my government to step in too far and be regulating me to death.” The growth of farm size also concerned many participants. One described the impacts of increasing farm sizes to farming communities, suggesting a loss of a sense of community: “Probably the one thing I would love to see changed is the enormous size that some of these farms are getting. They’re not only destroying friendships, they’re destroying communities.” A few participants expressed unease about the public perception of farmers as polluters. One participant contended that urban residents are unknowing polluters: “I can honestly say, I think the farmer’s doing a better job than the guys up town that are fertilizing their lawn three times a summer that don’t know what they’re putting on. The farmer knows what he’s putting on and the guy on the street, he just wants to beat his neighbor.”

Participants described their connection to the area’s water resources along four general themes: wildlife, recreation, consumption, and conservation (Table 11). Streams and other water bodies were seen as prime wildlife habitat. As one farmer explained, “Right now we’ve got beaver down there. The

deer are quite plentiful in the area. It's just...it's neat having that resource on your own property where you can walk to one end of your farm and see a beaver swimming." Other participants referred to their connection to water resources as recreational in nature, describing swimming, fishing, and hunting activities. A few participants recognized their connection to water through their consumption of it: "I have to drink it...I have grandchildren and our water source is our own private well. The days of having your well placed down slope of the old cattle barn, those days are gone." When asked about their connection to water resources, some participants noted their involvement in water resource management to improve the quality of local water bodies. "I guess I'm probably a little more involved with the realization of nutrients, water quality, whatnot," responded one participant, "I've been a part of the county water plan, a [water resource professional], I've got three open drainage ditches, and I live on the crick."

Participants' perceptions of the quality of local water resources diverged. Nine of the 15 Rush River watershed participants characterized local water resources as being of good quality. One participant surmised, "I would say it's very good. For the most part I think people are protecting it." Six participants described water quality as compromised in the area. "The lake is pretty much worthless now," one participant noted. Another participant added,

I know that even in nature, [the lakes] wouldn't be like they are up north, but I don't think they have to be as degraded as they are. I know when you put a lot of nitrogen into a system, a lot of algae and everything else is going to grow. Are we having an impact? Yes. I don't think it's just perception. I think it's real.

A few farmers expressed concern about water quality standards and their impact on farming. For example, one participant contemplated the challenge of providing a stable food production system while also protecting water resources:

My challenge would be: what is your realistic expectation? If I'm over-applying nitrogen and my tile water is coming out at 25 ppm, could I get it down to 15 with fine-tuned management? Probably, but I don't think I can move it much more than that. If we're going to continue to raise these crops and provide stability in the food production system, then we need these tools.

When asked who is responsible for maintaining healthy water resources, most participants expressed a shared responsibility: "All of ours. All of ours. Everybody's responsibility. The State, farmers, everybody."

#### *Elm Creek watershed*

Elm Creek watershed participants' descriptions of what they like about farming and what farming means to them converged along four primary themes: independence, overcoming challenges, raising a family, and production of crops. Independence of operations and decision-making was a strong theme (Table 9). "You're a businessman and your own boss," said one participant. Responding to the variety of challenges presented by farming was another aspect participants enjoyed: "There's mechanics,

management, financial, chemistry, math...It's just a real broad spectrum of challenges and I've always enjoyed that." Participants also expressed fondness for raising a family on the farm. One participant related, "It's a great way of raising a family and teaching responsibilities. Teaching them how to do certain aspects of the farming and giving them the responsibility of doing certain tasks on their own." Producing crops was also important. For some the process of growing crops is as rewarding as the outcomes. As one farmer acknowledged, "My farming, the tractor driving, the truck driving, the combine driving, is golf. If you love farming the way I do, that's golf. There's nothing in the world I'd rather do than run one of those pieces of equipment."

Elm Creek watershed participants appeared to be most concerned about economics and risk, government regulations, farm size, and public perceptions of farming (Table 10). Land prices, the price of commodities, and the costs of inputs were chief concerns among several participants. One participant recalled the economic struggles farmers faced in the 1980s: "We remember the 80s and I see a lot of those trends happening with those land prices. I hope that we don't experience something like that, because you never forget it. It's like your grandparents telling you about the Depression. Our generation remembers the 80s." Several respondents expressed apprehension about government regulations, describing them as uninformed and inefficient. One farmer explained, "Their job is to come down here and tell me how to plant, or how to farm, stay so far away from the water. When I say I want government out, that's what I mean. They have no idea what the heck's going on." The increasing size of farms worried many farmers. This phenomenon was described as damaging to farming communities and also to smaller farmers who have an economic disadvantage: "Because I'm a farmer and I'll tell you right now: the big get a lot of it. The bigger you are, the more you get. The more you get, the more you can do. If we didn't have all that, everybody's on the same playing field. If you're a good operator, you'll make it." Negative public perceptions of farming also concerned participants. One explained, "Environmental activists can change the whole nature of your business by what are generally lies. They get in the media...even when they called it the swine flu. That had nothing to do with pigs. It destroyed the hog industry and the corn industry for a year, and it had nothing to do with the pig industry."

Participants expressed their connection to water resources in three themes somewhat similar to those of Rush River: recreation, production, and conservation (Table 11). Recreation was mentioned as an important connection for participants and their families: "We have a lake in our backyard and cricks to play in. [The kids] were always making rafts or having fun or building something." A utilitarian connection was also expressed as water is also used for agricultural and livestock production. A participant described, "We have wells for our hog barns, so we're pulling ground water up. We use water to spray for our carrier." The third theme, water resource conservation, was expressed in concern about the degradation of nearby waters: "I think because you live here, you hate to see lakes fill with silt, things erode. So you're always connected that way."

Elm Creek watershed participants also offered varying perceptions of the health of local water resources. Ten of the 15 participants characterized local water resources as being of good quality. Most discussion was oriented toward the causes of water quality impairments. Some participants pointed to agricultural practices: "There are probably some shallow wells that have been contaminated with fecal

stuff because of poor feedlot practices or poor septic systems. There are some wells that are around that I know have that issue.” In contrast, other participants believed that water quality impairments can be attributed to natural causes. One participant noted, “A lot of that stuff is from a natural decomposition; the leaves blowing off the trees, logs, whatever. That’s all decaying matter.” Another participant acknowledged a history of naturally turbid waters in the prairie pothole region: “When the buffalo roamed here, there was black dirt flowing in these streams. Depending on what they flow through, where they are, they’re going to be different. The Muddy Mississippi was the Muddy Mississippi before we had as much ag as we have now.”

When asked whose responsibility it is to keep water resources healthy, the vast majority of farmers shared responsibility for their role in water resource health. One participant said, “Responsibility? I certainly think it relates to land ownership and land management.”

### **3. How do participants manage their farms?**

Participants were asked questions about their ownership and management arrangements, decision-making process on the farm, the success of their farm, and changes in farm management.

#### ***3.1. Management and ownership agreements***

With respect to Rush River and Elm Creek watershed participants’ ownership arrangements, it appears that the majority of farmers who have rental agreements do so on a cash rental basis. Cash was preferred primarily because of the ease of operation. As one participant explained, “For me, it’s a lot cleaner. The landlord knows up front what they’re getting. I know what my costs are and I make all the decisions from there. Crop-share agreements are very difficult to manage and prove.” The duration of most agreements was one year. Nearly all agreements were from one to three years. Though many rental agreements were short-term, several participants also mentioned a long-term relationship with landlords. Many participants were renting from family or neighbors they had known for several years and acquired rental agreements through personal relationships. High prices and market volatility were cited as the main reasons for the short duration of rental agreements. One Rush River watershed participant explained, “The way things are changing now, I’m sure there are contracts out there that are paying \$300 or plus an acre, but what if the bottom does drop out? They’re going to be in a world of hurt. So to review it every year is probably a good thing.” An Elm Creek participant similarly noted, “They [leases] used to be usually three year deals because we’d want to lock in a price. Now with them so high we do one year deals because if the ag economy falls apart and the prices drop, we don’t want to be locked into anything anymore.” Many participants expressed a preference toward longer leases for planning and management purposes. An Elm Creek watershed participant said, “Some had been multiple years, but as of late when this rent has kind of run away to some degree, they now are on a year-to-year type of agreement. That makes it a little more challenging for planning and stability and stuff.”

#### ***3.2. Factors influencing the decision-making process***

To understand what influences participants in making decisions about their farm’s management, we asked participants two questions: “What are the most important considerations for you when making



decisions about your farm?” and “Do you consult others when making decisions about your farm?” The latter question was followed with the question “If so, who do you talk to?”

In Rush River and Elm Creek watershed participants’ discussions of what influences their decision making on the farm, two predominating themes emerged: economics and stewardship. Economics played an important role in decision making for many participants. One Rush River watershed participant described what influences his decisions: “Cash flow on any of my enterprises. Being the most efficient that I can.” An Elm Creek watershed participant shared this perspective: “It’s always cost, that’s number one. You’ve got to be a viable business to survive.” Another Elm Creek watershed participant noted that with high operational costs, economic efficiency is crucial for success: “If it comes to big capital purchases, it’s not getting strung out too hard, too deep with the lenders and keeping pretty cash-heavy. Like I say, profitability.”

Stewardship and caring for the land was a second driving consideration. One Rush River watershed participant characterized this view as doing the right thing by the land: “Then long-term is care for the land. It’s doing the right thing by the land, both for fertility management and residue management and soil management.” Another participant agreed, “And the upkeep of the land, you know, that we do keep it in the way we got it and hopefully until the next generation gets it.” An Elm Creek watershed participant acknowledged, “First, you think of family and stewardship. You try to exhibit integrity in everything you do. When you make a decision, whether it be how you till, inputs, or whatever, you want to be cognizant of how what you do on the left hand is going to affect the right hand.” Another Elm Creek watershed participant offered tilling practices as an example of stewardship. Though this participant recognized profit as the number one concern, he added, “Number two would be ‘it’s the right thing to do’. Maybe changing tillage practices doesn’t make you more money in the near-term, but it saves your soil and eliminates erosion.”

#### *Rush River watershed*

When asked if they consult others when making decisions, farmers interviewed in the Rush River watershed identified three primary contacts: (1) cooperatives and agronomists, (2) other farmers, and (3) published sources of information. The majority of participants reported utilizing the expertise of the cooperative or agronomist when making decisions. A participant explained, “I allow the co-op to do a lot of that... They went to the university and studied agriculture so they apparently know what they’re doing.” Other farmers appeared to be a second major source of information. One participant noted, “I’ve got a couple other farmer friends, we converse on the phone, ‘What do you think about this?’” A network of farmers was mentioned by other participants as well: “Farmers are always talking. What’d you do there? What works? I noticed this, how’d that work?” A few participants reported consulting published sources to keep abreast of current information: “I read a lot of journals industry magazines to stay on top of the new trends in fertilizer or placement.”

#### *Elm Creek watershed*

Participants in the Elm Creek watershed reported consulting with financial resources and resource managers in addition to cooperatives and agronomists. One participant mentioned using an

independent agronomist, “We have an agronomy consultant that we hire to help us stay in check and he’s been very helpful in making some of those decisions for us.” Another participant mentioned a local co-op as a consultant: “My co-op guy that I buy my supplies from, he always gives his opinion, too.” Farmers interviewed in the Elm Creek watershed also reported consulting financial experts when making decisions. “I have a marketing guy that I work with,” one participant explained, “I do the Minnesota Farm accounting, which is through extension. I think as things become more complicated, it becomes important to have experts.” Another participant expanded on various financial resources, saying, “You’re going to get your advice from your taxman, your banker...you have a network of people you deal with.” A few participants described working, “...very closely with the soil and water conservation and NRCS” in making decisions about their farms.

### ***3.2. Criteria of success in farming***

Participants were asked three questions related to the success of their farms: “How do you evaluate the success of your farm operation?”; “What kinds of outcomes are you looking for in judging success?” and “What issues challenge or limit you in making your farm operation a greater success?”

#### ***Rush River watershed***

Rush River watershed participants characterized the success of their farm in terms of three major themes: financial, production, and health. The themes financial and production are related, but have unique attributes. As some farmers interviewed noted, “Financially is how I would evaluate whether it was a successful year or not,” and, “I’m in it for the money. Someday I’ll actually be able to live off the farm.” Others were more oriented toward getting top production from their crops: “First and foremost is, did I get the top production. Good is not good enough to me. I want great to excellent yields.” “What goes in the bin,” another replied, “If it’s a good crop, it’s a success.” Besides financial and production success, personal health was important. “If you got your health,” one participant responded, “I think you got everything. That comes first.”

Common challenges to farmers in the Rush River watershed were price volatility, limited ability to acquire land, weather, and regulations. “What limits my financial growth is the high cost of inputs right now,” said one farmer. Another concurred, “I think the uncertainty of the economics. It would be fun to try a lot of things, but it’s too scary to borrow money when you don’t know what’s coming around the curve.” Inability to acquire additional land was also described as a limitation: “The ability to procure more land. You become more efficient by running more land, running your equipment over more land to a certain level.” Another simply noted, “Land is something you can’t make more of.” Weather was a third challenge referenced by farmers: “Weather. That’s probably the biggest of them all.” Current and future regulations were also mentioned as limiting operations. One farmer, noting regulations concerning livestock, said, “One concern I have, what I see as more of a future challenge, is there seems to be a lot more regulations coming on livestock production.” Another commented on a regulatory disconnect inhibiting production: “Federal agencies that don’t understand farming are coming with rules and regulations that either make it very expensive or prohibit some practices.”

### *Elm Creek watershed*

Similar to Rush River watershed participants, producers interviewed in Elm Creek characterized their farms' achievements in terms of financial and production success. Elm Creek participants also described their accomplishments with respect to land stewardship, livestock health, and social contributions. A participant offered, "I do a financial statement every year. ROA, some people call it, return on assets. If you're just maintaining and your wealth isn't increasing, then there's something you gotta do different." Another participant emphasized successful production, saying "You've got to put all the pieces in place to potentially have a good yield. You have to have the right environment to be able to produce bushels." Land stewardship emerged as an important criterion of success. A participant explained, "You always want to have enough money to pay the bills, but there's a lot more to surviving agriculture than that. You want to know that you've done the right thing and made something better than what it was." Another farmer interviewed mentioned land stewardship and livestock health, "It's not always the absolute top dollar if you can make it a little better for things. How you till the ground and what you do to maintain the ground. When you got livestock, you always want to take good care of them. You've got to weigh all that." Other participants defined success in more personal terms pointing to their contributions to society as an important criterion of success. "I view personal and social success as more important than your business success. Granted, we all have to pay our bills and to eat and we all like a certain lifestyle, but I don't know that if I farmed 2,000 acres if I would feel that I was more successful." Another participant described attributes such as work ethic and honesty as fundamental to success:

My dad just passed away about a year ago. I had one brother, he raised the two of us and I would say both of us are successful. We're functioning, contributing members of society, so there's a certain success that comes from that. He instilled a work ethic and honesty and all those things in us, and that's success. I guess as I was saying before, I think we view success too much sometimes from how much money you make. We kind of forget the other things that truly really make you successful.

Similar to the Rush River watershed, Elm Creek watershed participants identified limited opportunity to acquire land, potential regulations, and weather as being challenges to greater success. A participant described the difficulty of finding land to rent: "I would say the biggest challenge is renting additional land to grow the operation. ...My cousin has a boy that's graduating from high school this year. If we're bringing another person in, that's another thousand, 1500 acres." Tied to reduced supply of land is an increase in land cost, resulting in decreased opportunities for many producers. As one participant put it, "Cost of land. It's pretty hard to cash flow \$10,000, \$15,000 an acre land." Some participants perceived threats of regulations were also limiting factors. A participant lamented, "If they stop us from tiling. That threat of stopping is making people tile. Also, the threat of limiting our fertility..." Weather and natural threats were also mentioned as big challenges to farming success: "There's always the threat of the weather, disease and more insects. We get something new every year in Minnesota."

### ***3.3. Changes in farm management to improve success***

Participants were asked, "Have you changed the way you farm in the past five years in an attempt to make your farm more successful?"

### *Rush River watershed*

The majority of participants in the Rush River watershed responded that they had changed the way they farmed in the past five years. These changes came in three major realms: operations, equipment, and crop inputs. Overall, changes were viewed as essential to success. As one participant described, “You need farm growth. You need the changes to keep growing. You have to be proactive, not reactive.” Concerning these changes, several participants described altering their field operations. “I sort of went away from the moldboard plow now,” one reported, “Gotten away from cultivating period.” Others responded that they had upgraded equipment and technology. One participant stated, “I’ve upgraded a lot of machinery as far as tractors and a different combine.” Another participant, commenting on changes, said, “We’re adopting the technology right along. Adopting the technology in the seed, but also the computers, the iPhones, the auto-steer, the yield monitors.” Farmers also noted the changes in crop inputs, with one saying, “I changed the varieties of seed I was planting and fertilizer and chemicals. Chemicals is a big deal there. You’re always changing chemicals.” Along with types of inputs, another farmer focused on the rate of application: “Being more precise on application of fertilizers. That’s probably the biggest thing I’ve changed.”

### *Elm Creek watershed*

Farmers interviewed in the Elm Creek watershed noted changes concerning aspects of field and business operations. Many mentioned alterations of field operations ranging from tillage to plant density. “We’ve done more minimum tillage” a participant replied, “Every year you try to do less passes across the field. You don’t cultivate anymore, you spray Round-Up. Technology always prevails; Round-Up is the technology.” Other participants reported experimenting with changing plant densities: “We wanted to go to 22-inch rows because there was a lot of research that there were a lot of benefits to narrowing that up.” Along with changes in the field, some participants reported altering the business aspects of their operations. One farmer interviewed noted, “We’ve hired more financial consultants than we’ve ever done before. We’ve always had our tax accountant, but we have a financial [consultant]. He takes the books and puts them in reports and does the financial statements. That’s the best thing that we ever did.”

## **4. How do participants use nitrogen on their farms and what influences their nitrogen use?**

Participants were asked about what they consider when applying nitrogen, how they apply nitrogen (including source, timing, method, and rate), and manure use. Participants also were asked how they determined nitrogen application rates, the importance of maximizing nitrogen efficiency, and the importance of minimizing potential impacts of nitrogen on the natural environment.

### **4.1 Nitrogen application**

Participants were asked to describe how they apply nitrogen on their farms and specifically their source, timing, method, and rate of application. They were also asked how they determine the amount of nitrogen fertilizer to use after they have applied manure.

### *Rush River watershed*

Participants in the Rush River watershed reported using a variety of sources, timing, methods, and rates of application. These differences depended on a variety of factors including weather, nitrogen costs, soil characteristics, previous crop rotations, acres fertilized, desired yield, and equipment available. One participant described the various applications on his acreage:

Typically I'm using anhydrous ammonia in the fall and I'm injecting that in the soil down about six or eight inches. I do have some farms that aren't compatible for that type of use of nitrogen application, so those I will spring apply urea. Anything that has a sandier texture I look at either spring applying or side-dressing anhydrous ammonia or a spring application of urea or maybe a split application. Maybe a little urea down and come back and side-dress some when the plants are in the 6-8 inch height.

It is difficult for farmers to pinpoint nitrogen applications for any given year. However, for the fall 2011 and spring 2012 seasons, Rush River participants reported the following:

- Nine applied nitrogen in the fall. Six applied nitrogen in either the spring or a split application.
- Ten applied anhydrous ammonia. Three applied liquid (28% or 32%) nitrogen. Two applied urea.
- Eleven utilized manure as a nitrogen source on their lands.
- Nitrogen application rates ranged from 100lbs of spring applied liquid nitrogen to 200lbs of fall anhydrous on corn following corn.

All participants reported using nitrogen levels from soil samples to determine application rates for the following year. Eleven participants in the Rush River watershed used manure as a nitrogen source on their lands. Manure application varied in source, timing, and rates. Manure was viewed as an inexact science because of the variability of manure tests and unknown rate of organic nitrogen breakdown in varying environments. One farmer interviewed explained, "Sometimes I'll cut my manure rate and come back with anhydrous ammonia, because it's a form of nitrogen that I know is going to be available, whereas the manure, I may not get the mineralization out of it. I don't want to be losing any of my ground on vegetative growth." Participants also described the immobile characteristics of phosphorus and potassium and expressed more concern with nitrogen. "P [phosphorus] and K [potassium] don't move," a participant stated, "So if you're going to have a big tax year, you might put down 450lbs. You've got it in the bank." Nitrogen would then be applied according to soil sample requirements. A more comprehensive look at nitrogen use in the Rush River watershed is provided in Appendix I.

Of the eleven participants who utilized manure:

- Six sampled the manure for nutrient content.
- Six also reported utilizing nitrogen inhibitors (N-Serve or Instinct) in their nitrogen application process.
- Four participants used chicken manure, three used cattle manure, and two used hog manure.
- Application rates ranged from twice a year to once every five years.
- All participants reported soil sampling.

### *Elm Creek watershed*

Participants in the Elm Creek watershed reported using a variety of sources, timing, methods, and rates of application. These differences depended on a variety of factors including weather, nitrogen cost, soil characteristics, previous crop rotations, acres fertilized, desired yield, and equipment available. For the fall 2011 and spring 2012 seasons, Elm Creek participants reported the following:

- Three applied nitrogen in the fall. Twelve applied nitrogen in either the spring or a fall/spring split application.
- Nine applied only anhydrous ammonia. Six applied both anhydrous and liquid (28% or 32%) nitrogen.
- Nine utilized manure as a nitrogen source on their lands.
- Nitrogen application ranged from 130lbs of spring applied anhydrous ammonia to 215lbs of fall applied anhydrous ammonia.

All of participants reported using nitrogen levels from soil samples to determine application rates for the following year. Nine participants in the Elm Creek watershed utilized manure as a nitrogen source on their lands. Manure application varied in source, timing, and rates. Similar to Rush River, Elm Creek participants expressed more concern over nitrogen availability than that of phosphorus or potassium. When asked how nitrogen was determined after manure was applied, one farmer responded, “That depends on how the manure is testing. If you’re trying to hit the P and the K, but the nitrogen is probably more limiting than the P and the K.” Another referenced the stability of phosphorus and potassium: “We have the manure analyzed, but basically all we ever put on any of these fields is nitrogen. These fields here, they’re sampled and they show that they do not need any P and K.” A more comprehensive look of nitrogen use in the Elm Creek watershed is provided in Appendix J.

Of the nine participants that utilized manure:

- All nine sampled the manure for nutrient content
- Six utilized nitrogen inhibitors (N-Serve or Instinct)
- All nine participants used hog manure with one also using cattle manure
- Manure was applied once every one to three years with many farmers rotating field application
- All reported soil sampling

### **4.2. Factors that influence nitrogen application**

To understand what influences decisions around nitrogen application, participants were asked “What are the most important considerations for you when applying nitrogen on your farm?”

### *Rush River watershed*

Two themes emerged from participants’ responses to what they consider when applying nitrogen: cost and precision. “I’m looking at my cost per acre,” one farmer interviewed explained, “There’s various sources of nitrogen that we use and we have to look at the cost of each one of those sources.” Along with cost of nitrogen, economics associated with the amounts applied also factor into nitrogen considerations. One participant reported, “The most important considerations are that I get the most

response per nitrogen applied. Economic. Not just response, economic response.” Another consideration for participants was precision of application. As one participant described,

Not over applying is huge. They’ve been stressing that to farmers for a while now. For the longest time people were putting on manure not knowing what they were putting on. They had no idea what kind of nitrogen, phosphorus, or potassium they had in that fertilizer. Now everybody’s not just broadcasting anymore. Everything is more specific.

Along with precision of amount, precision of timing was also cited as an important driver of decision making. One participant noted, “The timing. Part of it I’ll put on just as I plant, maybe half of it. But only if I know I’ve got a system where it’s fairly stable. The other half I put on when the crop is up.”

#### *Elm Creek watershed*

Akin to participants in the Rush River watershed, Elm Creek participants described precision as one of the most important considerations when applying nitrogen. “Well, I don’t want to just put it out there”, one participant stated, “We fertilize according to our recommendations. We try not to overdo it, but that’s a fine line. We’re very conscious of what we put on and where we put it.” The fine line between too much and too little nitrogen was noted several times. Another participant characterized the precision of application as the most difficult task in farming:

To put the exact right amount on to not limit the yield. You don’t dare to put too much on because it’ll kill you and you don’t dare to put too little on because it’ll kill you too. And to try and figure that out with the weather and when to apply it, I think it’s the toughest thing a farmer probably does.

Minimizing leaching was also an important goal. One farmer commented on avoiding leaching, “We get most of our nitrogen needs from manure, so we like to wait to get our soil temperatures so we don’t start leaching. We try to minimize the leaching because we don’t want to short our crop of nitrogen and we don’t want it going into the environment.”

#### **4.3. Sources of information about nitrogen application**

Participants were asked, “Where do you get information when making decisions about nitrogen application?”

#### *Rush River and Elm Creek watersheds*

When asked where they get information about nitrogen application, farmers interviewed in both study watersheds cited cooperatives and agronomists as primary sources of information. Soil tests were used in conjunction with the expertise of the cooperative or agronomist. A Rush River participant explained “I allow the co-op to do a lot of that. They went to the university and studied agriculture so they apparently know what they’re doing.” An Elm Creek participant reported getting information from an agronomy vendor: “I use the agronomy vendor. I get my rate recommendations through them because they’re dealing with it on a common basis.”

#### ***4.4. Importance of maximizing farm efficiency***

Participants were asked “How important is it to you to maximize the efficiency of the nitrogen use on your farm?”

##### *Rush River watershed*

Participants regarded nitrogen efficiency as important along two main themes: economics of efficient nitrogen use and concern for the environment. A participant describing the economic benefits contended, “I think that nitrogen is one of the biggest wastes of money that farmers have been using. Knowing what you’re putting on and knowing what the plant needs helps farms be more profitable.” High inputs costs motivate farmers to utilize nitrogen efficiently, as one participant explained, “Number one, it’s expensive. You only want to use what’s needed. It’s a matter of economics.” In contrast, one participant emphasized a concern for the natural environment instead of a concern for nitrogen efficiency: “I don’t really care about the efficiency. I care about the runoff. I mean, it’s there.” Another participant linked nitrogen efficiency to environmental impacts: “And now they’re blaming the dead zone in the Gulf of Mexico because of the high nitrates, probably from tiling. So farmers gotta be careful.”

##### *Elm Creek watershed*

Participants in the Elm Creek watershed expressed the importance of maximizing the efficiency of nitrogen use in terms of economics and ensuring sufficient nutrients for the crop. One farmer commented on the economic importance with a discussion of rising fertilizer costs: “I think it’s become more important than it ever had because the price of it. There was a time when nitrogen was cheap and I think people put on an extra 30lbs to make sure. You don’t see that done much anymore.” Ensuring sufficient nitrogen was also a key objective for farmers when weighing nitrogen efficiency. One participant commented, “Nitrogen is the key. That’s what grows the bushel of corn.” Another participant called nitrogen a predominant driver of corn yield: “The 150 to 170lbs is what’s necessary because if you short yourself, the corn is going to take a hit on yield for sure. Nitrogen is the predominant driver for yield on corn.”

#### ***4.5. Importance of minimizing impacts to the natural environment***

Participants were also asked, “How important is it to you to minimize the potential impacts of nitrogen on the natural environment?”

##### *Rush River watershed*

When asked about the importance of minimizing potential impacts of nitrogen on the natural environment, participants responses suggested three different perspectives associated with concern about impacts to groundwater, ecological impairments, and future regulations. Some participants focused on impacts to groundwater: “A lot of well water has high nitrates, depending on the aquifer and the soil. Again, it comes back to knowing what you’re doing when you’re applying nitrogen. You don’t want it to run off. You don’t want it to get into the groundwater.” Other participants described potential threats to ecosystems. One participant said, “I want to see a healthy ocean. I know that what we do here affects the Gulf, the Dead Zone. That tie, to me, is not hard to see at all. The multiplier factor, acre



after acre after acre... You can't help but have a reaction." A few participants framed the issue in terms of avoiding government regulations: "If we don't [minimize impacts of nitrogen to the natural environment], we're going to be told to do it. It's very important for us to consider that. I know what's coming if I'm being an absolute idiot throwing 250lbs of N on and it ends up in the groundwater or rivers and streams."

#### *Elm Creek watershed*

Elm Creek watershed participants' discussions about the importance of minimizing potential impacts of nitrogen on the natural environment converged around the human benefits of healthy water resources. For example, one participant was concerned about groundwater and private wells: "Boy, we don't want that water polluted more than anybody else does. We have wells we live on out here. My goodness, do you want nitrates in your wells for your grandkids to drink? Not a chance in the world." Another participant linked healthy water resources to improved recreation opportunities, saying, "We want to protect the environment because we enjoy doing outdoor activities. My cousin's boys are big into hunting and fishing. We want to take care of all of that because we want to continue to live here and enjoy those."

### **5. What are participants' perspectives on nitrogen best management practices?**

To generate more specific discussion around what factors drive and constrain the adoption of best management practices (BMPs), participants were asked to describe their use of BMPs, their perceptions of BMPs, and factors that influence their decisions around the use of BMPs on their farms. At the outset, participants were asked if they were familiar with the term "best management practice" (BMPs). A list of 10 nitrogen BMPs was read to participants so they could comment on each specific practice. The list included (1) installing a two-stage ditch, (2) adding alfalfa to a crop rotation, (3) growing alternative energy crops, (4) installing bioreactors, (5) planting buffer or filter strips, (6) controlling drainage, (7) growing cover crops, (8) using variable rate technology, (9) following the University of Minnesota recommendations for nitrogen application, and (10) creating or restoring wetlands. Participants were asked several questions to elicit their perceptions of constraints to and drivers of BMP adoption. For the BMPs that participants reported using, they were asked, "What has motivated you to use this particular practice?"; "Is this practice doing what it was intended to do?" "What do you like and dislike about this practice," and "Do you plan on continuing to use this practice.;" For the BMPs participants were not using, they were asked, "What have you heard about this practice?"; "What has influenced your decision not to use this practice?" and "Would you adopt this practice if things were different?"

#### **5.1. Use of best management practices**

Of the 10 BMPs listed for participants, the most commonly used BMPs overall were planting buffer or filter strips (80%) and following the University of Minnesota recommendations for nitrogen application (53%, Table 14). The least commonly used BMPs were installing a two-stage ditch and planting alternative energy crops, neither of which was used by any of the study participants.

## **5.2. Constraints to best management practice adoption**

In participants' discussion of the BMPs, seven primary categories of constraints to adoption emerged (Table 12):

- economics
- knowledge
- autonomy
- market/demand
- farm/landscape suitability
- weather sensitivity
- effectiveness

### *Economics*

A primary constraint to the adoption of nitrogen BMPs was economics. The economics associated with the cost of implementing a BMP and the corresponding loss of income from land taken out of production were seen as principal impediments. One Rush River watershed farmer explained the economics of removing land from production: "If they're getting \$250 or \$300 an acre rent, they aren't going to jump on that if they're only going to get \$100 in a CRP payment—if it's going to be half of what the rental rates are. I'm concerned about the environment, but I'm not going to be generating the rent." Speaking on the economics of variable rate technology, one Elm Creek watershed farmer interviewed simply stated, "It's going to cost me a lot of money. A lot of money."

### *Knowledge*

Familiarity with various BMPs was also an inhibiting factor for many producers in both watersheds. According to participants, issues arise from both existing knowledge of nitrogen BMPs and outreach oriented to familiarize producers with management practices. Knowledge was a constraint with newer or more experimental BMPs such as bioreactors and two-stage ditches that participants reported hearing nothing or very little about (Table 15). Efforts to familiarize producers with BMPs were also viewed as insufficient. One participant admitted that a major constraint was, "... more education, but there again, how you're going to go about it, I don't know. The only meetings that famers want to go to is if they have to or if they want to."

### *Autonomy*

Autonomy was mentioned as a primary driver of what producers most enjoyed about farming, but this need for independence was also seen as constraining BMP implementation. A Rush River watershed participant noted that, "Farmers, not only are they reluctant to sell, they're reluctant to give up their power. They want to stay the manager. They don't want to give that up. And that hurts them." The reluctance to relinquish control over their land was described as a constraint to entering into conservation agreements in which landowners would lose management control. An Elm Creek producer interviewed explained, "I think not everyone is interested in partnering with someone or giving up some of their input or maybe control. Because, typically when you partner with somebody on a cost share, there's commitments that go along with it."

### *Market/demand*

The lack of an established market and/or demand was also a key constraint to BMP adoption according to interviewees. With respect to BMPs focused on subsidiary crop production (e.g., adding alfalfa to a crop rotation and alternative energy crops), many participants noted the challenge of implementation with no market outlet. Regarding alternative energy crops specifically, an Elm Creek producer stated, “There doesn’t seem like there’s any real immediate, close proximity market for anything like that, so therefore that’s not something we’re entertaining by any means.” Though some producers have been able to utilize alfalfa for livestock bedding and feed, those who did not produce livestock described the futility of alfalfa with no market demand. An Elm Creek farmer asked, “The problem is, on a large scale, what do you do with all the alfalfa?”

### *Farm/landscape suitability*

Factors ranging from farm size, topography, climate, and crop rotations all contributed to several producers’ perception that their lands were not suited for various BMPs. In a discussion of controlling drainage, an Elm Creek watershed participant described topography as an issue:

1.2 inches on a 100-foot run. In that sense, we were running an average of three-tenths grade on that distance. In essence, we’d have had to have at least six levels of tile in those structures in that field. And if you gotta be able to out and adjust them and farm around them? How are you going to be able to do that? It’s a fine thought, but it works on a drawing board.

BMP suitability and farm size was a constraint described by an Elm Creek producer in considering installing bioreactor: “We have way too much tile for bioreactors. There’s gotta be a better way than bioreactors. Bioreactors work, but on 40 acres or something. I’m talking about tiling 1,000 acres.” Growing cover crops was also perceived as not necessary in farms where stover from previous crops remained. An Elm Creek farmer explained, “If you look at that cornfield, there’s a cover crop on there already. It’s corn. And even the beans when you look across there. We’re not plowing anymore. It’s not black. There’s something covering it already, so why should we spend the expense?”

### *Weather sensitivity*

Unpredictable weather and climatic conditions were perceived as major constraints to adopting nitrogen BMPs. Weather conditions were described as inhibiting factors in the management of nitrogen and alternative crops. Erratic rain patterns are constraints to using University of Minnesota nitrogen recommendations, according to an Elm Creek watershed participant, “They’re generally a low threshold. 7 out of 10 years they’ll be fine, but then you get too much rain or whatever and then they’re way too low.” Unpredictable moisture was also a constraint to controlled drainage. A producer interviewed described: “You don’t know what the weather’s going to do for a control structure. You don’t know if it’s going to rain ten inches tomorrow if you want the water table low. You don’t know if you want the water table high.” Unsuitable climate was also viewed as a constraint to growing alternative crops such as alfalfa and cover crops. An Elm Creek farmer acknowledged, “We have too short a growing season

and we need every day we can get to grow a crop. If you had grass or winter wheat on a field in the spring, it'd probably take two weeks extra to thaw it out, warm it up. We don't have two weeks extra."

### *Effectiveness*

Many producers questioned the effectiveness of various BMPs at reducing nitrogen loads. Skepticism regarding the installation of bioreactors, controlling drainage, University of Minnesota recommendations, and variable rate technology was common among participants. Regarding bioreactors, a Rush River farmer interviewed expressed uncertainty: "How effective are they? What's the service life of them, the maintenance costs, and things like that?" The effectiveness of controlled drainage was an unknown to a Rush River watershed participant who asked, "Do we truly have the data to know that it will be a mechanism for continuing to help us increase crop yields by controlling water that when we need it, like during pollination periods and things like that?" University of Minnesota recommended nitrogen levels were viewed by some farmers as ineffective at producing maximum crop yields. A producer interviewed explained his perspective, "Well, that's sort of what my fertilizer guys tell me. They think the University's a little on the low side, so we tend to go a little above that." The logistics of variable rate technology and its effectiveness overall was questioned by a Rush River watershed participant:

So, my question is: why isn't that crop bigger there? Is it because it was wet early? Because there's a P and K deficiency? Is it nitrogen deficient? Is it lack of water? Are there too many weeds underneath? So why is the vegetative index less robust there than in the other fields? Besides that, in Minnesota, by the time you can see a growth difference or color difference, it's too late. You've already lost your 15 bushel. And that's proven. That's just a fact.

### **5.3. Drivers of best management practice adoption**

In participants' discussion of the drivers of best management practice adoption, three primary categories emerged (Table 13):

- Land Management
- Economics
- Responsibility

#### *Land management*

According to several participants who had adopted BMPs, the practices were consistent with their land management goals associated with stewardship and production. Stewardship associated with maintaining native tree species was a motivator for a Rush River watershed participant: "That's why we want trees. We took out a grove, I'm sure I could plow it up, but I kind of want a little native prairie. You can't find a native tree, hardly, anymore. They're all this ornamental foreign garbage." An Elm Creek participant emphasizing a land management ethic said, "I think, as a farmer, it's like anything you do in life, we want to try and leave our soil...we want to leave it better than what we got it. There's no doubt about that. I know this farm is going to be left better than I got it. I think that's the goal, it should be, of

this generation.” Discussions of land management also focused on the maintenance of optimal agricultural land. For example, an Elm Creek farmer interviewed described efforts to manage land: “Some [BMPs] I could cost share, but I just did it out of my own pocket because it’s an economic, it comes back to me. I can’t have all my soil down there and I can’t be migrating through these deep gullies with equipment or combines.”

### *Economics*

Economics as a driver of BMP adoption was discussed relative to the need to maximize efficiency of crop inputs and the return on marginal lands. Reducing nitrogen leaching was important for many participants. A Rush River watershed participant noted the economics of reducing nitrogen runoff: “I know if I manage [nitrogen] for economics, I’m also managing it environmentally. They both walk hand-in-hand, or they both align themselves very well.” Implementing BMPs on marginal lands was viewed as a way to increase profit from what would have been diminished crop yields. One Rush River producer interviewed described the benefits of implementing buffer strips, noting, “A lot of these ditch banks were clay, not the highest producing spots. Here you could put a buffer strip in and you’d get a check every month. Two things happening: it produces some income and it helps water quality.”

### *Responsibility*

Notions of improving and accepting responsibility for the health of water resources were also evident as drivers for implementing BMPs. A Rush River watershed participant called for cooperation in improving the quality of water resources:

Are we going to get the Mississippi River or the Minnesota River cleaned up in this generation? Probably not. But if we do better than when we came here, that’s a big improvement. We got into a bad situation where everybody was in it for themselves, but if you leave your lot better than what you came in with, it’s an improvement. I think that’s what we all have to work together for.

Accepting responsibility for water resources was also important to some farmers interviewed. An Elm Creek watershed participant explained, “[It is] everybody’s [responsibility]. Absolutely everybody. We’re willing to do our best to protect that as well. That is going to become the most precious resource of any going forward along with clean air to breathe. Those things are the most important things.” Another Elm Creek participant added, “Any little thing you can do to help, you should be doing.”

### ***Water Resource Professionals Focus Group Findings***

Study findings reported here are based on two focus groups conducted with 15 resource professionals working in the Rush River and Elm Creek watersheds. The findings are organized to respond to three questions:

1. What are participants’ perceptions of water resources and best management practices?
2. What barriers exist to nitrogen best management practice adoption?
3. What are strategies for increasing best management practice adoption?

## **1. What are participants' perceptions of water resources and best management practices?**

Focus group participants were asked to complete a fixed-choice survey addressing their concerns about the impact of nitrogen on different watershed scales (Appendix G). They were also asked their opinions about specific BMPs including the BMP's effectiveness at reducing nitrogen impacts of water resources and the likelihood the BMPs would negatively affect yield and profitability.

### ***1.1. Concerns about the impacts of nitrogen on water resources***

In the survey, participants were asked, "How concerned are you about the impacts of nitrogen on water resources in..." four regions including the Rush River or Elm Creek watershed, the Minnesota River Basin, the State of Minnesota, and the United States. Overall, participants reported being the most concerned (i.e., moderately to very concerned) about the impact of nitrogen on water resources within the Minnesota River Basin (Table 20). When discussing their responses, one participant noted the impact of agriculture on nitrogen loading in the Minnesota River watershed: "I think that in southern Minnesota, there's a lot of agriculture and farming activity, so nitrogen does tend to get into the water system." Another expressed concern regarding non-point source nitrogen loading, stating "...[nitrogen] definitely is biomagnifying and accumulating. It's an issue that compounds itself as you go down the stream"

### ***1.2. BMP effectiveness at reducing impacts of nitrogen on water resources***

Participants were asked, "How effective do you think each of the following practices is at reducing impacts of nitrogen on water resource?" Overall, variable rate technology, wetlands, and following University of Minnesota recommendations for nitrogen were rated the three most effective BMPs at reducing the impacts of nitrogen on water resource (Table 21). One resource professional described the advantages of wetlands, saying "...volume of water is causing erosion down the line. So slowing and moderating flows, metering them out better. To me, that's restoring hydrology. Maybe not pure wetlands, but maybe wetlands on steroids, using that model." Constructing a two-stage ditch and planting cover crops were rated as the least effective nitrogen BMPs. One participant with reservations regarding two-stage ditches explained, "It's very expensive to build, getting an easement for it, and there are some discussions I've had with people, they're not so certain how effective they are on certain areas."

### ***1.3. BMP likelihood of negatively affecting yield and profitability***

Finally, focus group participants were asked, "How likely is each of the following practices to negatively affect yield and profitability?" Overall, wetlands and planting alternative energy crops were rated the most likely to negatively affect yield and profitability (Table 22). A resource professional surmised, "I put wetlands as being extremely effective at reducing nitrogen, but then being extremely negative on yield." Another participant added, "To me, it's got the greatest potential to reduce nitrogen, but it's the least potential to implement unless you have a lot of money to do it." Using variable rate technology and University of Minnesota recommendations for nitrogen application were judged to be least likely to negatively impact yield and profitability.

## **2. What barriers exist to best management practice adoption?**

Focus group participants were asked “What do you see as the biggest barriers to increasing BMP adoption in the [Elm Creek or Rush River] watershed and the surrounding area? Their responses were recorded on a flipchart. Each participant was asked to assign up to three votes for the biggest barriers listed on the flipchart. Overall, six primary categories of constraints emerged in these discussions:

- economics
- farm culture
- education
- agency limitations
- farmer values
- enforcement

### *Rush River watershed*

Rush River watershed focus participants identified 10 different specific barriers (Table 16). The barriers receiving the most votes as the most significant were economics, prioritizing willing landowners, convincing landowners of a problem, and communication (Table 18). Economics was viewed by the group as the most imposing barrier overall for BMP adoption. One participant noted, “There are CRP contracts coming up that aren’t going to be re-assigned because corn is \$7 and land is \$9,000 an acre.” Along with taking profitable land out of production, lack of economic resources within conservation agencies was also cited. One resource professional expressed, “We can identify banks that are going to contribute great amounts of sediment, but do we have the amount of money to do that and are the people that own the land willing to have something done?” Convincing landowners of a problems and communication were also noted as major barriers to increasing BMP adoption. “I think to convince people there is a problem [is a barrier],” stated one professional. “I think communication is a barrier,” responded another. Translating the science and practice of BMPs to the landowner was viewed as an additional hurdle: “Talking to them, getting to them. It’s a logistics problem and how do you effectively translate your ideas to them?”

### *Elm Creek watershed*

Elm Creek watershed focus participants identified 10 different specific barriers, as well (Table 16). The six barriers receiving the most votes were economics, landowner education, absentee landowners, bureaucracy, lack of statutory and logistical support, and land value (Table 18). Similar to Rush River watershed participants, economics was seen as the primary barrier for BMP implementation. One participant acknowledged, “Probably the number one is the economics of corn price where it is. The corn acres going in compared to any other crop is probably the driving force.” Landowner education and outreach were also seen as barriers. A resource professional explained, “One thing I see is a lack of education, landowners understanding the impact of their decisions... I don’t know how much they understand.” Agency bureaucracy was also seen as restricting BMP adoption. One participant noted, “Boy, it’s bureaucratic, and I’m a person who believes in it.” A lack of a statutory logistical support capabilities were also seen as inhibiting broader BMP adoption. “I think you could say that there’s not a proper statutory framework,” noted one participant. Another added that even with statutory support,

regulation logistics would impede BMP adoption: “Well, are you going to go monitor tile outlets to meet the regulatory compliance? So you think about the mouth of the drainage system and everybody upstream, how are you going to determine that?”

### **3. What are strategies for increasing best management practice adoption?**

Participants were asked to list ways to increase best management adoption in their respective watersheds and the surrounding areas (Table 17). Overall, five primary categories of strategies emerged including:

- education
- farmer tailored programs
- show results
- identify innovators
- regulation

#### *Rush River watershed*

Participants of the Rush River watershed focus group listed eight different strategies (Table 17). The top five strategies were the use of demonstration/pilot projects, working with organizations, communication, target funding, and promoting education (Table 19). Implementing demonstration or pilot projects received the most votes overall. One participant recognized, “I think getting some demonstration projects within the watershed so people could see it and see how it works would be helpful. Not a lot of that’s been implemented and to get it scattered around throughout the Minnesota River Basin so farmers can see if it makes sense for them.” Participants also noted that demonstration projects would improve BMP credibility and incorporate farmer education. “Having extra money to do some smaller side projects to help educate some of the local farmers,” one stated. “I think it will be easier for them to accept the results from somebody locally or in the same position as them rather than somebody like me.”

Targeting funding was also suggested as a means to increasing BMP adoption. Regarding BMP effectiveness, managers noted the importance of effectively targeting both landscapes and people: “For me, it all came down to ‘they [BMPs] all have the capacity to work, but how are they being implemented in site-specific situations?’” Another described varying methods of tailoring strategies to various groups:

There’s the poultry industry, which is this big organization and has a lot of resources. Then you have the independent, larger farmers. Then you have the smaller farmers and ten-animal feedlots. So you have to take different approaches for those different groups. Maybe there’s a situation where you’re allocating a little bit more money for larger production operations to do a few things, but maybe implement a different benefit to some of the smaller farms. Maybe a bit more of a tax incentive would be a bit more appealing to one group versus a cost-share or payment program.



### *Elm Creek watershed*

Participants of the Elm Creek watershed focus group listed 12 different specific strategies (Table 17). The top five strategies were make implementation easier, increase flexibility, prioritize community meetings, water storage, and pay farmers (Table 19). One participant noted, “Make it easy so they don’t have to think about, ‘I have to turn that sprayer off to kill that grass’....Something that makes it an easy part of their operation.” Increasing the flexibility of BMP implementation was seen as a possible strategy for improving adoption: “Give them [farmers] flexibility on the size and scale. Now, it’s not that simple because some of those practices need to be engineered, but there are, perhaps, things they can do on their own.” Local meetings prioritizing community issues were also suggested as a strategy to enhance education and open communication between agency personnel and agricultural producers. One participant described the strategy of, “Take it township by township, educating these people here, doing meetings. [I wish we had] been doing that for as long as we’ve been meeting about water quality issues all over...” Water storage was also viewed as a strategy for reducing nitrogen runoff. Differing from wetlands, water storage was defined as, “...storing that raindrop where it falls on the landscape and keeping it there instead of having it move towards the nearest surface water.” Examples of practices concerning, “...the direction of rows, tillage practices, soil health and type, a steep slope...” were given as ways to keep water on the landscape and avoid the complications of wetlands.

### **Summary and Recommendations**

The study findings are grounded in the everyday experiences, beliefs and practices of a sample of farmers in the Rush River and Elm Creek watersheds. We adopted a qualitative research approach to explore determinants of nitrogen BMPs in the words of local farmers and resource professionals themselves. The themes presented here include both shared and divergent perspectives expressed by participants. The findings provide a framework for understanding farmers’ decision making processes at multiple levels including whole farm management, nitrogen application and nitrogen best management practices. The study identifies a range of environmental, psychological, social and institutional factors that influence these decisions. The qualitative approach used here preserves richness and detail in the descriptions and evaluations of those interviewed. It does not attempt to be statistically representative of the opinions of a broader population. Still, we believe the individuals participating in this study are largely representative of the variety of farmers living and working in the study watersheds. Participants included middle-aged and older farmers, operators of big and small farms, and farmers with a range of formal education and income levels. Farmers participating in the study also varied in their nitrogen use and conservation practices. Thus, while study findings may not be generalizable to all farmer populations, we believe study findings provide important insight about farmers in similar social and biophysical settings and how they view nitrogen best management practices. This study complements our increasing knowledge of the biophysical context of BMPs with new understanding of the psychosocial aspects of voluntary BMP adoption.

The study indicates farmers are engaged in agriculture for benefits besides producing crops including the independence farming affords, the challenges it poses, and the unique opportunities it provides in raising a family. These qualities were deemed important motivators to participants from both study watersheds. Participants’ perspectives also converged on what concerns or worries them about farming.

Economics and risk, government regulations, the increasing size of farms, and negative public perceptions of farming weigh heavily on the minds of farmers. The study further revealed that farmers frame their connections to water resources along five dimensions: wildlife, recreation, consumption, agricultural production, and water resource conservation. Farmers' perceptions of water quality in their watersheds appear to vary significantly. Two-thirds of participants in both watersheds evaluated water quality as at least "good." The remaining participants believed water resources are compromised. Resource professionals participating in our study reported on average being "very concerned" about water resources in the two study watersheds.

General decision making on the farm appears to be driven by several basic underlying farm management goals associated with economics, land stewardship, civic responsibility, livestock health, and personal health. At the same time, farm management decisions also are made in response to challenges or opportunities that arise in farming including crop price volatility, acquiring additional land, weather, and current or potential regulations. Farmers consult others in making decisions, especially farm cooperatives and agronomists, other farmers, financial experts and resource professionals. Our study indicates that the adoption of nitrogen BMPs is limited by several constraints including environmental (e.g., farm/landscape suitability of BMPs, weather sensitivity), economic (e.g., costs of BMP adoption, market/demand for affected crops) and psychological (e.g., knowledge of BMPs, need for autonomy in implementation, perceived BMP effectiveness) factors. Participants are compelled to adopt nitrogen BMPs when they are perceived to be consistent with farmers' underlying goals. The drivers of nitrogen BMP adoption are economics (e.g., reduced nitrogen loss), stewardship values, and a sense of moral obligation (i.e., BMPs perceived as consistent with being a good farmer).

In sum, the study uncovered several determinants of nitrogen BMP adoption for the farmers interviewed in the Elm Creek and Rush River watersheds (Table 1). While it is apparent that the economics of BMPs play a major role in the decision making process, other factors drive and constrain adoption. Two basic environmental factors that appear to have an impact on adoption are farm or landscape suitability and weather sensitivity of BMPs. Several farmers interviewed acknowledged that these conditions may render a particular BMP ineffective or put their crop at greater risk during BMP implementation. Psychological determinants of BMP adoption also emerged. Decision making is a psychological process that requires organizing and evaluating information. BMP decision making is no exception. Psychological determinants are categorized across three dimensions: values, beliefs and norms. The values-beliefs-norms (VBN) framework (Stern, 2000) has been used in several past studies to better understand what drives environmental behaviors. Farmers, like other environmental actors, apply a very basic set of values when making farm management decisions. These values frame their beliefs about how humans relate to one another (i.e., cultural values) and how humans relate to the natural environment (i.e., environmental values). Participants in our study demonstrated a range of values tied to individualism (e.g., autonomy), collectivism (e.g., sense of community), utility (e.g., resource use), and stewardship (e.g., environmental conservation).

According to VBN theory, fundamental values inform more specific beliefs and attitudes about certain issues or behaviors (e.g., farming, water resources, nitrogen use, and nitrogen best management

practices). For instance, farmers interviewed here regarded water resources as important for wildlife habitat, recreation and livestock consumption. Farmers demonstrated concern about water resource impacts to human health and ecological integrity. Farmer decisions are further influenced by their knowledge of BMPs and their perceptions of BMP effectiveness. Norms play an important role in farm decision making. Farmers have a sense of individual moral obligation to do the right thing—to be a good steward of the land. Farmers also are exposed to social norms through conversations with agronomists, cooperatives, and other farmers. Not only are farmers receiving basic technical advice from these agricultural community members but also normative feedback about how they “should be” operating their farms. Some farmers interviewed also reported feeling a sense of civic responsibility for their farm and its impacts. Furthermore, many farmers are attuned to public perceptions of farming and are concerned that farmers are portrayed as polluters. Finally, several institutional determinants were documented. Farmers’ decision making is affected by their trust in government, the flexibility, efficiency and simplicity of BMP programs, and communication strategies used to promote BMP programs.

Table 1. Determinants of Nitrogen BMP adoption

<b>Economic</b>	<ul style="list-style-type: none"> <li>• Costs of BMP implementation</li> <li>• Impacts to commodity crop production</li> <li>• Market/demand for crops produced/affected</li> </ul>	
<b>Environmental</b>	<ul style="list-style-type: none"> <li>• Farm/landscape suitability for BMPs</li> <li>• Weather sensitivity of BMPs</li> </ul>	
<b>Psychological</b>	Cultural and environmental values	<ul style="list-style-type: none"> <li>• Autonomy</li> <li>• Sense of community</li> <li>• Resource use and consumption</li> <li>• Environmental/land stewardship</li> </ul>
	Beliefs	<u>Perceived costs and benefits</u>

	Beliefs (cont'd)	<ul style="list-style-type: none"> <li>• Recreation</li> <li>• Wildlife habitat</li> <li>• Human health</li> <li>• Livestock health</li> </ul> <u>BMP-specific beliefs</u> <ul style="list-style-type: none"> <li>• Knowledge of BMPs</li> <li>• Perceived BMP effectiveness</li> </ul>
	Norms	<ul style="list-style-type: none"> <li>• Individual moral obligation</li> </ul>
<b>Social</b>	Norms	<ul style="list-style-type: none"> <li>• Agricultural community information/advice</li> <li>• Civic responsibility</li> <li>• Public perception of farming</li> </ul>
<b>Institutional</b>	<ul style="list-style-type: none"> <li>• Trust in government</li> <li>• BMP program flexibility</li> <li>• BMP program efficiency/simplicity</li> <li>• Resource professional communication strategies</li> </ul>	

Study findings and the recommendations outlined below provide much-needed practical insight into several critical questions identified by local resource professionals, most notably “how do we increase the adoption of BMPs by agricultural producers?” and “which BMPs are most and least likely to be adopted?” We believe this social science study will inform, enhance, and facilitate future agricultural and water resource planning and management initiatives in the two study watersheds and across the state. We encourage resource professionals to incorporate the three recommendations highlighted

below in the design and implementation of communication, education, and outreach programs aimed at increasing BMP adoption.

**Recommendation 1: Raise awareness and provide a forum for discussion and information exchange about local water resource issues, their consequences, and agricultural BMPs as a solution**

Our study indicated that the economics of BMPs is a major limitation to their adoption. Farmers must consider the bottom line when making decisions about their farms' management and the adoption of conservation practices. While incentive and payment programs may prompt BMP adoption, programs that influence the way farmers think about BMPs (e.g., their concern about the consequences of nitrogen use and perceptions of best management practices) are more likely to be internalized and thus sustain behavior change in the long-term. Furthermore, as many resource professionals have learned, crop prices and land values can have a greater impact than incentive and payment programs on the final economic cost-benefit analysis of BMPs. At the same time, we learned that although economics is a major driver of farm decision making, it is not the only driver. When making decisions about their farms, agricultural producers also consider land stewardship, civic responsibility, and human health.

Calls to voluntary action must clearly articulate what the problem is, why it is a problem, and how farmers individually and collectively can contribute to a solution. Farmers interviewed expressed uncertainty concerning natural versus agricultural sources of nitrogen, skepticism about BMP effectiveness, and criticisms of existing BMP programs and potential regulations. Resource professionals participating in our study by and large expressed much greater concern about water resource problems in the watershed than the farmers interviewed. Thus, knowledge of water resource problems, concern about their consequences, and confidence in solutions may be significant barriers to BMP adoption for many farmers. We also learned that farmers are most influenced by agronomists, cooperatives, and other farmers in their nitrogen management decision making. Based on these findings, we recommend that resource professionals raise awareness about local water resource issues, their consequences and BMPs as a solution. We recommend creating a forum for farmer-tailored and farmer-led information exchange aimed at enhancing knowledge and changing perceptions. To be effective, the BMP dialogue should be relevant and significant to targeted stakeholders and led by farmers themselves.

Our study identified several constraints to adoption associated with perceived farm/landscape suitability, weather sensitivity, and effectiveness of BMPs. Several farmers expressed uncertainty and even skepticism about the risks and rewards of nitrogen BMPs. This finding is consistent with findings of a recent survey of riparian landowners in Scott and Dakota counties, Minnesota (Davenport & Pradhananga, 2012). In this study, non-adopters of riparian buffers held stronger beliefs that buffers reduce land values and weaker beliefs that buffers improve water quality than adopters. For farmers who hold very strong negative attitudes toward BMPs, more direct interventions beyond communication may be needed. Direct types of interventions may encourage or reward (e.g., financial incentives, public recognition) "desired" behavior or, alternatively, they may discourage or punish (e.g., fines, public admonition) "undesired" behavior. Incentives and rewards are generally favored over sanctions because they tend to promote positive feelings and social support around the desired behavior. However, as suggested earlier, rewards have their limits. Monetary incentives, in particular,

have been shown to produce only short-term effects on behavior change because the behavior and outcomes are less likely to be internalized (Abrahamse et al., 2005; Steg & Vek, 2009).

A less immediate but perhaps more long-lasting strategy for incentivizing conservation behavior is offering information and assistance that better enable farmers to attain the specific benefits they desire. For example, individualized shoreland audits, in which water resource professionals assess stream and shoreland conditions on a farmer's property and provide technical advice about how to implement a practice (e.g., plant and maintain buffers) for certain benefits (i.e., wildlife or soil conservation) would be well-received. Individualized, specific, and timely information and assistance will make issues and solutions more personal to farmers. As the resource professionals participating in our study noted, showing results of behavior is critical to sustaining behavior change. Providing feedback on the extent to which BMPs are having the desired outcomes (e.g., water quality improvement, soil conservation, wildlife habitat protection) further validates a farmer's decision to adopt a practices and will increase the likelihood the practice is maintained.

Resource agency-led information campaigns must directly tackle local conditions and problems (i.e., impairments in stream reach A or township B), their potential consequences (i.e., impacts to aquatic life in A or B), and a range of solution alternatives (i.e., streamside buffer installation or wetland restoration near A or B). However, a peer-to-peer network of information exchange, informed by practical experience as well as the latest science and technology, is likely to be the most trusted communication approach. Meetings or forums at the local level (i.e., township or watershed) in which water resource professionals and members of the agricultural community (i.e., agricultural producers, agronomists, cooperatives) exchange information about water resource issues, farm management and BMPs will help all those involved to clarify and prioritize local issues/needs, assess available expertise and resources, and discuss the risks and rewards of BMP adoption. This process would also enable resource professionals to identify local champions or innovators and opportunities for demonstration projects that would serve as concrete examples of local applicability and effectiveness of BMPs.

## **Recommendation 2: Integrate local knowledge, needs and resource conditions to create flexible and tailored BMP programs**

To be effective, BMP programs should be responsive to knowledge and expertise across the local agricultural community. BMP programs also must be sensitive to farmers' needs and the obstacles they face. To increase a BMP's credibility and legitimacy in the eyes of farmers, resource professionals must be able to answer questions of primary concern to farmers upfront such as "How much will the practice cost me today and in the future?"; "How will the practice affect my crop productivity?"; "How will the practice improve water quality?"; "Will this practice work on my farm?"; "How difficult is the practice to implement and maintain?"; "How will varying weather conditions affect its implementation or outcomes?" Of course, the answer to many of these questions may be "it depends." Still, an open and honest dialogue between farmers and resource professionals that validates these concerns and begins to address them is important.

When asked what the major constraints are to farmer BMP adoption, one participant responded succinctly, “There are as many different ways to farm as there are farmers.” Our data supported this notion. While some notable differences existed in BMP implementation across our study watersheds (e.g., Elm Creek watershed farmer participants implemented an average of 2.13 BMPs and Rush River participants implemented an average of 3.13 BMPs), none of these differences appeared to be directly related to sociodemographic variables. For example, though some studies have identified education, farm size and income levels as determinants of BMP adoption, our small sample showed no clear patterns across these variables. Of the 10 producers who implemented the most BMPs

- Three had high school diplomas, one had some college but no degree, one had an associate or vocational degree, three had bachelor’s degrees, and two had graduate degrees.
- Four operated under 500 acres, two operated 500 – 1,000 acres, and four operated over 1,000 acres.
- One reported income of \$35,000 - \$49,999, one reported \$50,000 - \$74,999, two reported \$75,000 - \$99,999, three reported \$100,000 - \$149,999, and three reported over \$150,000.

Many producers interviewed showed interest in effective, cost-efficient BMPs and the opportunity to experiment with farm practices such as tilling, timing and method of fertilizer application, and planting densities. Thus, having the freedom to adjust and adapt practices based on nitrogen reduction and crop productivity may be appealing to many producers. Programs promoting a suite of BMP options that afford flexibility and enable farmers to adopt or adapt the practice or practices that best suit their farms’ characteristics, their management objectives and changing external conditions (i.e., weather, commodity prices) may have the most success in increasing adoption.

One objective of this study was to examine perceptions of specific BMPs associated with nitrogen reduction. The study documented study participants’ perceptions of 10 unique BMPs and the factors farmers contemplate when making decisions to adopt or not to adopt each practice. Rush River and Elm Creek resource professionals participating in the focus groups identified variable rate technology (VRT) and UMN recommendations for nitrogen application as the BMPs that are most effective in improving water quality and least likely to reduce farm productivity. However, some farmers interviewed perceived constraints associated with the adoption of these BMPs. VRT was perceived to be expensive to adopt, especially in labor costs associated with its implementation. A few farmers interviewed questioned the effectiveness of VRT, as well, suggesting that the “machine” reported data are not always accurate or sensitive to the variability of farm and landscape conditions (e.g., soils, microtopography, flows). The UMN recommendations for nitrogen application were viewed by some farmer participants as a baseline; often times being too low to ensure crop productivity, especially under changing weather conditions. A few participants admitted they came to this conclusion in consultation with fertilizer retailers. One participant acknowledged that his “fertilizer guys” told him the recommendations were low.

Overall, BMPs such as maintenance of buffer/filter strips and UMN recommendations for nitrogen application were most popular among farmers interviewed and had been adopted by the more than half of the participants. Thus, these BMPs are the most likely to be adopted or maintained by farmers into

the future (Table 2). Some farmers told us they maintained buffers out of habit or tradition, and others noted that ditch banks are “not generally very productive anyway.” One farmer acknowledged the dual financial and water quality benefits of maintaining buffers on his farm. In contrast, another farmer argued that farm “profitability goes down” when farmers adopt buffer strips. He added that when he compares Conservation Reserve Program payments to current land prices, buffers are not practical economically. Other participants were concerned about the width requirements of existing conservation programs and asked for more flexibility around those parameters.

Table 2. Rankings of BMPs across adoption factors <sup>†</sup> (n = 30)

<b>BMP</b>	<b>Overall likelihood of adoption<sup>a</sup></b>	<b>Current adoption<sup>b</sup></b>	<b>Farmer familiarity<sup>c</sup></b>	<b>Ease of adoption<sup>d</sup></b>	<b>Crop impact<sup>e</sup></b>	<b>Landscape suitability<sup>f</sup></b>
<b>Buffer/filter strips</b>	1	1	1*	3	4	3
<b>UMN recommendations for nitrogen application</b>	2	2	6*	1	3	2
<b>Variable rate technology</b>	3	3*	6*	2	1	1
<b>Cover crops</b>	4	3*	1*	5	7	6
<b>Alfalfa</b>	5	3*	1*	6	8	4
<b>Controlled drainage</b>	6	6*	6*	8	2	10
<b>Bioreactors</b>	7	9*	9	4	5	7
<b>Wetlands</b>	8	6*	1*	10	9	9
<b>Two-stage ditch</b>	9	9*	10	9	6	8
<b>Alternative energy</b>	10	8	1*	7	10	5

<sup>†</sup> Analysis of qualitative data using a 1-10 ranking system (1=highest relative likelihood of adoption/maintenance)

<sup>a</sup> A summary ranking of likelihood of adoption/maintenance based on adoption factors <sup>b-f</sup>

<sup>b</sup> BMP adoption (1=adopted by highest number of participants), based on question 19, see Table 14

<sup>c</sup> Familiarity with BMP (1=familiar to the highest number of participants), based on question 20, see Table 15

<sup>d</sup> Perceived ease of BMP adoption (1=easiest to adopt), based on questions 19e and 20b, see Table 12

<sup>e</sup> Perceived BMP impact on crop (1=least impact to crops), based on questions 19e and 20b, see Table 12

<sup>f</sup> Perceived landscape suitability for BMP (1=most suitable for landscapes), based on questions 19e and 20b, see Table 12

\*Indicates a tie



Individual decision support using contemporary planning tools and technologies such as stream modeling, light detection and ranging (LIDAR), geographic information systems mapping, comprehensive cost-benefit spreadsheets, and scenario planning can help farmers visualize and assess more holistically the risks and rewards associated with BMPs on their farms. Farmer-sensitive watershed planning with farmers' values, beliefs and normative influences in mind will ensure that multiple benefits are achieved and will support more flexible decision making needed under uncertainty or variable conditions. While a farmer-tailored approach is important, identifying opportunities to coordinate farm and water resource management activities across farms is critical to increasing a sense of civic responsibility and protecting water resources at a watershed scale. Synergies existing in the watershed both in farmer objectives and landscape suitability should be nurtured. For example, multi-purpose drainage systems, wetland creation through tile daylighting, and increasing water storage may be best achieved across farm ownership boundaries. Opportunities for this type of coordination and cooperation between farmers are more likely established through open dialogue and recognition of individual farmer needs.

**Recommendation 3: Coordinate water resource management programs across resource agencies and with multiple agricultural community member partners**

Most participants reported a strong dependence on various sources of information including agronomists, cooperative operators, and other crop input consultants for their decision making. Our study suggests that some producers rely completely on these sources. Further, it appears many producers regard these consultants with a high level of trust and credibility. Even though efficient nitrogen use and cost reduction were primary objectives of our study participants, several farmers acknowledged that their consultants advised applying nitrogen levels exceeding the University of Minnesota recommendations. Since agronomists, cooperative operators, fertilizer retailers and other crop consultants are crucial and trusted sources of information for producers, they could also play a critical role in water resource management and watershed planning—as liaisons between resource professionals and farmers.

Communication between resource managers and local agronomists, cooperatives, and crop consultants concerning method, rate, source, and timing of nitrogen application and the effectiveness of other BMPs may lead to better coordination of resources and a more accurate and holistic picture of nitrogen management and water resource integrity at a local watershed scale. This ongoing dialogue around the use of nitrogen will facilitate information exchange and resource sharing creating a broader peer-to-peer knowledge network. Farmers will have access to up-to-date information and insight into the latest technologies and practices associated with nitrogen management and their suitability and effectiveness under various conditions. In turn, a social norm is established in which farmers and resource professionals can rely on one another to provide accurate and reliable reporting about farm operation and BMPs. One clear challenge will be elevating the conversation from a field-scale focus to a watershed scale. Agronomists, cooperatives, and crop consultants are traditionally field-focused. Thus, farmers have made fertilizer application decisions based solely on a field-scale perspective, not a watershed scale perspective. However, the cumulative impacts of individual field-scale decisions are among the greatest challenges of water resource protection.

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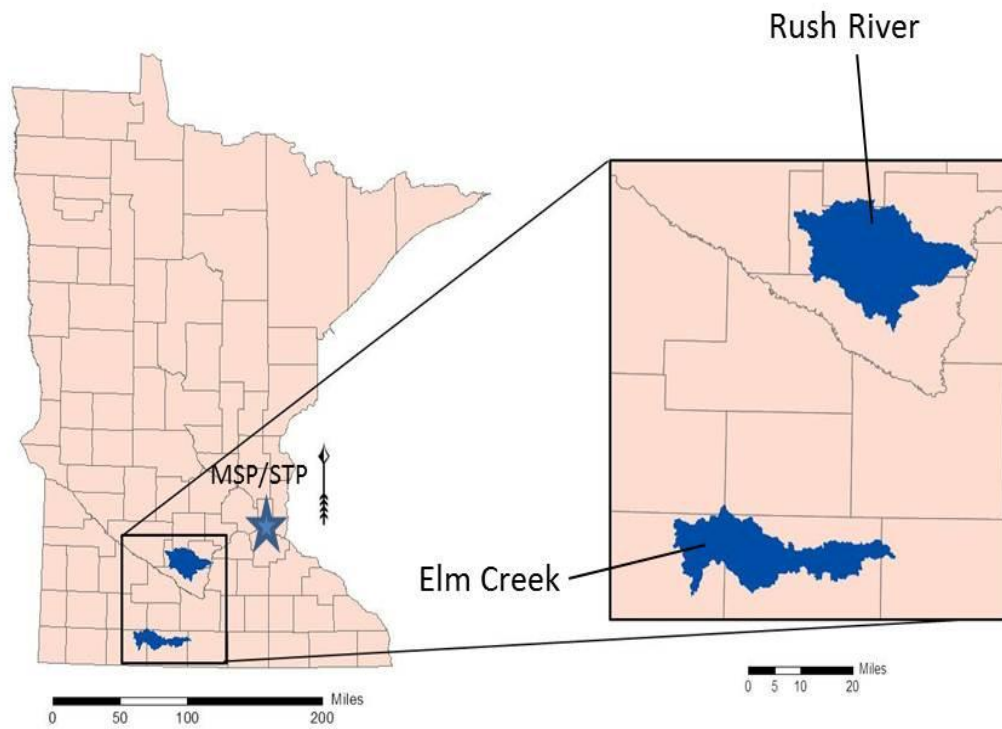
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## Appendices

### A. Map of Rush River and Elm Creek watersheds



Map created by Jacob Galzki

## B. Interview recruitment script

### Nitrogen Runoff Reduction Framework

#### Script for Initial Contact

“Hello, my name is \_\_\_\_\_. I am a graduate student conducting research on watershed management for Mae Davenport, Assistant Professor in the Department of Forest Resources at the University of Minnesota. This study involves farmers in the Rush River Watershed and Elm Creek Watershed. This research is to create an assessment tool specific to farmers and their fields that aids in reducing nitrogen runoff in an effective and economical way. I have been interviewing farmers to gather their insights about their operations regarding nitrogen and was hoping you would be able to assist me by participating in the study and sharing your perspectives with me. We are offering an optional \$20 gift for your participation. The interview takes about one hour. Would you be willing to participate?”

**If yes:** “Thank you. I am available on \_\_\_\_\_ (days of week, times, have alternates ready) is there a time that would work best for you? [Set date, time, location (get directions)]. I would like to send you a confirmation email with date, time and location information. The email will include all of my contact information, in case you have any questions or concerns. Do you have an email address I can send the confirmation to?”

- a. **If yes,** take it down or confirm we have the correct email address for them. “Thank you. I look forward to meeting with you on \_\_\_\_ (agreed upon date)\_\_\_\_\_.”
- b. **If no,** “Is \_\_\_\_ (phone # you contact them with)\_\_\_\_\_ the best way for me to get a hold of you? In case you need to get a hold of me with questions or concerns, my phone number is \_\_\_\_\_.” I look forward to meeting with you on \_\_\_\_ (agreed upon date)\_\_\_\_\_.

**If no:** “Ok, thank you for your time. Good bye.”

**If they seem unsure:** “Just to be clear, participation is completely voluntary and if you decide to participate you can withdraw at any time. Your identity will remain confidential and we won’t include any information that would make it possible to identify you in the final report. We’re only talking to a limited number of key representatives, so capturing your perspective is important. Can I ask what your concerns about participating are?” [Try to address their concerns]

**If they want to know why they are being asked to participate:** “We’re interviewing a variety of community members to try to get diverse perspectives and a range of experiences. I’ve been conducting background research and see that you are a [position in organization] **OR** [Name of person] recommended I contact you. Since we are only able to conduct a limited number of interviews, capturing your perspective is important.”

**If they want to know how the information will be used:** “We are trying to understand the opportunities and constraints to improving watershed management in the community. We’ll be putting together a final report that identifies those opportunities and constraints to share with community leaders, educators and water resource professionals. Your information will be kept confidential and there will not be any identifying information in the report.”

**If they want to know what the study is for:** “This project is aimed at understanding the critical capacities communities need to sustainably manage their watersheds. We’re collecting social data to assess the needs and opportunities in your community and identify strategies that could be used to sustainably manage the watershed. This will lead to an improved understanding of the drivers

and constraints to sustainable watershed planning and management at the landowner, community and watershed levels.”

**If they want to know who is supervising the research:** “Mae Davenport is the supervisor for this study. She is an assistant professor in the Department of Forest Resources at the U of M. If you would like to contact her directly I can give you her phone number [612-624-2721] or email address [mdaven@umn.edu].”

**If they ask about IRB:** The research project has been approved by the IRB/Human Subjects Committee.

### **C. Interview consent form**

#### **Nitrogen Runoff Reduction Framework Consent Form**

You are invited to participate in a research study designed to develop a framework to assist in reducing nitrogen runoff in Minnesota. You were selected as a possible participant because of your experience and expertise with agricultural practices in your watershed district. We ask that you read this form and ask any questions you may have before agreeing to be in the study.

This study is being conducted by: Mae Davenport, Professor at Department of Forest Resources, University of Minnesota.

#### **Background Information**

The purpose of this study is to better understand agricultural practices concerning nitrogen and effective, economical ways to reduce nitrogen runoff to surrounding water resources.

#### **Procedures:**

If you agree to be in this study, we would ask you to do the following things:  
Participate in an interview, lasting approximately 60 minutes. The interview will be audio recorded and transcribed.

#### **Risks and Benefits of being in the Study**

A risk of participating in this study may arise if some find your opinions at variance with their own. This risk is minimal, responses are confidential and names will not be linked to any information in any publications.

Benefits of participation include increased awareness of watershed and community issues. Study results will be made available to the public and all participants will have access to them.

#### **Compensation:**

A gift card, valued at \$20 will be offered for participation in an interview and/or focus group.

#### **Confidentiality:**

The records of this study will be kept private. In any sort of report we might publish, we will not include any information that will make it possible to identify a subject. Research records will be stored securely and only researchers will have access to the records. Your responses to the interview questions will be audio recorded, transcribed and kept for three years in a locked file cabinet. Afterward, these tapes will be destroyed. Only those directly involved with the project will have access to the audio tape of the interview notes.

#### **Voluntary Nature of the Study:**

Participation in this study is voluntary. Your decision whether or not to participate will not affect your current or future relations with the University of Minnesota. If you decide to participate, you are free to not answer any question or withdraw at any time without affecting those relationships.

**Contacts and Questions:**

The researcher conducting this study is: Mae Davenport. You may ask any questions you have now. If you have questions later, **you are encouraged** to contact her at address: 115 Green Hall 1530 Cleveland Ave. North, St. Paul, MN 55108-6112, phone: 612-624-2721, email: mdaven@umn.edu.

If you have any questions or concerns regarding this study and would like to talk to someone other than the researcher, **you are encouraged** to contact the Research Subjects' Advocate Line, D528 Mayo, 420 Delaware St. Southeast, Minneapolis, Minnesota 55455; (612) 625-1650.

*You will be given a copy of this information to keep for your records.*

**Statement of Consent:**

I have read the above information. I have asked questions and have received answers. I consent to participate in the study.

"I agree\_\_\_\_\_ I disagree\_\_\_\_\_ to have my responses recorded on audio/video tape"

"I agree\_\_\_\_\_ I disagree\_\_\_\_\_ that Mae Davenport may quote me anonymously in her papers"

Signature:\_\_\_\_\_ Date: \_\_\_\_\_

Signature of Investigator:\_\_\_\_\_ Date: \_\_\_\_\_



**D. Interview guide**  
**Nitrogen BMP Interview guide**  
**University of Minnesota**

ID # \_\_\_\_\_

**First, I'd like to start with a few questions about your farm and farming in general.**

- 1. Tell me about your farm and what it means to you.**
  - a. How would you describe your farm to a friend?**
- 2. What do you like about being a farmer?**
- 3. What do you dislike about being a farmer?**
- 4. What worries or concerns you the most about farming today?**
- 5. If you could change anything about farming today, what would you change?**

**Next, I would like you to discuss your decision-making process on your farm.**

- 6. First, could you please describe for me the ownership and management arrangement on your farm**
  - a. For example, do you rent farmland through a crop-share lease or a cash rental?**
  - b. How many years is your agreement?**
  - c. How is the rental rate calculated?**
- 7. What are the most important considerations for you when making decisions about your farm?**
- 8. Do you consult with others when making decisions about your farm?**
  - a. If so, who do you talk to?**
- 9. How do you evaluate the success of your farm operation?**
  - a. What kinds of outcomes are you looking for in judging success?**
- 10. What issues challenge or limit you in making your farm operation a greater success?**
- 11. Have you changed the way you farm in the past 5 years in attempt to make your farm more successful?**

**The following questions explore your use of nitrogen on your farm.**

- 12. What are the most important considerations for you when applying nitrogen on your farm?**
- 13. How do you apply nitrogen on your farm?**
  - a. Could you describe source, timing, method, and rate of application?**

- b. Where do you get your information when making decisions about nitrogen application?
- c. How reliable do you think these sources are?

**14. Do you use manure as a fertilizer source?**

[If “yes” ask]

- a. **Could you describe the source, timing, method, and rate of application of manure?**
- b. Where do you get your information when making decisions about manure application?
- c. How reliable are those sources?  
[If “no” ask]
- d. What has prompted you to not to use manure?

**15. How do you determine the amount of nitrogen fertilizer to use after you’ve applied manure?**

- a. **Do you factor in nitrogen levels from previous crops (alfalfa, soybeans), field productivity, soil/stalk tests, or other sources?**

**16. How important is it to you to maximize the efficiency of nitrogen use on your farm?**

**17. How important is it to you to minimize the potential impacts of nitrogen on the natural environment?**

**18. Are you familiar with the term “best management practice” or “BMP”?**

**19. What types of best management practices do you use to address nitrogen efficiency and minimize impacts?**

*[Write down practices on BMP checklist, then for each practice participant uses ask the following]*

- a. How long have you used this practice on your farm?
- b. What has motivated you to use this particular practice?
- c. Is this practice doing what it was intended to do? Please explain.
- d. What do you like about this practice?
- e. What don’t you like about this practice?
- f. Do you plan on continuing to use this practice? Please explain.

**20. I have a list of best management practices that some resource professionals recommend to reduce the impact of nitrogen on the natural environment. You’ve described some of these already. I’d like to ask your opinion about a few other best management practices. *[Ask for all remaining BMPS in checklist, those not described in 11b.]***

- a. What have you heard about this practice?
- b. What has influenced your decision not to use this practice?
- c. Would you adopt this practice if things were different? Please explain.

**21. What are the most important considerations for you when making decisions about using nitrogen best management practices on your farm?**

- a. Does your crop-share or rental arrangement affect your use of nitrogen management practices?
- b. Are you concerned that nitrogen best management practices may reduce yields?
- c. Do you have the resources you need to adopt these practices?

**22. Would you be interested in getting more or different information about nitrogen management practices? Please explain.**

**23. What is your connection to the water resources in this area?**

- a. Are there any improvements or changes you would like to see?

**24. Some resource professionals are concerned about the impact of nitrogen on streams and lakes in the area. What is your perspective on the issue?**

- a. How would you describe the quality of the groundwater, streams and lakes in this area?
- b. Whose responsibility is it to keep water resources in this area healthy?

**25. What do you think are the 3 biggest constraints to the adoption of nitrogen best management practices by farmers in this area?**

**Okay, to close I have one final interview question for you.**

**26. Is there anything you would like to add about your farm or nitrogen management practices that we haven't covered?**

# **E. BMP implementation checklist**

ID # \_\_\_\_\_

<b>Nitrogen BMP:</b>	<b>Definition/Benefit:</b>	<b>In Use (U)/Not in Use (N)</b>
Planting buffer or filter strips	Vegetation (grasses, trees, and shrubs) planted and maintained adjacent to streams, ditches and lakes that filters water, stabilizes the stream bank, and provides habitat for wildlife.	
Constructing a ditch	A permanent, designed waterway, shaped, sized, and lined with appropriate vegetation or structural material used to direct concentrated runoff from an area without damage from erosion.	
Constructing a two-staged ditch	A permanent, designed waterway with two flow channels (low and high) to stabilize the stream bank, reduce nutrient loading and improve habitat while requiring less maintenance than a standard ditch.	
Adding alfalfa to crop rotation	Alfalfa's deep, nitrogen-fixing roots enhance water uptake and replenish nitrogen to soil.	
Creating or restoring wetlands	Wetlands store water in landscape depressions, reducing the volume of water delivered to surface waters. Wetlands also filter water and remove nitrogen from runoff.	
Implementing Controlled drainage	Water control structures are installed at the drainage outlet to allow farmers to raise or lower water levels. Controlled drainage systems are designed to release only the amount of water needed to provide an aerated root zone and ensure best conditions for field operations.	
Installing bioreactors to drainage system	Solid carbon substrates (often fragmented wood products) are added to water flow paths. The bioreactors act support the conversion of nitrate to nitrogen gases.	
Using variable rate technology for nitrogen application	Using real-time plant-sensing technology to optimize nitrogen application while redressing corn.	
Following University of Minnesota recommendations for nitrogen	Nitrogen application that accounts for all sources of nitrogen in calculating nitrogen input rates, delays the timing of fertilizer application from fall to spring, and/or tailors methods of injection or incorporation to reduce runoff.	
Planting alternative energy	Low maintenance, alternative crops used to generate	

crops	biomass for energy and replaces nitrogen intensive crops like corn.	
Planting cover crops	Winter cover crops are planted shortly before or soon after harvest in fall. Cover crops remove water and nitrogen from the soil after the primary crop is removed. Examples of cover crops include rye, small grains and clover.	

Best Management Practice: Practices that prevent and/or minimize degradation of ground and surface water

**F. Interview background survey**

ID # \_\_\_\_\_

To better document the types and range of farmers we talk to, we are asking participants to complete a short background information worksheet. This information will only be presented as a summary of study participant characteristics. All efforts will be made to maintain confidentiality and any information provided that may reveal your identity will be excluded from published documents. Your name will not be associated with the data collected and will not be referenced in any future publications.

1. How many years have you lived in your community? \_\_\_\_\_.
2. How many years have you been farming? \_\_\_\_\_.
3. Approximately, how long has your farm been in your family? \_\_\_\_\_.
4. What type of crops do you grow? And, approximately what percent of your total crops is made up of each crop type?

Crop type	% of total crops
<b>Total</b>	<b>100%</b>

5. What crop rotation are you currently using?
6. How far is the distance from your home to your farmland (in miles)? \_\_\_\_\_.
7. Which of the following best describes the ownership arrangement of the land you farm?
  - a. I own and manage my own farmland.
  - b. I rent my farmland to another party.
  - c. I rent farmland from another party.
  - d. I own and manage my own farmland and rent farmland *to* another party.
  - e. I own and manage my own farmland and rent farmland *from* another party.
  - f. Other (please specify): \_\_\_\_\_.
8. Approximately how many acres is your land/property? \_\_\_\_\_

9. Are you involved in any farming-related organization/associations in your community (e.g., MN Corn Growers Association, MN Farmers Union, etc.)? Please specify:

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10. What is your gender?      Male                      Female

11. In what year were you born? \_\_\_\_\_.

12. What is the highest level of formal education you have completed?

- |  |                              |
|--|------------------------------|
| a. Did not finish high school            | f. Some graduate work        |
| b. Completed high school                 | g. Completed graduate degree |
| c. Some college but no degree            | (Masters or PhD)             |
| d. Associate degree or vocational degree |                              |
| e. College bachelor's degree             |                              |

13. What percent of your income is dependent on your land?

- a. 0%
- b. 1-25%
- c. 26-50%
- d. More than 50%

14. Which category best describes your **total household income from all sources** in 2010 before taxes?

- |                      |                        |
|----------------------|------------------------|
| a. Under \$10,000    | e. \$50,000-\$74,999   |
| b. \$10,000-\$24,999 | f. \$75,000-\$99,999   |
| c. \$25,000-\$34,999 | g. \$100,000-\$149,999 |
| d. \$35,000-\$49,999 | h. \$150,000 or more   |

## G. Focus group worksheet

### Worksheet A

Some people are concerned about the impacts of nitrogen on water resources. To what extent are you concerned about this problem? (Please circle one response for each item)

**A) How concerned are you about the impacts of nitrogen on water resources in the Elm Creek watershed?**

not at all    slightly    moderately    very    extremely    don't know

**B) How concerned are you about the impacts of nitrogen on water resources in the Minnesota River Basin?**

not at all    slightly    moderately    very    extremely    don't know

**C) How concerned are you about the impacts of nitrogen on water resources in the State of Minnesota?**

not at all    slightly    moderately    very    extremely    don't know

**D) How concerned are you about the impacts of nitrogen on water resources in the United States?**

not at all    slightly    moderately    very    extremely    don't know



## H. Focus group worksheet II

### Worksheet B

Resource professionals around the state have been encouraging the use of various best management practices to minimize impacts to water resources. Some are concerned that these practices will reduce yield and affect profitability. Please answer the following questions and circle one response for each best management practice.

**E) How effective do you think each of the following practices is at reducing water resource impacts?**

**1. Planting buffers or filter strips**

not at all slightly      moderately      very      extremely      don't know

**2. Constructing a ditch**

not at all slightly      moderately      very      extremely      don't know

**3. Constructing a two-stage ditch**

not at all slightly      moderately      very      extremely      don't know

**4. Creating or restoring wetlands**

not at all slightly      moderately      very      extremely      don't know

**5. Implementing controlled drainage**

not at all slightly      moderately      very      extremely      don't know

**6. Installing bioreactors to drainage systems**

not at all slightly      moderately      very      extremely      don't know

**7. Using variable rate technology for nitrogen application**

not at all slightly      moderately      very      extremely      don't know

**8. Following University of Minnesota recommendations for nitrogen**

not at all slightly      moderately      very      extremely      don't know

**9. Planting alternative energy crops**

not at all slightly      moderately      very      extremely      don't know

**10. Planting cover crops**

not at all slightly      moderately      very      extremely      don't know

**F) How likely is each of the following practices to negatively affect yield and profitability?**

**1. Planting buffers or filter strips**

not at all slightly      moderately      very      extremely      don't know

**2. Constructing a ditch**

not at all slightly      moderately      very      extremely      don't know

**3. Constructing a two-stage ditch**

not at all slightly      moderately      very      extremely      don't know

**4. Creating or restoring wetlands**

not at all slightly      moderately      very      extremely      don't know

**5. Implementing controlled drainage**

not at all slightly      moderately      very      extremely      don't know

**6. Installing bioreactors to drainage systems**

not at all slightly      moderately      very      extremely      don't know

**7. Using variable rate technology for nitrogen application**

not at all slightly      moderately      very      extremely      don't know

**8. Following University of Minnesota recommendations for nitrogen**

not at all slightly      moderately      very      extremely      don't know

**9. Planting alternative energy crops**

not at all slightly      moderately      very      extremely      don't know

**10. Planting cover crops**

not at all slightly      moderately      very      extremely      don't know

## I. Study findings tables

Table 1. Respondents' farm characteristics (n=30)

	Rush River	Elm Creek	Total
<b>Years lived in community (n=30)</b>			
Min	28	20	20
Max	74	71	74
Mean	50	54	52
<b>Years farming (n=30)</b>			
Min	22	15	15
Max	56	52	56
Mean	35	38	37
<b>Years of farm in family (n=30)</b>			
Min	27	44	27
Max	150	125	150
Mean	90	81	85
<b>Miles from home to farm (n=30)</b>			
Min	0	0	0
Max	8	25	25
Mean	2	6	4

Source: Questions 1-3, 6

Table 2. Respondents' ownership arrangement (n=30)

Response	Rush River		Elm Creek		Total	
	Frequency	Percent	Frequency	Percent	Frequency	Percent
Own and manage	1	7	2	13	3	10
Rent farmland to another	1	7	1	7	2	7
Own and manage and rent <i>from</i> another	9	60	12	80	21	70
Own and manage and rent to <i>and from</i> another	3	20	0	0	3	10
Other	1	7	0	0	1	3
Total	15	100	15	100	30	100

Source: Question 7

Table 3. Size of respondents' property (n=30)

Response	Rush River		Elm Creek		Total	
	Frequency	Percent	Frequency	Percent	Frequency	Percent
Under 500 acres	6	40	4	27	10	33
501 – 1000 acres	5	33	5	33	10	33
1001 acres or more	4	27	6	40	10	33
Total	15	100	15	100	30	100
Min	120		280		120	
Max	2000		6400		6400	
Mean	755		1427		1091	

Source: Question 8

Table 4. Respondents' gender (n=30)

Gender	Rush River		Elm Creek		Total	
	Frequency	Percent	Frequency	Percent	Frequency	Percent
Male	14	93	14	93	28	93
Female	1	7	1	7	2	7

Source: Question 10

Table 5. Respondents' age (n=30)

Respondent Age	Rush River	Elm Creek	Total
Min	47	42	42
Max	80	73	80
Mean	58	61	59

Source: Question 11

Table 6. Respondents' highest level of formal education (n=30)

Response	Rush River		Elm Creek		Total	
	Frequency	Percent	Frequency	Percent	Frequency	Percent
Did not finish high school	0	0	0	0	0	0
Completed high school	5	33	3	20	8	27
Some college but no degree	0	0	3	20	3	10
Associate degree or vocational degree	4	27	3	20	7	23
Completed bachelor's degree	4	27	4	27	8	27
Some graduate work	0	0	1	7	1	3
Completed graduate degree (Masters or PhD)	2	13	1	7	3	10
Total	15	100	15	100	30	100

Source: Question 12

Table 7. Respondents' percent of income dependent on land (n=30)

Response	Rush River		Elm Creek		Total	
	Frequency	Percent	Frequency	Percent	Frequency	Percent
0%	0	0	0	0	0	0
1-25%	1	7	1	6.5	2	7
26-50%	5	33	1	6.5	6	20
More than 50%	9	60	13	87	22	73
Total	15	100	15	100	30	100

Source: Question 13

Table 8. Respondents' total 2010 household income before taxes (n=28)

Response	Rush River		Elm Creek		Total	
	Frequency	Percent	Frequency	Percent	Frequency	Percent
Under \$10,000	0	0	0	0	0	0
\$10,000 - \$24,999	0	0	1	7	1	4
\$25,000 - \$34,999	0	0	0	0	0	0
\$35,000 - \$49,999	1	8	2	13	3	9
\$50,000 - \$74,999	1	8	3	20	4	14
\$75,000 - \$99,999	2	15	2	13	4	14
\$100,000 - \$149,000	5	38	2	13	7	25
\$150,000 or more	4	31	5	33	9	32
Total	13	100	15	100	28	100

Source: Question 14

Table 9. What participants like about farming

Topic	Category	Exemplary Quotes
What Participants Like About Farming	Independence	<ul style="list-style-type: none"> <li>You're a businessman and your own boss. (ECW)</li> <li>First of all, I like being my own boss. (ECW)</li> <li>Self-employment...you don't have a boss and you live and die by your own decisions. (RRW)</li> </ul>
	Challenge	<ul style="list-style-type: none"> <li>One thing's for sure, there are never going to be two years alike, and I enjoy that. (RRW)</li> <li>There's mechanics, management, financial, chemistry, and math. It's just a real broad spectrum of challenges and I've always enjoyed that. (ECW)</li> </ul>
	Family	<ul style="list-style-type: none"> <li>It's a great way of raising a family and teaching responsibilities. Teaching them how to do certain aspects of the farming and giving them the responsibility of doing certain tasks on their own. (ECW)</li> <li>The rural community is a great place to raise a family. Great for my kids, they're involved in 4H. They take their animals to the fair. (RRW)</li> <li>The family life is great. I wouldn't live</li> </ul>

	Family (cont'd)	anywhere else but out in the county. I think it's the open-airness. Your neighbor is miles away from you, not ten feet from you. (RRW)
	Production -Crops - Farming process	<ul style="list-style-type: none"> <li>• We do take pride in producing the food and fuel and fiber for the world. (ECW)</li> <li>• Doing something that's productive that I can feel something physical coming off the land from my efforts, my management. There's always the thrill of putting the seed in the ground and managing it until you harvest your crop. (RRW)</li> <li>• Farming is a wonderful occupation. You get to drive big equipment. I run a field cultivator and I'm ready to plant. Spray it and harvest it. It's neat. (ECW)</li> <li>• My farming, the tractor driving, the truck driving, the combine driving, is golf. If you love farming the way I do, that's golf. There's nothing in the world I'd rather do than run one of those pieces of equipment. (ECW)</li> </ul>
	Environment -Connection to land -Seasonality	<ul style="list-style-type: none"> <li>• I have the change of seasons: the spring planting season and tending of the crops in the summer and the fall harvest has always been fun for me. I think I've got the greatest job on earth because by the time I get really sick of what I'm doing, I'm moving to the next season already. (RRW)</li> <li>• We have river bottom land we got flat land, you can see wildlife, you can see nature, you can see things the way other people can't see it. (RRW)</li> <li>• Most farmers respect the land. The land is part of them and they do their best to preserve what it is for the next generations. I like to see farmers own the land, they take care of the land, they respect it. As long as it stays family farms, they're part of the soil. (ECW)</li> </ul>

Source: Questions 1 & 2

Table 10. Challenges participants face in farming

Topic	Issues	Exemplary Quotes
<b>Economics</b>	Land	<ul style="list-style-type: none"> <li>It's highly competitive right now. Landlords can name their price and they can have somebody snatch up your land in an instant. We're down 300 acres this year already. It's almost cutthroat out there. Not like it used to be like with a handshake and a nod and you could run the farm for years and years and years. It's different now. (RRW)</li> <li>I have friends down in Iowa and there was a guy who put every one of his farms up for auction. The highest was \$530 and acre and the lowest was \$480. Rent. (ECW)</li> </ul>
	Commodities	<ul style="list-style-type: none"> <li>Some day it might just go broke and then we're back down to \$3 corn and we just gave \$10,000 an acre based on \$6 corn. Now the payback on the \$10,000 an acre land is 200 years. (RRW)</li> <li>Some people say things are manipulated, but if we have a lot of something it still goes down and if you don't have a lot of something it still goes up. We could easily see \$4 or sub-\$4 corn for the coming year. (ECW)</li> </ul>
	Inputs	<ul style="list-style-type: none"> <li>We're going to need good prices for commodities, because our inputs are getting extremely expensive. My seed cost is tripling. We used to get poultry manure for nothing per acre. Now my last bill was \$200 an acre. (RRW)</li> <li>Everything has gone up. Fuel, fertilizer, seed. Everything just keeps ratcheting up and they all tend to take a piece of the pie. (ECW)</li> </ul>
<b>Government Programs</b>	Trust <i>-Knowledge</i> <i>-Experience</i>	<ul style="list-style-type: none"> <li>You can't say the farmer is not doing his job, but we don't want to be pushed to the wall where we can't do what we have to do. We feel like the people up there in Washington D.C. don't know nothing about farming as much as we do. About conservation, about saving the soil. (RRW)</li> <li>They go to school and they get this diploma and now they got a job. And their job is to come down here and tell me how to plant, or how to farm, stay so far away from the water. That's the scary part. When I say I want government out, that's what I mean.</li> </ul>

	Trust (cont'd) -Knowledge -Experience	<p>They have no idea what the heck's going on. (ECW)</p> <ul style="list-style-type: none"> <li>• But [the NRCS/SWCD staff] needs to be well-trained and they need to understand the research, where it comes from and they need to understand the finer points of nitrogen cycling and what form it's in and where it's at. (RRW)</li> <li>• If you and I sit down and decide this might work, let's see if we can try this, I'll try it. If you come into my house and say, "You're going to do this." I'll say, "You think so?" You're coming here, not living here, not having a clue, telling me what to do when I've lived here all my life and my great-grandkids are going to farm it. No. You've got to be serious. (ECW)</li> </ul>
	Communication Strategies	<ul style="list-style-type: none"> <li>• It's maybe a criticism I have of [the staff] is I don't think they go out and try to sign people up or try and encourage it. I'd like to see them be a lot more aggressive. Not demanding, because they can't demand, but they could certainly go out and help farmers understand how much more potential they could get from their land. (RRW)</li> <li>• And [NRCS/SWCD] could have had their damn one-acre pond, but quit being an ass about it. We're gonna move it to the corner so I get my big machinery in there and you'll have a pond that holds water year-round. (RRW)</li> </ul>
	Autonomy	<ul style="list-style-type: none"> <li>• Call me a bullhead, whatever you want, but this running up and, "Yeah, I want to put 10 feet of tile in here." What a bunch of hooley, you know? "Hey Daddy, can I put tile in?" A guy gets sick of that stuff. (RRW)</li> </ul>
	Productivity	<ul style="list-style-type: none"> <li>• I worry about EPA putting out regulations that will inhibit our ability to produce. We have been told that we have to increase our yields just to feed the world. I'm ready, willing, and able, but I don't want my government to step in too far and be regulating me to so-called death. (RRW)</li> <li>• Sometimes the regulations stifle the production or how we have to farm. (ECW)</li> </ul>
	Efficiency	<ul style="list-style-type: none"> <li>• I don't mind doing [paperwork], but the way they have of doing it is so inefficient, it's kind</li> </ul>



	Efficiency (cont'd)	<p>of frustrating. Nothing's electronic. They have to do the same thing over every year. You might just have a rotation and you could just say you flipped it, but you have to sit down there for hours, you know. (ECW)</p> <ul style="list-style-type: none"> <li>Keep it simple so everyone can conform to the regulations and be in compliance. Simple is good. The simpler it is, the more likelihood that people will be in compliance and are willing to do it. If you make it too complex, people tend to push back and not comply. (ECW)</li> </ul>
<b>Farm Size</b>	Stewardship	<ul style="list-style-type: none"> <li>I think there's just more TLC, tender loving care, for the land when you got somebody my size or a thousand, fifteen hundred acres or two thousand acres, something like that versus somebody that comes in that's farming thirty-five thousand acres. (RRW)</li> <li>And they mine the ground. That's the only way you can pay that crazy rent. They're hurting themselves in the end, but some people, all they can think of is getting bigger. You shouldn't go out and pay whatever it takes to get it to try and pick up a piece of land. It's got to make some economic sense. (ECW)</li> </ul>
	Competition	<ul style="list-style-type: none"> <li>What worries me the most about farming today is it's almost get big or get out. (RRW)</li> <li>I see agriculture changing. The competitiveness of it, the bigness of it. I see that as a negative for rural communities. There are certain people that are driven by, probably the best word is greed. (ECW)</li> <li>Probably the one thing I would love to see changed is the enormous size that some of these farms are getting. They're not only destroying friendships, they're destroying communities. (RRW)</li> <li>Because I'm a farmer and I'll tell you right now: the big get a lot of it. The bigger you are, the more you get. The more you get, the more you can do. If we didn't have all that, everybody's on the same playing field. If you're a good operator, you'll make it. (ECW)</li> </ul>
<b>Impacts to Water Resources</b>	Expectations	<ul style="list-style-type: none"> <li>It's interesting because if I'm going to raise an optimum crop, I don't think I'm ever</li> </ul>

	Expectations (cont'd)	going to get back to some sort of historical background level. It just isn't going to happen that way. Yeah. So my challenge would be: what is your realistic expectation? If I'm over-applying nitrogen and maybe my tile waters coming out at 25 ppm nitrate, could I get it down to 15 with fine-tuned management? Probably, but I don't think I can move it much more than that because, if we're going to continue to raise these crops in the world, provide stability in the food production system, then we need these tools. (RRW)
<b>Public Image of Farming/Farmers</b>	Behaviors	<ul style="list-style-type: none"> <li>• It kind of discourages me is, ok, now we're going to get a flood. What's the first thing you hear about up in the Cities or Shakopee? They open up their sewage plant. (ECW)</li> <li>• I can honestly say, I think the farmer's doing a better job than the guys up town that are fertilizing their lawn three times a summer that don't know what they're putting on. The farmer knows what he's putting on and the guy on the street, he just wants to beat his neighbor. (RRW)</li> </ul>
	Perceptions	<ul style="list-style-type: none"> <li>• Environmental activists can change the whole nature of your business by what are generally lies. They get in the media, or even when they called it the Swine Flu. That had nothing to do with pigs. It destroyed the hog industry and the corn industry for a year and it had nothing to do with the pig industry. (ECW)</li> <li>• I worry greatly that we are such a small percentage of the population and that things are going to be dictated by emotion, by populist thoughts, not by scientific rationale. (ECW)</li> </ul>
<b>Risk and Uncertainty</b>	Stability	<ul style="list-style-type: none"> <li>• Most farmers worry about paying their mortgage, buying groceries, clothing their children. They have day-to-day concerns that are on their ass like you can't believe. It's a dog eat dog world. Whether or not the Minnesota River flows clean, that's way down on the priority list. They're in survival. They're managing crop prices, they're worrying about global events, energy, fertilizer, the crop protection products to do</li> </ul>

	Stability (cont'd)	<p>the job, huge prices swings, whether they'll have the land in a competitive environment so that they can even purchase inputs two, three years ahead like they need to. There are a lot of concerns. (RRW)</p> <ul style="list-style-type: none"> <li>• I've got a daughter that's getting ready to go to college and I've got a son that's a couple years behind her. We've got some land debt. I've got a cousin that wants to get rid of some of his land. So I think the debt obligation on me is going to grow. And that's fine if everything stays as it is, but if we turn around... All we have to do is take grain prices back down to 3 ½, 4 dollars and I think you're going to see a lot of people in agriculture start to struggle. (RRW)</li> </ul>
	Cyclical Markets	<ul style="list-style-type: none"> <li>• We remember the 80s, and I see a lot of those trends happening with those land prices. I hope that we don't experience something like we did in the 80s because you never forget that. It's like your grandparents telling you about the Depression. Our generation remembers the 80s. (ECW)</li> <li>• I tell my four kids, you gotta plan for that rainy day because she's gonna come along. We won't have \$6, and \$7 corn. There'll be something that will come along and knock us back down to four and five and those people that are paying 3 and \$400 an acre rent or have upgraded to all new machinery and have a big debt load, they're going to hurt. They're going to have the old banker shut them down. (ECW)</li> <li>• It shaped me as far as I saw neighbors losing their farm, saw that farm population and community be destroyed by the 80s. It reshaped how the family farm structure looks today versus what it did back when I first started farming. (RRW)</li> </ul>

Source: Questions 3-5, 10

Table 11. Participants' connection to water resources in the area

Topic	Issues	Exemplary Quotes
<b>Connection to Water Resources</b>	Wildlife	<ul style="list-style-type: none"> <li>Well, I grew up as a kid walking through woods, fishing out of the river, doing those types of things. Nothing I like better than being able to combine and see pheasants fly up in front of the combine and deer grazing out in the field. The environment means a lot to us. (RRW)</li> <li>Right now we've got beaver down there. The deer are quite plentiful in the area. It's neat having that resource on your own property where you can walk to one end of your farm and see a beaver swimming. (RRW)</li> </ul>
	Recreation	<ul style="list-style-type: none"> <li>I love the Minnesota River. It's one of my favorite places to go. I've been going there since I was a child. (RRW)</li> <li>We have a lake in our backyard and cricks to play in. They [kids] were always making rafts or having fun or building something. (ECW)</li> <li>I canoed and walked every tributary and the east fork going to the lake. I know everything about that place. (ECW)</li> </ul>
	Water Management	<ul style="list-style-type: none"> <li>I was on the water and soil here a few years ago. (RRW)</li> <li>My main connection is the desire to restore our local lake and to improve our river systems. (RRW)</li> <li>I think because you live here, you hate to see lakes fill with silt. Things erode, so you're always connected that way. (ECW)</li> </ul>
	Next Generation	<ul style="list-style-type: none"> <li>I have to drink it. I have grandchildren and our water source is our own private well. The days of having your well placed downstream or downslope of the old cattle barn are gone. (RRW)</li> </ul>

Source: Question 23

Table 12. Constraints to nitrogen best management practice adoption

Topic	Constraints	Exemplary Quotes
<b>General Constraints to BMP Adoption</b>	Economics - <i>Implementation costs</i> - <i>Loss of income</i>	<ul style="list-style-type: none"> <li>• If they're getting \$250 or \$300 an acre rent, they aren't going to jump on that if they're only going to get \$100 in a CRP payment—if it's going to be half of what the rental rates are. I'm concerned about the environment, but I'm not going to be generating the rent. (RRW)</li> <li>• Well, I think every farmer at this point right now wants to have every acre to produce. Whether it produces 120 bushel acre corn, you're still going to make some money on it. (RRW)</li> </ul>
	Knowledge - <i>Education</i> - <i>Engagement</i>	<ul style="list-style-type: none"> <li>• Probably third is a basic understanding of soils and hydrogen cycling. I work with a lot of farmers and the ones that are adaptable seem to understand these concepts have a pretty good background. (RRW)</li> <li>• I guess the more education, but there again, how you're going to go about it, I don't know. The only meetings that famers want to go to is if they have to or if they want to. (RRW)</li> </ul>
	Autonomy	<ul style="list-style-type: none"> <li>• Farmers, not only are they reluctant to sell, they're reluctant to give up their power. They want to stay the manager. They don't want to give that up. And that hurts them. (RRW)</li> <li>• I think not everyone is interesting in partnering with someone or giving up some of their input or maybe control. Because, typically when you partner with somebody on a cost share, there's commitments that go along with it. (ECW)</li> </ul>
<b>Two-Stage Ditch</b>	Farm Suitability - <i>Land availability</i>	<ul style="list-style-type: none"> <li>• Yeah. I'd like to do it, but I don't own the land. (RRW)</li> </ul>
	Economics	<ul style="list-style-type: none"> <li>• Two stage ditches are expensive to build, take up a lot of land. (RRW)</li> <li>• No. There's not enough money in the world and look at all the land you take out of production. (ECW)</li> </ul>
	Economics - <i>Maintenance</i>	<ul style="list-style-type: none"> <li>• I think conceptually it's fine, but the maintenance... None of these ditches are maintained now. They all fill up with dirt and they don't work. To actually have a contoured ditch would be that much more maintenance. (ECW)</li> <li>• I could see where the problem would be where you've got deep ditches and suddenly you have to move so much soil. (ECW)</li> </ul>
	Knowledge - <i>Familiarity with BMP</i>	<ul style="list-style-type: none"> <li>• No, I have not heard that term. (ECW)</li> <li>• Two stage? No, I'm not familiar with it. (RRW)</li> </ul>

<b>Alfalfa</b>	Weather Sensitivity	<ul style="list-style-type: none"> <li>I used to always [grow alfalfa], but I don't anymore. It's not profitable. The labor. If you ever get good quality alfalfa, you could maybe make a dollar on it, but it's not worth taking the chance, because of the fact that if you cut the hay down and it rains, it's ruined. It ain't worth nothing. (RRW)</li> <li>If you live in South Dakota where it don't rain all the time, you put up the hay when it's dry and you bail it. Here, you just can't get it all up. It's not a practical thing in this area. If they're lucky, they can get one or two cuttings a year to sell. The other two they feed themselves. (ECW)</li> </ul>
	Economics <i>-Equipment/labor</i>	<ul style="list-style-type: none"> <li>Wider crop rotations are good, no doubt about it. It's whether or not you have the equipment and the capital to do it. Not a lot of alfalfa grown in this area (RRW)</li> <li>Just from the standpoint it's labor-intense and we don't have the equipment to do such and we don't really have a readily available outlet. Most of them are raising alfalfa for their own personal feed needs. There's not a lot of dairy operations around Martin County anymore. A few smaller ones, but those are the ones that are still raising the alfalfa for the most part. (ECW)</li> </ul>
	Market/Demand	<ul style="list-style-type: none"> <li>The problem is, on a large scale, what do you do with all the alfalfa? (ECW)</li> </ul>
<b>Alternative Energy</b>	Farm Suitability <i>-Nutrient loss</i>	<ul style="list-style-type: none"> <li>It'd be a way to pull a lot of biomass off, but if you start harvesting lots of tonnage per acre, you better be realistic about what you have to replace those nutrients with, what that costs and where you're going to get that from. Right now we're taking off the grain and leaving the residues back on the soil and that's a big difference on P and K removal. (RRW)</li> </ul>
	Market	<ul style="list-style-type: none"> <li>Well, I don't think the industry's there, first of all. (RRW)</li> <li>There doesn't seem like there's any real immediate, close proximity market for anything like that, so therefore that's not something we're entertaining by any means. (ECW)</li> </ul>
	Economics <i>-Commodity competition</i>	<ul style="list-style-type: none"> <li>I can't see where you can get that much energy off an acre and make it pay. I don't know where you could use it in this area; land is too high priced, food is too high priced. You gotta maximize your income. I can't see where that switchgrass is ever going to take over. (RRW)</li> </ul>

<b>Bioreactors</b>	Effectiveness	<ul style="list-style-type: none"> <li>I guess the question is: How effective are they? What's the service life of them, the maintenance costs, and things like that? (RRW)</li> </ul>
	Landscape/Farm Suitability	<ul style="list-style-type: none"> <li>We have way too much tile for bioreactors. There's gotta be a better way than bioreactors. Bioreactors work, but on 40 acres or something. I'm talking about tiling 1,000 acres. (ECW)</li> </ul>
	Economics	<ul style="list-style-type: none"> <li>I have a four-year degree. I'm a junior nature lover, I might try it, but it has to work. If you're going to want 50 grand for a pile of woodchips, go to hell. It ain't gonna happen (laughs). (RRW)</li> </ul>
<b>Buffer Strips</b>	Economics	<ul style="list-style-type: none"> <li>Well, every time you buy a piece of land you're paying taxes on all the acreage, even the ones that you're not farming. So profitability goes down when you add a buffer strip. And there are farming programs where, like CRP, but \$300 an acre to \$110 payments is not always practical. (ECW)</li> <li>Do they gotta be 100 feet wide? I'd say, like, 20. You go too far on some of that stuff. 100 feet for a half mile, there's an acre. Forget it. (RRW)</li> <li>Ok, now it comes to, how the hell are we going to pay for it? So, instead of taking complete quarter sections of land out, let's use those dollars and target those areas along the ditches. I can tell you one thing, when you talk about nesting habitat, wildlife, you got the wildlife right there, you got a buffer strip. (RRW)</li> </ul>
<b>Controlled Drainage</b>	Knowledge <i>-Familiarity with program</i>	<ul style="list-style-type: none"> <li>I think there'd be a lot more farmer acceptance on existing systems if there was, unless I'm not aware of it, a cost share on something like that. (RRW)</li> </ul>
	Economics <i>-Labor</i>	<ul style="list-style-type: none"> <li>There you got to have a lot of labor and management involved in that because you gotta be on it. If you aren't gonna be on it and have it managed properly then it's a waste of money. Its labor intensified and I don't know the costs. 'Cause if you aren't going to do it properly, there's no use in doing it. (RRW)</li> </ul>
	Effectiveness	<ul style="list-style-type: none"> <li>I know it's a little more expensive to install, but my question is: do we truly have the data to know that it will be a mechanism for continuing to help us increase crop yields by controlling water that when we need it, like during pollination periods and things like that, that it's there. (RRW)</li> </ul>

	Farm/Landscape Suitability	<ul style="list-style-type: none"> <li>1.2 inches on a 100-foot run. In that sense, we were running an average of 3/10<sup>th</sup> grade on that distance. In essence, we'd have had to have at least six levels of tile in those structures in that field. And if you gotta be able to out and adjust them and farm around them? How are you going to be able to do that? It's a fine thought, but it works on a drawing board. (ECW)</li> </ul>
	Weather Sensitivity	<ul style="list-style-type: none"> <li>You don't know what the weather's going to do for a control structure. You don't know if it's going to rain ten inches tomorrow if you want the water table low. You don't know if you want the water table high. (ECW)</li> </ul>
<b>Cover Crops</b>	Economics <i>-Equipment</i>	<ul style="list-style-type: none"> <li>We don't grow wheat. We don't have that kind of equipment—We don't have that kind of storage. So it wouldn't make sense for us to try it. (RRW)</li> </ul>
	Farm Suitability	<ul style="list-style-type: none"> <li>I don't think corn and soybeans really necessarily need it because most people are doing tillage. If you look at that cornfield, there's a cover crop on there already. It's corn. And even the beans when you look across there. We're not plowing anymore. It's not black. There's something covering it already, so why should we spend the expense? (ECW)</li> </ul>
	Weather Sensitivity	<ul style="list-style-type: none"> <li>If you're south of I-80, I think you're fine. We're too far north. We have too short a growing season and we need every day we can get to grow a crop. If you had grass or winter wheat on a field in the spring, it'd probably take two weeks extra to thaw it out, warm it up. We don't have two weeks extra. That's why, yeah, we see some of that, but it's just not practical to grow the crops that we grow today. (ECW)</li> </ul>
<b>UMN Recommendations for Nitrogen Application</b>	Weather Sensitivity	<ul style="list-style-type: none"> <li>They're generally a low threshold. 7 out of 10 years they'll be fine, but then you get too much rain or whatever and then they're way too low. They're not bad, they're kind of outdated. They're a baseline, but you don't necessarily use them that much. (ECW)</li> </ul>
	Effectiveness	<ul style="list-style-type: none"> <li>Well, that's sort of what my fertilizer guys tell me. They think the University's a little on the low side, so we tend to go a little above that. Not too terribly much but some, you know. (RRW)</li> <li>But I rely, I look at those levels and also my own experience and my retailer and come up with what I feel comfortable with. (RRW)</li> </ul>
<b>Variable Rate</b>	Economics	<ul style="list-style-type: none"> <li>It's going to cost me a lot of money (laughs). A lot</li> </ul>



<b>Technology</b>	<i>-Labor</i>	<p>of money. (ECW)</p> <ul style="list-style-type: none"> <li>I want to see you talk me into going out into my 2-foot corn that starts to need nitrogen after my 8-hour day and have me go over with an 8-row or a 12-row and run my corn over. Ain't gonna happen. I know it doesn't need any nitrogen until it's 2-feet high, but I'll be damned if I'm driving out there. Good luck selling that one. (RRW)</li> </ul>
	Effectiveness	<ul style="list-style-type: none"> <li>We did a project with the University and they weren't really doing what they said they were doing. They'll show you an as-applied map, but that's just what the machine is supposed to be doing; it's not what actually was applied. (ECW)</li> <li>So, my question is: why isn't that crop bigger there? Is it because it was wet early? Because there's a P and K deficiency? Is it nitrogen deficient? Is it lack of water? Are there too many weeds underneath? So why is the vegetative index less robust there than in the other fields? Besides that, in MN, by the time you can see a growth difference or color difference, it's too late. You've already lost your 15 bushel. And that's proven. That's just a fact. (RRW)</li> </ul>
<b>Wetlands</b>	Economics	<ul style="list-style-type: none"> <li>Wetlands is your answer. Well, how much wetlands? Say you take 3,000 acres and turn it back into wetlands. Here's the problem: you're going to have to find them acres someplace, buy them, that ain't gonna be possible. Not in this day and age. (RRW)</li> </ul>
	Autonomy	<ul style="list-style-type: none"> <li>We've got a pothole in the middle of the field, it really is no good for a duck. If it's a wetland, it's not holding water, so it doesn't have that sponge effect. So yeah, let's move that to a corner field alongside a ditch bank or something because if it's sitting on a corner, I'm not going to be plowing it up wasting my time and seed and fertilizer. Now, if I want to do that, NRCS, U.S. Fish and Wildlife, I got to go through four agencies. I'm sure my consulting fee is going to be \$10-20,000. I know we can make better wetlands. If I want to drain 20 acres here, leave 20 acres alongside a wetland, it's going to be a win-win situation for everybody. But the amount of regulation you have to go through is insanity. (RRW)</li> <li>If you wanted to do this, it would take you</li> </ul>

		probably 3 to 4 years. Most farmers just say this is a joke. (ECW)
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Source: Questions 12-17, 19-21, 25

Table 13. Drivers of nitrogen best management practice adoption

Topic	Drivers	Exemplary Quotes
<b>General Drivers of BMP Adoption</b>	Land Stewardship	<ul style="list-style-type: none"> <li>That's why we want trees. We took out a grove, I'm sure I could plow it up, but I kind of want a little native prairie. You can't find a native tree, hardly, anymore. They're all this ornamental foreign garbage (RRW).</li> <li>I think, as a farmer, it's like anything you do in life, we want to try and leave our soil, we want to leave it better than what we got it. There's no doubt about that. I know this farm is going to be left better than I got it. I think that's the goal, it should be, of this generation. (ECW)</li> <li>People don't like to see poor resource management out here, because we're all responsible for our ditches and our road ditches and for our waterways and everything else. It just doesn't look good. It doesn't appear well. It's not good long-term management (RRW).</li> </ul>
	Production	<ul style="list-style-type: none"> <li>I have some land; it's a little rolly, but all the land has got waterways in it. It's got stands in that take the water off the top of the hill and it's all tiled out down below the hill into a main tile. So erosion is not a problem. That cost me thousands of dollars. Thousands and thousands of dollars, but who paid for it? I did. I paid for every bit of it (RRW).</li> <li>Some of them I could cost share, but I just did it out of my own pocket because it's an economic, it comes back to me. I can't have all my soil down there and I can't be migrating through these deep gullies with equipment or combines, I'm just going to wreck stuff (ECW)</li> <li>We have put some land in some CRP...ground that wasn't real productive. (RRW)</li> </ul>
	Economics	<ul style="list-style-type: none"> <li>We don't want to see those nutrients go down the stream. We don't want to see them go down the tile. (ECW)</li> <li>Well, that isn't my primary decision maker, because I know if I manage it for economics, I'm also managing it environmentally. They both walk hand-in-hand, or they both align themselves very well. (RRW)</li> </ul>

	Water Resource Improvement	<ul style="list-style-type: none"> <li>• Are we going to get the Mississippi River or the Minnesota River cleaned up in this generation? Probably not. But if we do better than when we came here, that's a big improvement. We got into a bad situation where everybody was in it for themselves, but if you leave your lot better than what you come in with, it's an improvement. I think that's what we all have to work together for. (RRW)</li> <li>• When I moved to this farm thirty years ago it had twelve open tile intakes. When it rains, the water runs right into that opening. So I got rid of all twelve of those but no one else does. (RRW)</li> </ul>
	Sense of Personal Responsibility	<ul style="list-style-type: none"> <li>• All of ours. All of ours. Everybody's responsibility. The State, farmers, everybody. (RRW)</li> <li>• Well, I think it's...we're all citizens. I think it all of our responsibility. (RRW)</li> <li>• The less government, the better, I'd say. The landowner. (RRW)</li> <li>• Responsibility? I certainly think it relates to land ownership and land management. (ECW)</li> <li>• Everybody's. Absolutely everybody. We're willing to do our best to protect that as well. That is going to become the most precious resource of any going forward along with clean air to breathe. Those things are the most important things. (ECW)</li> <li>• And any little thing you can do to help, you should be doing. (RRW)</li> </ul>
<b>Buffer Strips</b>	Tradition	<ul style="list-style-type: none"> <li>• But even when I was growing up, we always left a filter strip. All the time. I mean, now they come out, "You gotta leave your filter strip." Well, heck, I don't know who wouldn't want to leave a filter strip. (ECW)</li> </ul>
	Economics	<ul style="list-style-type: none"> <li>• A lot of these ditch banks were clay, not the highest producing spots. Here you could put a buffer strip in and you'd get a check every month. Two things happening: it produces some income and it helps water quality. (RRW)</li> </ul>
<b>Alfalfa</b>	Farm Suitability	<ul style="list-style-type: none"> <li>• I needed it for the livestock. (RRW)</li> </ul>
	Economics	<ul style="list-style-type: none"> <li>• It's a nice cash crop if you don't mind the work. (ECW)</li> <li>• If we could make money growing alfalfa and have some assurance that we could get it up in good shape, it would be a great third crop. Nothing better. Especially with the Round-Up ready alfalfa. (ECW)</li> </ul>

<b>Bioreactors</b>	Effectiveness	<ul style="list-style-type: none"> <li>Some of those are a good idea. We can't afford to pay for them, but if there's help... Take away some direct payments and start doing some projects. You could put that on one county tile and affect 2600 acres with one project. (ECW)</li> <li>You've got this big flush, maybe with controlled drainage. Put the two together, it might fit. (ECW)</li> </ul>
<b>Variable Rate Technology</b>	Effectiveness	<ul style="list-style-type: none"> <li>It's a good deal, I guess. I would think it's putting the nitrogen where it belongs. For me to do it on my own would be cost prohibitive, but if the co-op had it I'd probably use it. (RRW)</li> <li>If you justify the amount of acres, there's nothing better than variable rate technology. It's coming. It's going to be more and more all the time. (ECW)</li> </ul>
<b>Alternative Energy</b>	Production	<ul style="list-style-type: none"> <li>Someday, hopefully, we have more crops. We need another crop to take pressure of corn and soybean markets. Those guys that grow beets or other things for a third crop, their corn and soybeans are much better because they're eliminating pests, insects, funguses, diseases. If you can break that up with a different crop, you're better off all the way. I think everybody wants another crop. (ECW)</li> </ul>
<b>Cover Crops</b>	Economics	<ul style="list-style-type: none"> <li>I think it's a good idea and that is a way that farmers could make a little more profit off the land. I think it's a good idea, but like I said, limited knowledge about it. Not a lot of farmers do it out here. (RRW)</li> </ul>
<b>UMN Recommendations for Nitrogen Application</b>	Effectiveness	<ul style="list-style-type: none"> <li>The University's been growing crops for 150 years. They know exactly what it takes for 200-bushel corn. (RRW)</li> <li>We continue to learn. We continue to use research, both generated privately and publicly through our university system to try to make good decisions. A lot of this stuff we can't get at unless we have public researchers doing replicated, randomized, actual research out there. (RRW)</li> </ul>
<b>Wetlands</b>	Effectiveness	<ul style="list-style-type: none"> <li>I've got one landlord that did restoration years ago. Those are good because if you can hold the water when you get the heavy rains and hold the surface runoff, it's better for everything. (ECW)</li> </ul>
	Economics	<ul style="list-style-type: none"> <li>I was losing money on every acre I farmed of those wetlands. By restoring them into wetlands, I don't have to farm them, they get paid, there's no pollution, they're storing up water, they're</li> </ul>

		great for wildlife. (RRW)
<b>Two-Stage Ditch</b>	Effectiveness	<ul style="list-style-type: none"> <li>Ok, that makes sense. I can't picture one, but I can picture the process and that's something that makes sense. (RRW)</li> <li>I'm not really familiar with that, but I can see that could be helpful. (ECW)</li> </ul>
<b>Controlled Drainage</b>	Effectiveness	<ul style="list-style-type: none"> <li>Controlled drainage is, I think, the next, 21<sup>st</sup> century revolution because you can encapsulate the nutrients that are normally flushed down through your drain tile. (ECW)</li> </ul>
	Economics	<ul style="list-style-type: none"> <li>I'm excited about that because last year was a good examples of where we had way too much water at the beginning and if I could have shut off my system, I probably could have gained \$30,000 to \$40,000 of income. (RRW)</li> <li>I look at it as definitely added cost, but as long as it's documented, you're going to get it back someday, or my kids will when they sell the land. It makes it worth that much more money. (ECW)</li> </ul>

Source: Questions 12-17, 19-21, 25

Table 14. Best management practice adoption

	<b>Rush River</b>	<b>Elm Creek</b>	<b>Total</b>
Buffer/filter strips	11 (73%)	13 (87%)	24 (80%)
UMN recommendations for nitrogen application	9 (60%)	7 (47%)	16 (53%)
Variable rate technology	6 (40%)	5 (33%)	11 (37%)
Wetlands	7 (47%)	3 (20%)	10 (33%)
Alfalfa	7 (47%)	3 (20%)	10 (33%)
Controlled drainage	3 (20%)	1 (7%)	4 (13%)
Cover crops	4 (27%)	0 (0%)	4 (13%)
Bioreactor	0 (0%)	1 (7%)	1 (3%)
Alternative energy	0 (0%)	0 (0%)	0 (0%)
Two-stage ditch	0 (0%)	0 (0%)	0 (0%)

Source: Questions 19 & 20

Table 15. What participants have heard about various BMPs

BMP	Nothing or very little		Heard of BMP		Participants have heard of BMP (%)
	Rush River	Elm Creek	Rush River	Elm Creek	
Buffer/filter strips	0	0	15	15	100
Alfalfa	0	0	15	15	100
Alternative energy	0	0	15	15	100
Cover crops	0	0	15	15	100
Wetlands	0	0	15	15	100
UMN recommendations for nitrogen application	1	1	14	14	93
Variable rate technology	4	1	11	14	83
Controlled drainage	5	1	10	14	80
Bioreactors	8	2	7	13	66
Two-stage ditch	10	9	5	6	37

Source: Question 20

Table 16. Barriers to best management practice adoption (focus groups)

Topic	Constraints	Exemplary Quotes
<b>General Barriers to BMP Adoption</b>	Economics	<ul style="list-style-type: none"> <li>Probably the number one [constraint] is the economics of corn price where it is. The corn acres going in compared to any other crop is probably the driving force. (ECW)</li> <li>The commodity price is what drives the land, isn't it? I mean, there are other factors, but [prices] are driven hugely right now by what the land can make, and that's commodity prices. (ECW)</li> <li>There are CRP contracts coming up that aren't going to be re-assigned because corn is \$7 and land is \$8,000 an acre. (RRW)</li> </ul>
	Farm Culture	<ul style="list-style-type: none"> <li>There is a certain cultural view out there, I think it's a little more older generation. "This land needs to be black, needs to be farmed, needs to be productive." (ECW)</li> <li>I think its status quo, at times. People are just used to doing it. That's the way they've done it, why change? (ECW)</li> <li>And there's a cultural view, too, about water is bad and it should be out of here quick. (ECW)</li> </ul>
	Lack of Education	<ul style="list-style-type: none"> <li>One thing I see is a lack of education;</li> </ul>

		<p>landowners, understanding the impact of their decisions... I don't know how much they understand. (ECW)</p> <ul style="list-style-type: none"> <li>• That's my biggest concern; how to speak and address and influence [landowners] and get that education in. (RRW)</li> </ul>
	Agency Limitations	<ul style="list-style-type: none"> <li>• I'd call that a bureaucratic impediment. Boy, it's bureaucratic, and I'm a person who believes in it. (ECW)</li> <li>• We don't have unlimited resources to do all of this [conservation]. (RRW)</li> </ul>
	Farmer Values	<ul style="list-style-type: none"> <li>• [Farmers] don't care. To be honest, they don't care. (ECW)</li> <li>• What's the driving force that brings them to want to do that? It's a value, right? But if that value is of a lesser value, then why are they going to show up at the meeting? Why are they going to engage in it if it's not a high value to them? (ECW)</li> </ul>
	Regulations/ Enforcement	<ul style="list-style-type: none"> <li>• Lack of muscle in the regulations we have, what we'd like to see done. We don't have the authority to step in. (RRW)</li> <li>• Well, are you going to go monitor tile outlets to meet the regulatory compliance? So you think about the mouth of the drainage system and everybody upstream, how are you going to determine that? (ECW)</li> </ul>
	Drainage	<ul style="list-style-type: none"> <li>• With increased tile drainage and things that are happening, the conservation that we're working on isn't keeping up with the amount of hydrologic changes that are occurring. (RRW)</li> <li>• We all know more tiling is going on. The wheels are moving faster than ever, both with commodity prices and pockets full of money. So how do we mitigate the impacts of water that's moving faster and not the quality we want? (ECW)</li> </ul>
<b>Wetlands</b>	Land/Economics	<ul style="list-style-type: none"> <li>• I put wetlands as being extremely effective at reducing nitrogen, but then being extremely negative on yield. To me, it's got the greatest potential to reduce nitrogen, but it's the least potential to implement unless you have a lot of money to do it. (RRW)</li> <li>• As soon as you talk about wetlands in Minnesota, you've got seven agencies</li> </ul>

		regulating you. (ECW)
<b>Two-Stage Ditches</b>	Economics	<ul style="list-style-type: none"> <li>It's very expensive to build, getting an easement for it, and there are some discussions I've had with people, they're not so certain how effective they are on certain areas. (ECW)</li> </ul>
	Effectiveness	<ul style="list-style-type: none"> <li>And it's fairly new, so how do you know [effectiveness]? (ECW)</li> </ul>
<b>Buffer Strips</b>	Effectiveness	<ul style="list-style-type: none"> <li>You can plant filter strips as far as you want, but if you have 1,000 acres of pattern tiled land and all the tiles run underneath the filter strips, they're not going to work. (RRW)</li> </ul>
<b>Variable Rate Technology</b>	Farm Suitability	<ul style="list-style-type: none"> <li>It's all the bigger operations you see out there. It's probably because the equipment is in the co-ops and the people that hire them are the ones that have more acres. (RRW)</li> </ul>

Table 17. Strategies for best management practice adoption (focus groups)

Topic	Issues	Exemplary Quotes
<b>General Strategies to Increase Adoption of BMPs</b>	Education	<ul style="list-style-type: none"> <li>It seems like we could promote education. It seems like there were quite a few of the BMPs that people were not familiar with. (RRW)</li> <li>I think providing tools for farmers and ag decision makers. If they have a tool that will make their job easier to make those decisions, you always need to strive to find those things. (ECW)</li> <li>Take it township by township, educating these people here. Doing meetings. Had we been doing that for as long as we've been meeting about water quality issues all over... (ECW)</li> </ul>
	Farmer Tailored Programs	<ul style="list-style-type: none"> <li>You have to take different approaches for those different groups – [Farmers] have different drivers that motivate them to do things and different interests. (RRW)</li> <li>Allocate a bit more money for larger operations to do a few more things, but implement a different benefit to some of the smaller farms. Maybe a tax incentive would be more appealing to one versus a cost-share or payment program. (RRW)</li> <li>Make it easy so [farmers] don't have to think about. Something that makes it an easy part of their operation. (ECW)</li> </ul>



	Farmer Tailored Programs (cont'd)	<ul style="list-style-type: none"> <li>• Give [farmers] flexibility on the size and scale. Now, it's not that simple because some of those practices need to be engineered, but there are things they can do on their own. (ECW)</li> <li>• [Farmers are] interested in things they could do on their own. [Things they could] just go out and do when they have time. (ECW)</li> </ul>
	Show Results	<ul style="list-style-type: none"> <li>• There was a farmer who went through all this work. He put a wetland in, control structure, bioreactor. He says, "No one's monitoring. What are the results of what I did?" (ECW)</li> <li>• There are a lot of farmers I've talked to [who say], "Go ahead and monitor whatever you need to do, but I want to see what those results are. I want to know what's going on." (ECW)</li> </ul>
	Identify Innovators	<ul style="list-style-type: none"> <li>• I think it will be easier for [farmers] to accept results from projects from somebody locally, in the same position as them, or someone they know. (RRW)</li> <li>• I hear from producers, "My grandfather was the first to do this." If we could turn that around and say, "Well, you could be the first to install this bioreactor." (ECW)</li> <li>• I think another thing is to identify the innovators within that watershed. You always have the innovators start things and the next people later adopt them. (ECW)</li> </ul>
	Regulation	<ul style="list-style-type: none"> <li>• I say that works when there's a standard. You've got to meet this standard. Then they come together and say, "How are we going to meet that standard?" (ECW)</li> <li>• Independence has a big hand in what happens, but in the end you do have to have some standards. (ECW)</li> </ul>
<b>Wetlands</b>	Conceptualization	<ul style="list-style-type: none"> <li>• To me, that's restoring hydrology. Maybe not pure wetlands, but maybe wetlands on steroids, using that model. (ECW)</li> <li>• One of the things I'd like to see is to stop calling it wetlands and start calling it water storage...storing that raindrop where it falls on that landscape instead of having it more toward the nearest surface water. (ECW)</li> </ul>
<b>Buffer Strips</b>	Marketability	<ul style="list-style-type: none"> <li>• I don't know their effectiveness over some of the other ones [BMPs], but I think it's an</li> </ul>

	Marketability (cont'd)	easier selling point to producers. Granted, they're giving up some land, but it can be minimal and it's an easier sell than building a wetland or putting in a bioreactor. (ECW)
<b>Variable Rate Technology</b>	Experience	<ul style="list-style-type: none"> <li>I think if you have someone working in a co-op who's been doing it for a while and has some experience. That would help. (RRW)</li> </ul>
<b>Other BMPs</b>	Split Application	<ul style="list-style-type: none"> <li>With the newer hybrids, I think farmers are starting to see those new efficiencies and the genetic resistance, a lot healthier root mass on the crops. I think we are seeing more of a switch. Dealerships are actually promoting more of a switch to split application. (ECW)</li> <li>I think that's something farmers can do immediately. It's easy for them to tweak their management to make those chances. Plus, they're going to see it on their bottom line. (ECW)</li> <li>Plus it's probably something they've heard before. (ECW)</li> </ul>
	Collaboration	<ul style="list-style-type: none"> <li>Maybe working with the Corn and Soybean Growers Associations and try to set up projects of local interest. For producers, it might be easier for them to accept information coming from people like them. (RRW)</li> <li>What I think is exciting is, landowners seem really interested in making a change for the positive. I just look at the willingness of people to work together. In the last five, ten years, look at the positive things that have come about. (ECW)</li> </ul>

Table 18. Rankings of biggest barriers to BMP adoption (focus groups)

<b>Barriers to BMP adoption</b>	<b>Elm Creek (n*=11)</b>	<b>Rush River (n=4)</b>	<b>Total (n=15)</b>
Economics	9**	4	13
Landowner education	6	0	6
Absentee landowners	3	0	3
Bureaucracy	2	0	2
Prioritize willing landowners	0	2	2
Lack of statutory framework	1	0	1
Land value	1	0	1
Convince landowners of a problem	0	1	1
Communication	0	1	1

\*n = number of focus group participants

\*\*total number of votes (each Elm Creek participant had 3 votes, each Rush River participant had 2 votes)

Table 19. Rankings of most important strategies for increasing BMP adoption (focus groups)

<b>Strategies for BMP adoption</b>	<b>Elm Creek (n*=11)</b>	<b>Rush River (n=4)</b>	<b>Total (n=15)</b>
Identify innovators	3**	3	6
Make it easier	5	0	5
Prioritized community meeting	4	1	5
Flexibility	4	0	4
Water storage	4	0	4
Pay farmers	4	0	4
Providing tools	3	0	3
Long term planning	2	0	2
Work with corn growers and organizations	0	2	2
Landowner results	1	0	1
Things farmers can do on their own	1	0	1
Threaten with regulations	1	0	1
Monitor/target funding	0	1	1
Promote education	0	1	1

\*n = number of focus group participants

\*\*total number of votes (each Elm Creek participant had 3 votes, each Rush River participant had 2 votes)

Table 20. Concerns about nitrogen impact on water resources (focus groups, combined results)

<b>How concerned are you about the impacts of nitrogen on water resources in the...</b>	<b>Mean*</b>	<b>Not at all</b>	<b>Slightly</b>	<b>Moderately</b>	<b>Very</b>	<b>Extremely</b>	<b>Don't Know</b>
Rush River/Elm Creek watershed	2.77	0	1	2	9	1	0
Minnesota River Basin	2.85	0	0	3	9	1	0
State of Minnesota	2.69	0	0	4	9	0	0
United States	2.77	0	0	4	8	1	0

\*Responses based on a 5-point scale: 0=Not at all, 1= Slightly, 2=Moderately, 3= Very, 4=Extremely

Table 21. BMP effectiveness at reducing water resource impacts (focus group, combined results)

<b>How effective do you think each of the following practices is at reducing the impacts of nitrogen on water resources?</b>	<b>Mean*</b>	<b>Not at all</b>	<b>Slightly</b>	<b>Moderately</b>	<b>Very</b>	<b>Extremely</b>	<b>Don't Know</b>
Using variable rate technology for nitrogen application	3.08	0	1	1	6	4	1
Creating or restoring wetlands	3.00	0	1	3	4	5	0
Following University of Minnesota recommendations for nitrogen	3.00	0	1	2	4	5	1
Planting buffers or filter strips	2.85	0	0	4	7	2	0
Installing bioreactors to drainage systems	2.77	0	2	2	6	3	0
Planting alternative energy crops	2.58	0	0	6	5	1	1
Implementing controlled drainage	2.42	0	1	7	2	2	1
Planting cover crops	2.38	0	4	3	3	3	0
Constructing a two-stage ditch	1.92	0	4	6	3	0	0

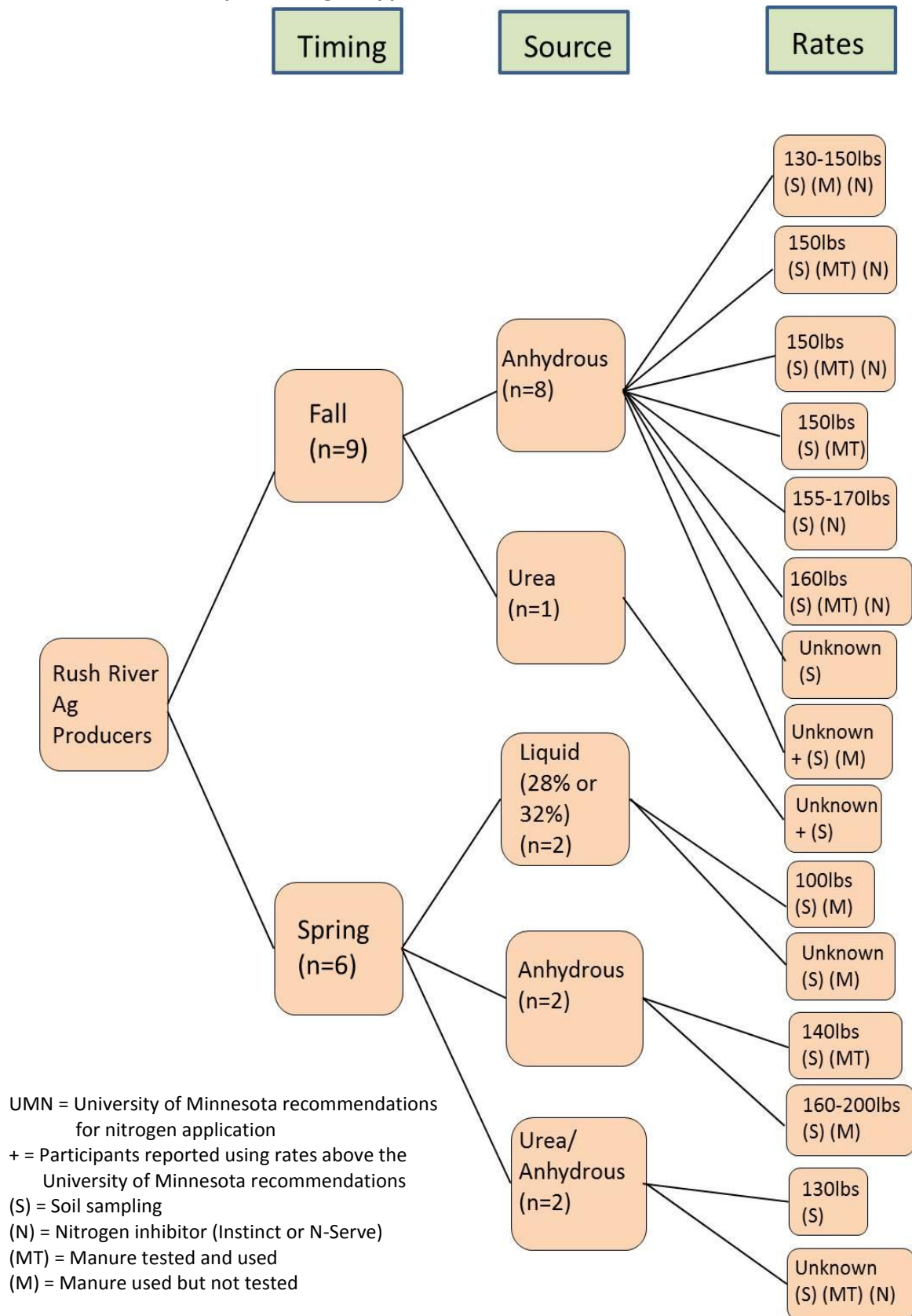
\*Responses based on a 5-point scale: 0=Not at all, 1= Slightly, 2=Moderately, 3= Very, 4=Extremely

Table 22. BMP negative impacts to yield and profitability (focus groups, combined results)

<b>How likely is each of the following practices to negatively affect yield and profitability?</b>	<b>Mean*</b>	<b>Not at all</b>	<b>Slightly</b>	<b>Moderately</b>	<b>Very</b>	<b>Extremely</b>	<b>Don't Know</b>
Creating or restoring wetlands	2.31	0	4	4	2	3	0
Planting alternative energy crops	1.92	2	3	2	4	1	1
Constructing a two-stage ditch	1.85	0	5	6	1	1	0
Planting buffers or filter strips	1.69	2	3	6	1	1	0
Installing bioreactors to drainage systems	1.38	2	6	4	0	1	0
Planting cover crops	1.31	2	7	2	2	0	0
Implementing controlled drainage	1.17	2	8	1	0	1	1
Following University of Minnesota recommendations for nitrogen	.92	4	5	3	0	0	1
Using variable rate technology for nitrogen application	.82	4	6	0	1	0	2

\*Responses based on a 5-point scale: 0=Not at all, 1= Slightly, 2=Moderately, 3= Very, 4=Extremely

## J. Rush River Participant Nitrogen Application Model



# K. Elm Creek Participant Nitrogen Application Model

