FARMER BELIEFS AND PERSONAL NORMS ASSOCIATED WITH NITROGEN BEST MANAGEMENT PRACTICES IN THE RUSH RIVER AND ELM CREEK WATERSHEDS, MN

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Abstract

Nitrogen from agricultural nonpoint source pollution is a primary cause of water quality impairments in the Mississippi River Basin. The cumulative effects of nitrogen loading cause water resource problems at local, regional, and national scales as epitomized by the hypoxic "dead zone" at the mouth of the Mississippi River. Agricultural best management practices (BMPs) designed to reduce nitrogen runoff are promoted across the U.S., yet adoption rates are discouragingly low. This study explores farmer perspectives on BMP adoption using interviews with 30 farmers across two agricultural watersheds in southern Minnesota. The research questions that drove this study are 1) What drives nitrogen best management practice adoption among farmers in the study watersheds? 2) What constrains nitrogen best management practice adoption?, and, 3) What role do personal norms play in influencing best management practice decisions? Study findings suggest that three primary drivers (land stewardship, economics, and personal responsibility) motivate BMP adoption; seven primary constraints (including economics, knowledge, and autonomy) hinder adoption; and egoistic, social/altruistic, and biospheric-driven personal norms play varied and influential roles in BMP adoption. An understanding of how drivers, constraints, and personal norms combine to influence farmer decision-making processes is described using the Norm Activation Theory. These drivers, constraints, and the role of personal norms may prove useful when approaching farmers to participate in conservation programs or in tailoring conservation programs to fit farmers' needs.

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Chapter 1

Introduction

Since the mid-20th century, the modernization of American agriculture has contributed to an increase in water quality impairments. Increased nitrogen fertilizer application has led to increased runoff and leaching which has severely impacted both freshwater and coastal ecosystems. Agricultural best management practices (BMPs) minimize nitrogen losses to water bodies, but adoption rates are low across the U.S. Increasing BMP adoption is a crucial component toward improving the nation's water quality issues. To increase implementation, it is important to understand the drivers of and constraints to farmer adoption of BMPs in order to develop effective conservation strategies.

BMP outreach efforts that accommodate farmer behavioral drivers and constraints may result in increased adoption rates, water quality benefits, and improved relationships with water resource managers. This research explored the drivers of and constraints to farmer adoption of nitrogen BMPs and analyzed the influence of personal norms in the farm decision making process. The Rush River and Elm Creek watersheds in south central Minnesota were selected as research sites because of heavy reliance on agriculture and the prevalence of local water quality impairments. One-on-one semi-structured interviews were used to investigate participant attitudes toward nitrogen BMP adoption and the roles that personal norms played in their farm management decisions.

Nitrogen and Water Quality in the U.S.

The EPA estimates close to 40% of surveyed U.S. waters are too polluted for basic uses like fishing or swimming (EPA, 2012). Approximately two-thirds of coastal rivers and bays in the United States are moderately to severely degraded from eutrophication caused by reactive nitrogen (Howarth, Boyer, Pabich, & Galloway, 2002).While approximately two-thirds of all nitrogen inputs in the U.S. were denitrified or stored in soils and biota, an estimated one-third of reactive nitrogen inputs were exported. The largest pathway of this exported nitrogen is riverine flux to coastal oceans (Howarth et al, 2002). From 1961 to 1997 nitrogen levels carried to coastal zones have nearly doubled (Howarth et al., 2002) The majority of water quality impairments are the result of non-point source pollution, which Arnold (2000) states is, "…now the number one water quality problem in the United States" (p. 1).

The Mississippi River Basin (Appendix A) exemplifies these troublesome issues. The basin is one of the most productive agricultural regions in the world and is the world's third largest drainage basin, emptying approximately 40% of the continental U.S. (Foley, Kucharik, Twine, Coe, & Donner, 2004). However, similar to national trends, pollution loading in the basin is increasing. Nitrogen loads alone have tripled over the past four decades (NRC, 2000). Currently, the Mississippi Basin delivers roughly 1.65 million tons of nitrogen to the Gulf of Mexico each year (Morton & Weng, 2008). In 2008, the hypoxic zone in the Gulf measured 20,720 km^2 (roughly the size of New Jersey) and the five largest "dead zones" have been measured in the last decade (Rabotyagov, 2010). This makes the Gulf "dead zone" the second largest hypoxic zone in the world with multiple ecological impairments including "…accelerated growth of phytoplankton, large-scale depletion of bottom-level oxygen concentrations, degradation of habitat, mass fish migrations, and increased mortality of crabs, worms, and shrimp" (Mulla, 2008, p. 2).

Nitrogen and Agriculture

While nitrogen loading can come from many sources (including natural mineralization, industrial discharge, and urban runoff), agriculture is responsible for over half of all nitrogen contributions (NRC, 2000). In the United States, inorganic fertilizer is the single largest source of reactive nitrogen (Howarth et al., 2002). This is largely attributed to the inefficiency of nitrogen uptake. An estimated 20% of nitrogen fertilizer applied to field leaches into ground and surface waters (Howarth et al., 1996). As water quality has diminished on a national basis, the effects of nitrogen can be seen at the regional and state levels as well. The Upper Mississippi River Basin (UMRB) further exemplifies the connection between nitrogen, agricultural production, and water quality impairments.

The UMRB, which includes parts of Minnesota, Iowa, Illinois, Wisconsin, and Missouri (Appendix B), drains approximately 18% of the entire Mississippi basin but contributes roughly 35% to 43% of the total nitrate loading at the river's mouth (Mulla, 2008; Rabotyagov, 2010). Agriculture is a major cause of non-point source (NPS) pollution in these Midwestern states with fertilizer runoff and leaching as the two main pathways that contribute nitrogen to water bodies (Morton & Weng, 2008; Ribaudo, Delgado, Hansen, Livingston, Mosheim, & Williamson, 2011). The Minnesota River Basin, a major tributary to the Mississippi and the basin containing the watersheds of this research, flows through the heart of southern Minnesota's agricultural region (MDA, 2012). It is also reported to be one of the 20 most polluted waterways in the United States and transports high levels of sediment, phosphorus, and an estimated 80 million pounds of nitrogen per year to the Upper Mississippi River (Lenhart, Brooks, Heneley, & Magner, 2009; Mulla, 2012). These high rates of nitrogen use and impaired water bodies can be attributed to two aspects of modern agriculture: what we grow and how we grow it.

Corn is the most widely produced feed grain in the country with the vast majority produced in the Heartland of the U.S. (Capehart & Allen, 2012). Since the 1960s, American corn production has risen exponentially (Appendix C). Demand for feed grain, ethanol, and industrial uses have pushed corn supply and demand to new levels (Capehart & Allen, 2012). In response, corn acres planted, harvested, and average farm price hit record highs in the 2012 growing season (USDA, 2012). Corn is also the most intensive user of nitrogen on a per acre basis and in total use (Ribaudo et al., 2011). Thus, as corn production has risen dramatically, production of nitrogen fertilizer use has nearly quadrupled throughout the same period (Appendix D). Within the UMRB, Iowa, Illinois, and Minnesota are the first, second, and fourth largest corn producers in the U.S., respectively (USDAb, 2012). In total, the entire Mississippi River Basin produces around 90% of the nation’s corn (NASS, 2012).

The rapid growth in nitrogen use and crop production is a direct consequence of the changes to farming methods that have occurred since the mid-20th century. The Post-WWII application of science and technology to the agricultural realm is responsible for the “Green Revolution” (Cash, 2003). Advances in crop genetics, farm mechanization, fertilizer production and use, and demand for products derived from commodity crops have caused agricultural output to increase exponentially since the mid- to late 20th

century (USDA, 2012). While agriculture's exponential growth has brought many benefits, intense fertilizer regimes, increasing mechanization, and large-scale practices of millions of agricultural producers across the land accumulate and diminish water quality (Morton & Weng, 2008).

Response to Water Pollution

Historically, the U.S. government began responding to public alarm over water pollution in the 1960s culminating in the enactment of the Clean Water Act in 1972 (Morton & Padgitt, 2005). In the decades following, water quality regulation consisted of centralized natural resource decision making to achieve national goals and encourage consistent approaches across the country (Margerum & Whitall, 2004). EPA and state agencies hired scientists, engineers, and lawyers to implement these prescriptive regulations (John & Mlay, 1999). These efforts led to significant reductions in point sources of water pollution (Margerum, 2007).

However, many have noted the infeasibility of applying a prescriptive, point source remedy to the nonpoint source problem of agricultural runoff. Feather and Cooper (1995) note that because NPS is not directly measureable, regulations would consist of expensive management of land and cropping practices. Furthermore, because BMP effectiveness is dependent on a variety of biological, climactic, and geographic variables, tailored management systems would be increasingly expensive. Technical costs are estimated between $2.6 and $3.7 billion, while other initiatives, such as outreach and education, would cause costs to escalate further (Ribaudo et al., 1987). These regulations may also increase tensions between land owners and resource agencies, decrease willingness to participate in voluntary programs, and fail to create conservation ethics and values (Morton & Weng, 2008). As such, alternative strategies must be employed to reduce NPS pollution.

The complexity of agricultural NPS pollution is attributed to a variety of issues. Increasing contaminant loads, a fluctuating agricultural economy, and volatile environmental and political climates are just some of the challenges surrounding NPS remediation. Furthermore, Corbett (2002) notes that sensitive riparian areas often targeted for BMP implementation "lie at the interface of private land and public waterways and represent the essential tension of land management: private utilization of resources versus public stewardship of them" (p. 259). Agricultural runoff is also particularly difficult to pinpoint, monitor, and regulate because of its diffuse origins. This can discourage stakeholders when results of nitrogen reduction strategies are difficult to verify, have long-term response times, and are dependent on environmental variables (Stedman, 2009; Jordan et al., 2011). Current agricultural best management practices (BMPs) are designed to reduce nitrogen loading. However, BMP adoption rates are low and agricultural producers have expressed frustration with current government programs designed to encourage BMP adoption (Corbett, 2002; Skelton & Josiah et al., 2005; Mulla, Kitchen, & David, 2006).

Within Minnesota, Soil and Water Conservation Districts (SWCDs) and the Natural Resource Conservation Service (NRCS) are charged with providing products and services that enable people to conserve, maintain, or improve the Nation's soil, water, and related natural resources on non-Federal lands. In agricultural settings, this consists of encouraging BMP adoption and monitoring/regulating few enforceable statutes (large confined animal feedlot operations (CAFO) stipulations, buffer strips on public ditches, etc.). Since conservation practices are mostly voluntary in nature, nitrogen BMP advocacy becomes a diplomatic endeavor. While regulatory abilities are rare, they nonetheless place staff in the precarious position to monitor and enforce while simultaneously asking producers to implement practices (the success rates of which, owing to a multitude of factors such as weather, soil type, slope, etc., are unpredictable). Economic costs of BMP implementation and insufficient funding for conservation initiatives such as the Conservation Reserve Program further challenge BMP implementation (Napier, 2001; Rabotyagov, 2010).

In sum, nitrogen nonpoint source pollution from agriculture adversely affects water bodies and nonpoint source regulations and economic incentives as well as insufficient levels of voluntary BMP adoption rates have been ineffective at reducing nitrogen loads. The purpose of this research is to understand the motivations of agricultural producers that have adopted voluntary BMPs as well as those who have not. Tailoring conservation practices and programs to incorporate those motivations may increase adoption of conservation programs and practices that are tailored to producer needs. The following research questions explore the drivers and constraints associated with agricultural BMP adoption.

Research Questions

This study investigates the drivers of and constraints to nitrogen best management practice adoption from the perspectives of farmers in two south-central Minnesota watersheds: Elm Creek and Rush River. The research focuses on current issues in agriculture, farm operations, and farmer perspectives on nitrogen and nitrogen BMPs. Three research questions frame this study:

1) What drives nitrogen best management practice adoption among farmers in the study watersheds?
2) What constrains nitrogen best management practice adoption among farmers in the study watersheds?
3) What role do personal norms play in influencing best management practice decisions?

Data were gathered through qualitative methods consisting of interviews with agricultural producers in the two south central Minnesota watersheds. Understanding the drivers of conservation behaviors will provide strategic insight for programs directed toward agricultural conservation. This research aims to bridge the gap between current strategies for promoting BMP adoption and the needs of the farmers who may implement BMPs.

This thesis is organized in five chapters. The first chapter includes an overview of the study including problem statement, background and research questions. Chapter two provides a review of the literature relating to agricultural conservation adoption and offers a theoretical framework for this study. Chapter three justifies the use of a qualitative research approach for this study, describes the data collection and analysis procedures, and examines the validity of qualitative research. Chapter four is presented as a stand-alone journal article with an introduction, literature review, and methods section as well as research findings and discussion sections. Chapter five includes a more in-depth discussion of the study findings and their implications for research and practice.

Chapter 2

Literature Review

Determinants of Agricultural Conservation Practices

Many social science studies have investigated agricultural conservation practices and the multiple factors that influence farmer adoption. A review of the literature highlights several behavioral constructs and antecedent variables that may influence conservation decision making and the adoption of conservation practices. For example, sociodemographic characteristics such as income (Genskow & Prokopy, 2008), gender (Lehman, 1999), and levels of formal education (Parisi, Taquino, Grice, & Gill, 2010; Ribaudo, 1998) have been hypothesized to influence conservation adoption. Researchers also have examined the effect of farm characteristics like size (Rhodes et al., 2002; Buttel et al., 1981; Ryan et al., 2003; Parker et al., 2007), appearance (Ryan et al., 2003; Carr & Tait, 1991; Nassauer, 1988, 1989), and crop diversification (Parker et al., 2007) on farmer decisions to adopt conservation practices.

The influence of economics on decision making also has received much attention. While some research findings point to economics as a driving force (Corbett, 2002; Feather & Cooper, 1995; Lynne, Casey, Hodges, & Rahmani, 1995; Rhodes, Leland & Niven, 2002), other findings question the role economics play. Several studies of landowner attitudes and behaviors suggest that the costs of practices or their effect on land profitability do not have a major influence on conservation decisions or, at minimum, are not the sole driver (Fielding et al., 2005; Rhodes et al., 2002; Ryan, Erickson & De Young, 2003; Schrader, 1995; Skelton & Josiah et al. 2005; Valdiva & Poulos, 2009). Research also has investigated previous experience with conservation practices and programs (Fielding et al., 2005; Ryan et al., 2003), as well as landowner awareness and knowledge of conservation practices (Feather & Cooper, 1995, Valdiva & Poulos, 2009) and programs (Corbett, 2002; Curry 1997; Kollmus & Agyeman, 2002; Nimmo-Bell, 1999; Petzrelka et al., 1996) with varying results. Finally, landowner perceptions of government-sponsored programs (Corbett, 2002; Kraft et al., 1996; Valdiva & Poulos, 2009) may also have an effect on conservation practices.

Altogether, these studies demonstrate that farmer decision making is complex and that adoption behaviors are not adequately explained by any one behavioral construct or antecedent variable. In fact, the influence of many factors like farmer age, farm size, economics, and knowledge has been mixed—some studies reveal positive relationships while others suggest negative or no relationships. Despite this extensive research, quantifiable factors that are consistent predictors of landowner conservation practice adoption across various agricultural landscapes remain elusive (Morton & Padgitt, 2005). Reimer, Thompson, and Prokopy (2012) argue, “Despite decades of research on farmer behavior there remains a need to refine our theoretical base in terms of understanding what factors motivate participation in agri-environmental programs in the United States” (p. 29). These authors suggest that new approaches and theoretical frameworks are needed to explore and develop a more reliable and accurate foundation for understanding farmer motivations.

Environmental Behavior: A Theoretical Framework

Theoretically grounded research on environmental behavior generally has examined conservation actions as either self-interested behavior or norm-driven behavior. For example, the Theory of Planned Behavior (TPB) proposes that decisions are based on a rationalistic, cost-benefit analysis (Ajzen, 1991). TPB has served as the theoretical framework for many studies of conservation behavior (Corbett, 2002; Feather & Cooper, 1995; Fielding et al. 2004, Sutherland, 2012) and agricultural conservation practices in particular (Carr & Tait, 1991; Fielding et al., 2008; Lynne, 1995; Valdiva & Poulos, 2008). In contrast, the Norm Activation Theory (NAT) proposes that altruistic motivation or “the self-expectation process…of helping based on internalized ‘personal norms” is a driver of human behavior (Schwartz, 1977, p. 223).

A handful of studies (i.e. Lokhorst et al., 2011; Olbrich, Quaas, & Baumgartner, 2012; Reimer, Thompson, & Prokopy, 2012; Ryan, Erickson, & DeYoung 2003) have investigated the role of personal norms in agricultural conservation decision making, but they are relatively scarce and only a fraction of those deal with conservation in the context of the United States. Thus, this study was designed to explore and further develop a theoretical foundation for the influence of personal norms on farmer decisions to adopt conservation practices. Personal norms (PN) are defined by Schwartz (1977) as, “The expectations, obligations, and sanctions…originating in social interaction [and] currently anchored in the self” (p. 223). Norms are constructed in social interaction with significant others and become self-expectations based on internalized values (Schwartz, 1977; Harland, Staats, Wilke, 1999). According to NAT, an individual will act when their personal norms are activated by a situation involving a perception of need. As Harland, Staats, and Wilke (1999) note, “…studying the influence of personal norms can increase our understanding of environmentally relevant behaviors” (p. 2509).

The NAT involves four steps: activation, obligation, defense, and response (Schwartz, 1977). Harland, Staats, and Wilke (2007) summarize the factors that trigger norms in the activation stage: awareness of need (extent to which an individual's attention is focused on the existence of a person or entity in need), ascription of responsibility to self for that need, the ability to provide relief (an individual's perception about the availability of resources and/or capabilities that are required to perform a behavior), and efficacy to alleviate the need (Figure 1). Two other behavioral factors that affect norm activation are awareness of consequences and denial of responsibility (Harland, Staats, & Wilke, 2007). In addition, when an individual is aware of the consequences of their behavior on others, feelings of responsibility and personal norm activation increase (Schwartz, 1977). The obligation step consists of feelings of obligation where pre-existing or situational personal norms are activated. The defense step involves an assessment of costs and probable outcomes and a reassessment of need and responsibility to respond. This step is where activated norms may be "neutralized" by cost and outcome assessments, thereby eliminating action (Schwartz, 1977). The final response step is either action or inaction (Schwartz, 1977). Thus, the NAT postulates that altruistic behavior occurs when personal norms are activated and override the defense step mechanisms.

Thus, norm construction creates self-expectations of moral obligation to act rather than "coldly intellective judgments" of a rational choice model (Schwartz, 1977, p. 234). As Schwartz and Howard (1984) summarize, "Whereas other attitudinal concepts refer to evaluations based on material, social, and/or psychological payoffs, personal norms focus exclusively on the evaluation of acts in terms of their moral worth to the self" (p. 245). Stern et al. (1993) apply the NAT to pro-environmental norms that are motivated by egoistic (concerning the self and/or family), social/altruistic (concerning others), and/or biospheric (concerning the environment) values. Furthermore, they state that motivation (M) for environmental concern results from combining potential adverse consequences (AC) on egoistic (${}_{ego}$), social/altruistic (${}_{soc}$), and biospheric (${}_{bio}$) values (V) (Figure 2).

Figure 1. Harland, Staats, and Wilke's (2007) NAT summary (adapted)

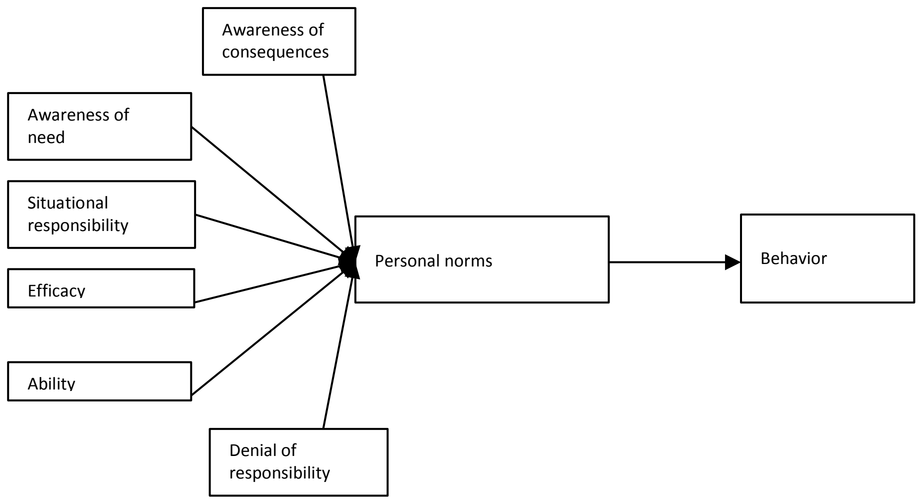
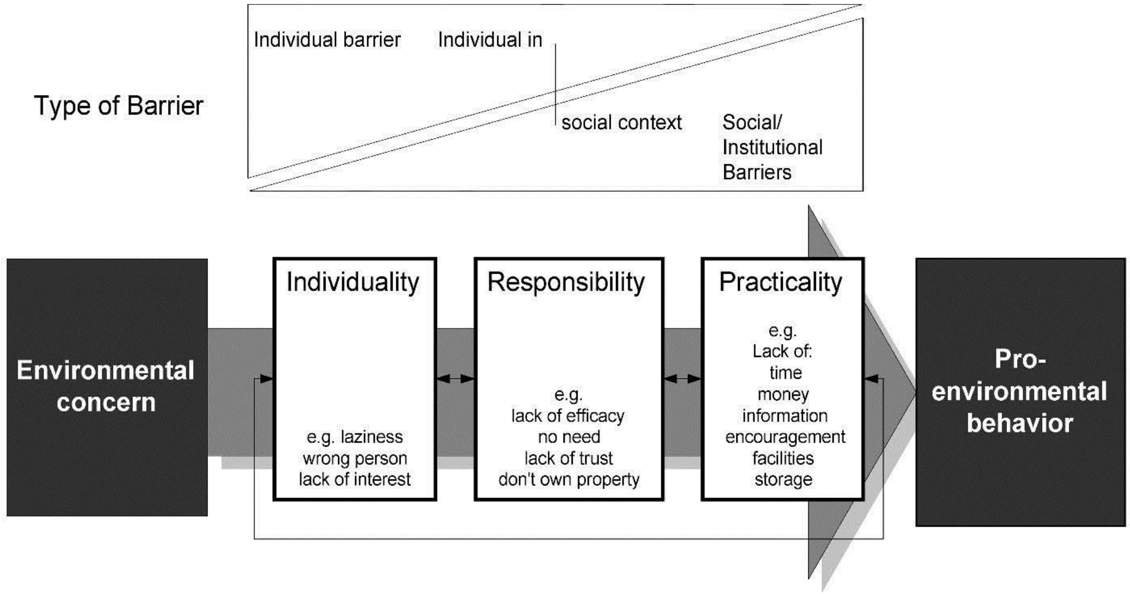


Figure 2. Stern et al.'s (1993) motivation for environmental concern

$$M = V_{ego}AC_{ego} + V_{soc}AC_{soc} + V_{bio}AC_{bio} ,$$

Harland, Staats, and Wilke (1999) acknowledge Stern’s categorizations as “closely related to Schwartz’s (1977) conceptualization of personal normative influence” (p. 2508). Blake (1999) cites the concept of environmental concern as the prerequisite for environmental action in his Value-Action Gap Model (Figure 3). The model also includes other elements of the NAT, such as responsibility to act, ability to act, and the efficacy of the action.

Figure 3. Blake's (1999) Value-Action Gap model



NAT is a well-respected theory of social behavior. Studies of various environmental issues associated with toxic chemical release (Vandenbergh, 2005), off-road vehicle impact on seashores (Noe, Hull, & Wellman, 2009), and curbside recycling (Guagnano, Stern, & Dietz, 1995) have used NAT to understand human behaviors. The theory has also been used to account for moral drivers in past studies (Harland, Staats, & Wilke, 1999; Johansson & Heningsson, 2011; Parker, Manstean & Stradling, 1995; Wall et al, 2007).

In summary, study results have been mixed as to which factors positively influence farmers' conservation adoption behaviors. Furthermore, much of the literature addresses *what* factors influence conservation adoption (i.e. awareness of programs and economic incentives), but few delve into *why* farmers were motivated to act. Two theoretical frameworks for understanding motivations for environmental behaviors provide a more holistic understanding of why farmers choose to adopt or not adopt agricultural conservation practices. TPB views environmental behavior as rationally motivated, grounded in self-interests. This study was guided by the notion that agricultural conservation practices are not predominantly a self-interested behavior but are also driven by personal norms consistent with the Norm Activation Theory.

Chapter 3

Methods

Three primary research questions drove this thesis: 1) What drives nitrogen best management practice adoption among farmers in the study watersheds? 2) What constrains nitrogen best management practice adoption among farmers in the study watersheds? and, 3) What role do personal norms play in influencing best management practice decisions? The researchers decided to use qualitative methods because of the in-depth and investigative nature of the research topic. One-on-one interviews were conducted with 30 agricultural producers (15 in each watershed) addressing the three research questions. Qualitative analysis procedures were used to identify themes and assess the drivers and constraints for farmer adoption of nitrogen BMPs. Sociodemographic information was collected in the form of a questionnaire accompanying the interview and adoption of BMPs was tallied on a BMP implementation checklist during the interview.

While several studies have examined BMP adoption and conservation behaviors of agricultural producers, few have used qualitative methods to describe the motivations and constraints from the producers' points of view. The following sections will explore the key tenets of qualitative research, address qualitative research validity, outline the procedures of the interview and data collection process, provide watershed and participant profiles, describe data analysis procedures, and address the generalizability and limitations of the data.

Qualitative Research Methods

"The power of social science," states Bernard (2005), "comes from the scientific method in which ideas are put forward, tested publicly, and replaced by ideas that produce better results…social science knowledge, like that of any science, can be used to enhance our lives …" (p. 17). Bernard (2005) argues that developing theory is a qualitative process of expressing ideas about cause and effect based on insight: "*Testing* causal statement – finding out *how much* they explain rather than *whether* they seem to be plausible explanations – requires quantitative observations. But theory construction – explanation itself – is the quintessential qualitative act" (Bernard, 2005, p. 68). Qualitative data collection is well-suited for investigating farmer beliefs and motivations concerning BMP adoption. As Mack, Woodsong, MacQueen, Guest, and Namey (2005) state,

> The strength of qualitative research is its ability to provide complex textual descriptions of how people experience a given research issue. It provides information about the "human" side of an issue …the often contradictory behaviors, beliefs, opinions, emotions, and relationships of individuals (p. 1).

Furthermore, Drury, Homewood, and Randall (2010) state that qualitative data is necessary to understand the "…categories, processes, relationships, and perceptions…" which strengthen the validity of the research (p. 14). Drury et al. (2010) also claim qualitative research as a "… valuable and valid approach to matters critical to conservation research and to designing successful conservation initiatives" (p.14).

Three primary methods of qualitative research are participant observations, in-depth interviews, and focus groups (Mack et al., 2005). Participant observation involves observation and/or participation in the study community's daily activities in locations relevant to the research questions. As Bernard (2005) explains, the goal of participant observation is to experience "the lives of the people you are studying as much as you can" (p. 344). This includes the actions, traditions, participant social/cultural interactions, and other experiences that provide insight into the lives of the participants. In-depth interviews consist of the researcher posing questions (usually based on an interview guide) to the participant in a neutral manner, listening and taking notes (and/or audio recording), and asking follow-up questions and probes based on those responses. Probes are interview techniques that elicit more information from a participant without injecting personal bias. Probing strategies can range from keeping silent and allowing the interviewee to reflect and continue to simple verbal encouragement such as "Uh-huh," or "Tell me more" (Bernard, 2005). Interviews are an effective way to compile individual perspectives and connect them to larger issues. A focus group is comprised of usually one or two researchers and several participants meeting together to discuss a research topic. Focus groups are usually recorded and are effective at providing large amounts of information involving identification of social norms, stakeholder interactions, and ranges of perspectives within a community.

Qualitative methods are well suited to the open-ended research questions posed by this study. As the drivers, constraints, and personal norms concerning BMP adoption explore the "human side" of conservation practices, participant interview responses can be analyzed through behavioral models and provide further insight for future research.

Validity of Qualitative Research

Social sciences are often confronted with questions of legitimacy and validity. As Drury et al. (2010) state, "A fundamental problem is that the research process involves human relationships similar to those under investigation…" (p. 23). Human biases and attitudes can affect qualitative (as well as quantitative) research via selective observation and/or recording of data and interpretation of the data. Johnson (1997) defines research validity in qualitative research as something that is "…plausible, credible, trustworthy, and, therefore, defensible." (p. 23). Johnson (1997) lists descriptive validity, interpretive validity, theoretical validity, and internal validity as crucial components of maintaining overall research integrity. Descriptive validity refers to factual accuracy of accounts and descriptions. Interpretive validity concerns the accurate portrayal of the participants' thoughts, experiences, and intentions by the researcher. Theoretical validity, either referencing previous theory or establishing new claims, refers to how a phenomenon operates and why it operates as it does. Finally, internal validity refers to the justification of concluding that a relationship is causal.

Data reliability and validity are further described by Bernard (2005). Reliability refers to getting the same results when measuring the same data more than once with the same instrument. In this study, the interview guide is considered reliable if a participant is asked the same questions and gives the same answer (generally). Face validity is an approach based on general consensus among researchers. If, for example, "everyone agrees that asking people 'How old are you?' is a valid instrument for measuring age, then, until proven otherwise, that question is a valid instrument for measuring age" (Bernard, 2005, p.56). Construct validity exists if there is a close fit between the construct it measures and actual observations made with the instrument. Construct definitions such as intelligence, ethnicity, machismo, etc. are difficult or controversial. Part of agreeing that an instrument has construct validity is agreement that the construct itself is valid (Bernard, 2005, p.58). Criterion validity is valid if there is a close fit between instrument results and the results produced by another instrument that is known to be valid.

To ensure unbiased and legitimate research, Johnson (1997) also suggests data triangulation, theory triangulation, methods triangulation, and reflexivity as strategies for responsible data collection and analysis. Data triangulation involves the use of multiple sources of data to understand a phenomenon. In this case, the data "sources" are people and the more diversity across the sample, the better triangulated the research will be. This includes variations of sociodemographics, occupations, geographic locations, and other variables that may contribute to differing views regarding a research topic. Incorporating a broad range of perspectives will provide a greater understanding and comprehension of an issue opposed to limited viewpoints. Theory triangulation involves the use of multiple theories to interpret and explain data. The more theories that are able to explain data, the more valid the research becomes. Methods triangulation is the use of a combination of methods to understand a phenomenon. By combining methods with complimenting strengths and weaknesses (i.e. utilizing focus groups and interviews), the result will be better evidence. Another strategy, deemed reflexivity, is a crucial self-evaluation method in which the researcher reflects on his/her potential biases and predispositions toward the research or participants. By honest identification of these potential predispositions, a researcher can seek to neutralize and/or remedy them in order to prevent data manipulation.

This research attempts to abide by the definition provided by Bernard (2005):

> Ultimately, the validity of any concept—force in physics, the self in psychology, modernization in sociology and political science, acculturation in anthropology—depends on two things: (1) the utility of the device that measures it; and (2) the collective judgment of the scientific community that a concept and its measure are valid. (p. 60)

The interview guide, sociodemographic questionnaire, and BMP implementation sheet are the devices that seek to measure the variables surrounding farmer attitudes and behavioral norms regarding adoption of BMPs.

Instrument Development

The study instruments used in this research were an interview guide, (Appendix I), a sociodemographic information sheet (Appendix J), and a BMP implementation list (Appendix K). The instruments were primarily developed by the two primary social scientists on the project with continuous review and input provided by a project team consisting of agricultural, economic, geospatial analysis, and related literature specialists as well as a representative from the Minnesota Pollution Control Agency. The interview guide was approved by the University of Minnesota Institutional Review Board (IRB)

The interview guide was focused around the three main research questions in their respective order: (1) What drives nitrogen best management practice adoption among farmers in the study watersheds? (2) What constrains nitrogen best management practice adoption among farmers in the study watersheds? and, (3) What role do personal norms play in influencing best management practice decisions? Three Minnesota farmers were interviewed with the guide to test for potential problems regarding clarity of language and research questions. The order of questions was intended to create open and trustworthy interactions with the first section allowing farmers to "warm up" to the interview and interviewee before discussing the more controversial topics regarding nitrogen use, BMP issues, and water quality.

The first section explores general topics of likes, dislikes, worries/concerns, and personal meaning participants ascribe to their farms. Section two focused on the ownership arrangements, decision making process, important considerations when making decisions about the farm, challenges toward greater success, and if any changes to the farm operation had occurred in the last five years. The third section focused on important considerations when applying nitrogen, nitrogen use on their operations, manure use, importance of maximizing nitrogen efficiency and minimizing nitrogen impacts to the environment. The fourth and final section asked participants about their use and familiarity with nitrogen BMPs, which BMPs they had not implemented and why, important factors when considering implementing a BMP, constraints to BMP adoption in the area, and the quality of water resources in the area. In addition, participants were asked if there was anything else they would like to comment on or ask questions about, which allowed for insight into categories which may have been left out of the interview guide.

Questions also addressed key aspects of the norm activation theory as suggested by the literature. The question, "How would you describe the quality of the groundwater, streams, and lakes in this area?" assessed participant awareness of need. Perception of impaired water resources would indicate the awareness component of NAT was activated. The question, "Whose responsibility is it to keep water resources in this area healthy?" assessed participant ascription of responsibility. Self-ascribed responsibility would indicate the responsibility component of NAT was activated. The question, “Do you have the resources you need to adopt these practices?” assessed participant perceptions of availability of resources and/or capabilities required to act. Efficacy of behaviors was assessed in various questions surrounding BMP evaluation, including, “Is this practice doing what it was intended to do?”, “What do you like about this practice?”, and “What don’t you like about this practice?” “How important is it to you to minimize the potential impacts of nitrogen on the natural environment?” assessed participant awareness of adverse consequences (an element of Stern et al.’s (1993) environmental concern) of water pollution. A high level of importance of minimizing nitrogen impacts and supporting reasons would indicate an activated awareness of consequences component of the NAT. Finally, “What is your connection to the water resources in this area?” assesses the value component of Stern et al.’s (1993) environmental concern. Responses describing various personal connections to water resources would indicate high values placed on water resource health.

The sociodemographic questionnaire addressed data deemed relevant by previous studies regarding farmers and conservation behavior. Data were collected on the number of years the participant has lived in the community and has farmed, how long the farm has been in the participants family, crops grown, crop rotation, distance from home to farm, ownership arrangements of the farm, size of the farm, involvement in farming-related organizations, gender, age, formal education achieved, percent of income dependent on land, and household income before taxes in 2010.

The BMP implementation list was developed by the primary social researchers and approved by the research team. BMPs were chosen from relevant literature and the advice of the project team. The instrument consisted of each BMP, a brief description of its structure and purpose, and whether or not the practice had been adopted.

Field notes were also taken during and after the interviews to document situational impressions, contexts, and interactions with participants. While these notes were not included in the transcription, analysis, and coding processes, they were nonetheless valuable as reminders of subtle intonations, meanings, and attitudes that were observed during interviews.

Recruitment

A stakeholder inventory was compiled consisting of agricultural producers within the Rush River and Elm Creek watersheds. Resource professionals and agricultural experts from the Soil and Water Conservation Districts, Natural Resource Conservation Services, Minnesota Pollution Control Agency, Board of Water and Soil Resources, Minnesota Farm Bureau, Minnesota Department of Agriculture, and a non-profit group were contacted for participant referrals. Potential interviewees were also referred by study participants, a process known as the chain referral or "snowball" sampling. In total, the names of 38 Rush River watershed farmers and 47 Elm Creek watershed farmers were gathered. From the Rush River watershed, 28 farmers were contacted, 15 of whom agreed to be interviewed. Nine farmers were unable to be reached despite repeated attempts and four declined to be interviewed. From the Elm Creek watershed, 31 farmers were contacted, 15 of whom agreed to be interviewed. Twelve farmers were unable to be reached despite repeated attempts and four declined to be interviewed.

Participants were recruited by telephone using a predetermined script which described the purpose of the study, the participation process and expectations, and how the data would be used (Appendix L). Interviews were conducted at participants' homes or their place of business. Before the interview, participants were given an informed consent form and briefed on the research background information, procedures, risks and benefits of participation in the study, confidentiality, the voluntary nature of the study, and contact information for the primary researcher and the Research Subjects' Advocate Line (Appendix M). Participants were given the option to have their interviews audio recorded and their statements used in the final report.

Study Watersheds

The two watersheds studied in this research are the Rush River watershed and Elm Creek watershed, both of which are located in south central Minnesota (Appendix E). The south central Minnesota agriculture district was selected because of the predominance of cultivated crops as land use cover and nutrient loading pollution of area water bodies. While Total Maximum Daily Loads (TMDLs) across the state are still being assessed by the Minnesota Pollution Control Agency, the Rush River and Elm Creek are recognized as impaired waters by both government and independent assessors (Lenhart et al., 2010; MPCA, 2012; MSU, 2006). Located in the Minnesota River Basin (Appendix F), these area water bodies eventually flow to the Mississippi River, thereby transporting nutrient pollution to regional and national waters. Both of the watersheds selected were of Hydrologic Unit Code (HUC) 10 size, which categorizes them as covering approximately 40,000 – 250,000 acres. Size selection was based on population to ensure sufficient participation as well as comprising a large enough area to encompass multiple sociodemographic and environmental variations.

Rush River Watershed

The Rush River watershed comprises 22% of the land area of the HUC-8 Lower Minnesota River watershed, a sub-basin of the Minnesota River Basin which joins the Mississippi in the Twin Cities metro area (Appendix G). The Rush River watershed drains approximately 257,770 acres across Sibley (74% of watershed), Nicollet (24% of watershed), and McLeod (2% of watershed) counties in south central Minnesota. The north, middle, and south branches of the river total 50 miles before draining into the Minnesota River south of Henderson, MN. An additional 500 miles of public open ditches, several miles of tile lines and an estimated 7,000 open tile intakes drain into the river. An estimated 9,010 people live in the watershed with 55% of the population living in the municipalities of Gaylord, Lafayette, Gibbon, and Winthrop. Ninety percent of the land is used for agricultural production of crops such as corn, soybeans, small grains and forage (Sibley County, 2008). Sibley ranks seventh among Minnesota counties in poultry production and Nicollet ranks fourth and seventh in poultry production and overall livestock, respectively (MDA, 2009; MDA 2009b).

Elm Creek Watershed

The Elm Creek watershed is located within the HUC-8 Blue Earth River watershed and joins the Blue Earth River south of Winnebago, MN. The Blue Earth River continues to flow north and joins the Minnesota River at Mankato, MN (Appendix H). The Elm Creek watershed drains approximately 185,380 acres across Jackson (29% of watershed), Martin (69% of watershed), Faribault (1.5% of watershed) and Cottonwood and Watonwan Counties (each less than 1% of watershed) along the southern border of Minnesota. The Elm Creek flows west to east with the north fork (5.4 miles) and the south fork (16.4 miles) joining at the mainstem and all combining for a length of 87 miles

(MN River Basin Data Center). Land use is 90% agricultural with Martin County ranked as first and second in hogs and corn, respectively, among all Minnesota counties (MDA 2009c). Demographic data specific to the watershed boundaries were unavailable, but the population of Martin County, which comprises the majority of the watershed, was estimated at 20,689 (U.S. Census, 2011). Major municipalities within the watershed include Trimont, Northrop, and Granada.

Participant Profile

Participants

Gender, age, and race of farmers in both the Rush River and Elm Creek watershed are reflective of the average American farmer according to the 2007 Census of Agriculture. Of the 2.2 million farms in the United States, 1.83 million have a white male principal operator averaging 57 years of age (AgCensus, 2007). Of the 15 Rush River participants, all were white, 14 were male, and the median age was 57. Of the 15 Elm Creek participants, all were white, 14 were male, and the median age was 63 (Table 1).

Table 1: Participants' gender and age

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

Respondent Age	**Rush River**	**Elm Creek**	**Overall**
Min	47	42	42
Max	80	73	80
Median	57	63	57

Participants varied from the national average in total household income and percentage of income dependent on land. Most U.S. farms are small (60% report less than $10,000 in annual sales) and average 418 acres (AgCensus, 2007). Over half of Rush River and Elm Creek participants reported over $100,000 from all income sources before taxes in 2010 (Table 2).

Table 2: Participants' income and percentage of income dependent on land

Respondent Income	Rush River		Elm Creek		Overall	
	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

The majority of total producers (70%) owned and managed their own land and rented land from another (Table 3). Respondents' property size was evenly distributed with 33% claiming less than 500 acres, 33% with 501-1000 acres, and 33% with 1001 or more acres overall. Median farm size for Rush River and Elm Creek farms was 600 acres and 900 acres, respectively. Farms ranged from 120 to 6,400 acres (Table 3).

Table 4 shows several other farm characteristics that were similar between the two research watersheds. Rush River participants have lived in their community an average of 50 years and with Elm Creek participants averaging 54 years. Rush River and Elm Creek participants averaged 35 and 38 years farming experience, respectively and both watersheds had similar longevity of farm duration with Rush River farmers averaging 90 years and Elm Creek farmers averaging 81 years of the farm being in the family. Most participants lived close to their farms averaging less than five miles from residency to the farm (Table 4).

Table 3: Participants' ownership arrangement and property size

Response	**Rush River**		**Elm Creek**		**Overall**	
	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 *from* another	9	60	12	80	21	70
Own and manage and rent to *and* from another	3	20	0	0	3	10
Other	1	7	0	0	1	3
Total	15	100	15	100	30	100

Respondent Land Size	**Rush River**		**Elm Creek**		**Overall**	
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

	Rush River	Elm Creek	Overall
Min	120	280	120
Max	2000	6400	6400
Median	600	900	650

Table 4: Participants' farm characteristics

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

BMP adoption rates varied significantly across the two watersheds. Farmers in the Rush River watershed reported adoption of 47 BMPs (3.13 per farmer) while Elm Creek farmers reported adoption of 32 BMPs (2.13 per farmer) (Table 5).

Table 5: BMPs adopted

Number of BMPs Adopted	Rush River Participants	Elm Creek Participants	Total BMPs Adopted
0	0	1	0
1	1	5	6
2	7	4	22
3	2	3	15
4	1	1	8
5	2	0	10
6	2	1	18
Total:	47	32	79

Data Analysis

Bernard (2005) defines analysis as: "the search for patterns in data and for ideas that help explain why those patterns are there in the first place" (p. 452). Grounded theory was used to extract and code data relating to the three primary research questions. Grounded theory is a well-known qualitative analysis method and has been used in a variety of studies including family research, student epistemological perspectives, and radical changes in governance (Kezar, 2005; LaRossa, 2005; Palmer & Marra, 2004). According to Corbin and Strauss (1990), grounded theory is a "… methodology for developing theory that is grounded in data systematically gathered and analyzed" (p. 273) Thus, "…data form the foundation of our theory and our analysis of these data generates the concepts we construct" (Charmaz, 2006, p. 3).

Constructing a grounded theory consists of several stages of data analysis and categorization. Ryan and Bernard (2003) include discovering themes and subthemes, deciding which themes are important to the project, building hierarchies of themes, and linking themes to theoretical models. Identifying initial themes and subthemes is accomplished through a coding process. Coding involves the categorization of data according to subthemes that reflect how a researcher selects, separates, and sorts data (Charmaz, 2006). Proper coding establishes the critical link between collecting data, analysis of data, and the development of theory to explain data (Charmaz, 2006). Strategies for identifying themes and subthemes are to identify repetition, slang, metaphors or analogies, missing data, and theory-related material within the data collected (Ryan & Bernard, 2003). Explanation of how the themes are related to each other uncovers the deeper or multiple meanings of the data (Bernard, 2005).

Charmaz (2006) identifies three phases of grounded theory coding: initial coding, focused coding, and theoretical coding. Initial coding involves the study of fragments of data (words, lines, segments, and incidents) for their analytical importance. Focused coding is the selection of the most useful initial codes and testing them against extensive data. Theoretical coding involves conceptualizing how the focused codes relate to one another as potential theoretical hypotheses (Charmaz, 2006, p. 63). In addition, there are two types of coding: inductive (or "open") and deductive. Inductive is used in the discovery phase of a research project to identify themes whereas deductive coding is used in the confirmatory stage of research. To identify themes in the data, this research used a method similar to that suggested by Wilms et al. (1990) and Miles and Huberman (1994). This method involves beginning analysis with general themes provided by relevant literature and developing additional themes and subthemes throughout. Thus, a researcher balances between inductive and deductive reasoning as major themes are identified and new themes emerge (Miles and Huberman, 1994).

Interviews were audio recorded and transcribed verbatim using Olympus DSS Player Standard Transcription Module Version 1.0.2.0. Qualitative data derived from transcriptions were analyzed and coded using QSR NVivo 9.0. Quantitative statistics were analyzed using Statistical Package for Social Sciences (SPSS release 17.0).

Generalizability and Limitations

As in every study, potential errors and limitations may be problematic. Sampling errors may have occurred if important or dissenting agricultural producers were not included in the initial stakeholder inventory process. Because names were gathered from mostly government organizations, the participants may have preexisting connections that could have influenced their responses and experiences with nitrogen BMPs. Efforts were made to address this by using the “snowball” method of sampling in hopes farmers would recommend others with weaker ties to conservation agencies, but few participants referred other farmers and of those, only one additional participant agreed to an interview.

The subtleties of agriculture also prompted alteration of the sociodemographic questionnaire. Question 8 of the original document asked producers to describe the size of their current land/property within six categories: under 1 acre, 1-5 acres, 6-20 acres, 21-50 acres, 51-150 acres, or 151 acres or more. It was quickly realized that the selected ranges were inadequate for accurately portraying the spectrum of farm sizes within our sample study as only one participant had less than 150 acres. This question was modified to ask: “Approximately how many acres is your land/property?” However, even this was met with confusion as some participants were uncertain if the question related to how many acres they owned or how many acres they farmed. Luckily, farm acreage was described in other parts of the interview with those participants who received the pre-modified questionnaire and no data was missed. In retrospect, two questions (one regarding size of property owned and one regarding size of property farmed) would have provided even further insight. Similar to Question 8, Question 7 also required alteration. The original questionnaire asked participants what categories best described the ownership arrangement of the land they farm. These parameters were soon realized to be inadequate as many producers engaged in multiple ownership arrangements in which they owned and/or rented to and/or from another party. The categories of question 7 were modified to: I own and manage my own farmland, I rent my farmland to another party, I rent farmland to another party, I own and manage my own farmland and rent farmland *to* another party, I own and manage my own farmland and rent farmland *from* another party, and, Other (please specify). In this way, a more complete understanding of ownership was established. Question 6, "How far is the distance from your home to your farmland (in miles)?" also had some shortcomings. Some farmers operated multiple parcels of land varying in distance from their homes. In these instances, participants either gave a range (i.e. 1-25 miles) or an average distance from home to farmland. However, since the average distance of all participants from home to farm was four miles (including one large outlier of 25 miles), the conclusion is that participants are generally uniform in proximity of residence to farmland. Furthermore, as these questions were largely unrelated to ascertaining the drivers, constraints, and personal norm influence on behaviors, they were mostly inconsequential.

Another limitation of this study is the list of BMPs assessed. Because time, funding, and interview timeliness were limiting agents, the BMP sheet did not include every potential nitrogen BMP. For instance, examples of minimum or conservation tillage was mentioned by some participants as a nitrogen management practice, but tillage practices were not included in our BMP list. Furthermore, drivers of and constraints to these management practices were not addressed or included in this study. This research pertains only to the management practices listed. Further insight into other BMPs must be left to continuing research.

This qualitative research does not attempt to be statistically representative of the opinions of a broader population. A multitude of differences (cultural, climactic, etc.) vary across national, regional, and even sub-state scales. However, the individuals from this study are largely representative of the farmers living and operating in the study watersheds. Participant demographics and similarity of crops grown (i.e. corn and soybeans) strongly resemble national statistics, which may lend these results to wider populations. Thus, while study findings may not be generalizable to all farmers, they may provide insight about what drives and constrains farmer BMP behaviors in similar settings. This study included middle-aged and older participants, farms of varying sizes, ranges of formal education and income levels, and various nitrogen use and conservation practices.

Chapter 4

Understanding farmer attitudes and personal norms associated with nitrogen BMPs

Abstract

This study explores the drivers of and constraints to adoption of nitrogen best management practices (BMPs) by agricultural producers as well as the role of personal norms in influencing decisions concerning best management practices. This study investigates these factors using qualitative research methodology. Interviews with 30 agricultural producers were conducted to examine farmer beliefs and attitudes associated with nitrogen and nitrogen BMPs. The results reveal three primary drivers, seven primary constraints, and expand upon the role of personal norms in influencing farmer adoption of nitrogen BMPs. Understanding the drivers of conservation behaviors will provide insight for outreach, education, and communication programs. This research aims to bridge the gap between current strategies for promoting BMP adoption and the needs of the farmers who may implement BMPs.

Keywords Conservation practice • Nitrogen • BMP • Norm Activation Theory • Agriculture

Introduction

The Mississippi River basin is one of the most productive agricultural regions in the world and empties approximately 40% of the continental U.S. (Foley, Kucharik, Twine, Coe, & Donner, 2004). It also delivers roughly 1.65 million tons of nitrogen to the Gulf of Mexico each year (Morton & Weng, 2008). In 2008, the hypoxic zone in the Gulf measured 20,720 km^2 (roughly the size of New Jersey), making it the second largest hypoxic zone in the world (Rabotyagov, 20120) with multiple ecological impairments including, "…accelerated growth of phytoplankton, large-scale depletion of bottom-level oxygen concentrations, degradation of habitat, mass fish migrations, and increased mortality of crabs, worms, and shrimp" (Mulla, 2008, p. 2).

The Upper Mississippi River Basin (UMRB), which includes parts of Minnesota, Iowa, Illinois, Wisconsin, and Missouri, drains approximately 18% of the entire Mississippi Basin but contributes roughly 35% to 43% of the total nitrate loading at the river's mouth (Mulla, 2008; Rabotyagov, 2010). Agriculture is a major cause of nonpoint source (NPS) pollution in these Midwestern states with fertilizer runoff and leaching as the two main pathways that contribute nitrogen to water bodies (Morton & Weng, 2008; Ribaudo, Delgado, Hansen, Livingston, Mosheim, & Williamson, 2011). Corn is the most widely produced feed grain in the country with the vast majority produced in the Heartland of the U.S. (Capehart & Allen, 2012). Corn acres planted, harvested, and average farm price hit record highs in the 2012 growing season (USDA, 2012). Corn is also the most intensive user of nitrogen on a per acre basis and in total use (Ribaudo et al., 2011). Within the UMRB, Iowa, Illinois, and Minnesota are the first, second, and fourth largest corn producers in the U.S., respectively (USDAb, 2012).

The Minnesota River Basin is located in the heart of Minnesota's southern agricultural region. It is reported to be one of the most polluted waterways in the United States and transports high levels of sediment, phosphorus, and an estimated 80 million pounds of nitrogen per year to the Upper Mississippi River (Lenhart, Brooks, Heneley, & Magner, 2009; Mulla, 2012). Within the state, Soil and Water Conservation Districts and the Natural Resource Conservation Service are charged with providing products and services that enable people to conserve, maintain, or improve the Nation's soil, water, and related natural resources on non-Federal lands. However, the voluntary nature of BMPs, economic costs, and insufficient funding for conservation initiatives such as the Conservation Reserve Program challenge BMP implementation (Napier, 2001; Rabotyagov, 2010).

This study investigates the drivers of and constraints to nitrogen best management practice adoption from the perspectives of farmers in two Minnesota watersheds: Elm Creek and Rush River. Three research questions frame this study:

1) What drives nitrogen best management practice adoption among farmers in the study watersheds?
2) What constrains nitrogen best management practice adoption among farmers in the study watersheds?
3) What role do personal norms play in influencing best management practice decisions?

Literature Review

Determinants of Agricultural Conservation Practices

Many social science studies have investigated agricultural conservation practices and specifically, the multiple factors that influence farmer adoption. A review of the literature highlights several behavioral constructs and antecedent variables that may influence conservation decision making and the adoption of conservation practices. For example, sociodemographic characteristics such as income (Genskow & Prokopy, 2008), gender (Lehman, 1999), and levels of formal education (Parisi, Taquino, Grice, & Gill, 2010; Ribaudo, 1998) have been hypothesized to influence conservation adoption. Researchers also have examined the effect of farm characteristics like size (Rhodes et al., 2002; Buttel et al., 1981; Ryan et al., 2003; Parker et al., 2007), appearance (Ryan et al., 2003; Carr & Tait, 1991; Nassauer, 1988, 1989), and crop diversification (Parker et al., 2007) on farmer decisions to adopt conservation practices.

The influence of economics on decision making also has received much attention. While some research findings point to economics as a driving force (Corbett, 2002; Feather & Cooper, 1995; Lynne, Casey, Hodges, & Rahmani, 1995; Rhodes, Leland & Niven, 2002), other findings question the role economics play. For instance, several studies of landowner attitudes and behaviors suggest that the costs of practices or their effect on land profitability do not have a major influence on conservation decisions or at minimum, are not the sole driver (Fielding et al., 2005; Schrader, 1995; Rhodes et al., 2002; Ryan, Erickson & De Young, 2003; Skelton & Josiah et al. 2005; Valdiva & Poulos, 2009). Research also has investigated previous experience with conservation practices and programs (Ryan et al., 2003; Fielding et al., 2005), as well as landowner awareness and knowledge of conservation practices (Feather & Cooper, 1995, Valdiva & Poulos, 2009) and programs (Corbett, 2002; Petzrelka et al., 1996, Nimmo-Bell, 1999; Curry 1997; Kollmus & Agyeman, 2002) with varying results. Finally, landowner perceptions of government-sponsored programs (Corbett, 2002; Kraft et al., 1996; Valdiva & Poulos, 2009) may also have an effect on conservation practices.

Altogether, these studies demonstrate that farmer decision making is complex and that adoption behaviors are not adequately explained by any one behavioral construct or antecedent variable. In fact, the influence of many factors like farmer age, farm size, economics, and knowledge has been mixed—some studies reveal positive relationships while others suggest negative or no relationships. Despite this extensive research, quantifiable factors that are consistent predictors of landowner conservation practice adoption across various agricultural landscapes remain elusive (Morton & Padgitt, 2005). Reimer, Thompson, and Prokopy (2012) argue, "Despite decades of research on farmer behavior there remains a need to refine our theoretical base in terms of understanding what factors motivate participation in agri-environmental programs in the United States" (p. 29). These authors suggest that new approaches and theoretical frameworks are needed to explore and develop a more reliable and accurate foundation for understanding farmer motivations.

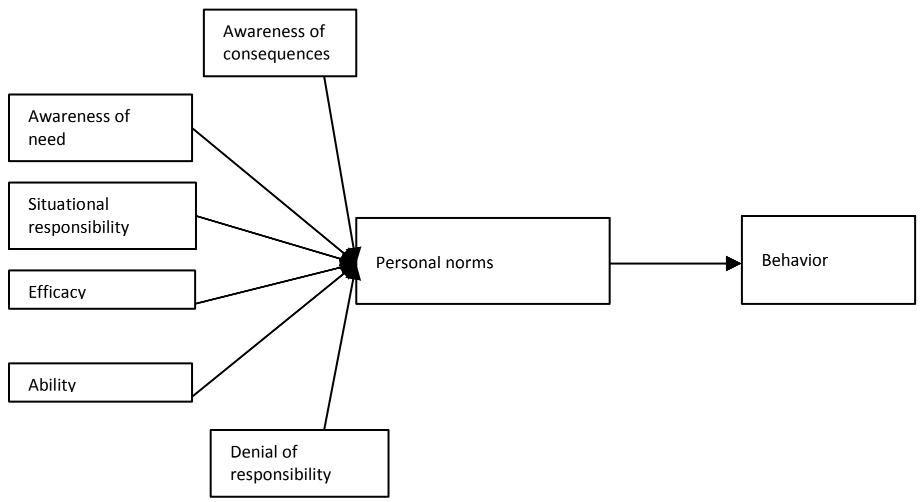
Environmental Behavior: A Theoretical Framework

Theoretically-grounded research on environmental behavior generally has examined conservation actions as either self-interested behavior or norm-driven behavior. For example, the Theory of Planned Behavior (TPB) proposes that decisions are based on a rationalistic, cost-benefit analysis (Ajzen, 1991). TPB has served as the theoretical framework for many studies of conservation behavior (Corbett, 2002; Feather & Cooper, 1995; Fielding et al. 2004, Sutherland, 2012) and agricultural conservation practices in particular (Carr & Tait, 1991; Fielding et al., 2008; Lynne, 1995; Valdiva & Poulos, 2008). In contrast, the Norm Activation Theory (NAT) proposes that altruistic motivation or "the self-expectation process…of helping based on internalized 'personal norms" is a driver of human behavior (Schwartz, 1977, p. 223).

A handful of studies (i.e. Lokhorst et al., 2011; Olbrich, Quaas, & Baumgartner, 2012; Reimer, Thompson, & Prokopy, 2012; Ryan, Erickson, & DeYoung 2003) have investigated the role of personal norms in agricultural conservation decision making, but they are relatively scarce and only a fraction of those deal with conservation in the context of the United States. Thus, this study was designed to explore and further develop a theoretical foundation for the influence of personal norms on farmer decisions to adopt conservation practices. Personal norms (PN) are defined by Schwartz (1977) as, "The expectations, obligations, and sanctions…originating in social interaction [and] currently anchored in the self" (p. 223). Norms are constructed in social interaction with significant others and become self-expectations based on internalized values (Schwartz, 1977; Harland, Staats, Wilke, 1999). According to NAT, an individual will act when their personal norms are activated by a situation involving a perception of need. As Harland, Staats, and Wilke (1999) note, "…studying the influence of personal norms can increase our understanding of environmentally relevant behaviors" (p. 2509).

The NAT involves four steps: activation, obligation, defense, and response (Schwartz, 1977). Harland, Staats, and Wilke (2007) summarize the factors that trigger norms in the activation stage: awareness of need (extent to which an individual's attention is focused on the existence of a person or entity in need), ascription of responsibility to self for that need, the ability to provide relief (an individual's perception about the availability of resources and/or capabilities that are required to perform a behavior), and efficacy to alleviate the need (Figure 1). Two other behavioral factors that affect norm activation are awareness of consequences and denial of responsibility (Harland, Staats, & Wilke, 2007). In addition, when an individual is aware of the consequences of their behavior on others, feelings of responsibility and personal norm activation increase (Schwartz, 1977). The obligation step consists of feelings of obligation where pre-existing or situational personal norms are activated. The defense step involves an assessment of costs and probable outcomes and a reassessment of need and responsibility to respond. This step is where activated norms may be "neutralized" by cost and outcome assessments, thereby eliminating action (Schwartz, 1977). The final response step is either action or inaction (Schwartz, 1977). Thus, the NAT postulates that altruistic behavior occurs when personal norms are activated and override the defense step mechanisms.

Figure 4. Harland, Staats, and Wilke's (2007) NAT summary (adapted)



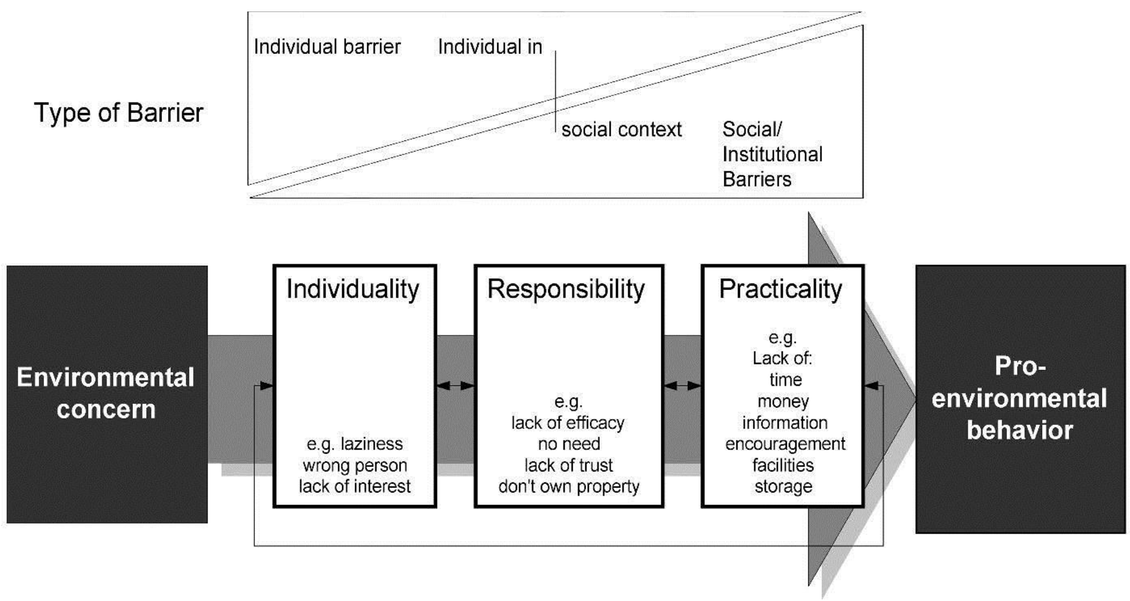
Thus, norm construction creates self-expectations of moral obligation to act rather than "coldly intellective judgments" of a rational choice model (Schwartz, 1977, p. 234). As Schwartz and Howard (1984) summarize, "Whereas other attitudinal concepts refer to evaluations based on material, social, and/or psychological payoffs, personal norms focus exclusively on the evaluation of acts in terms of their moral worth to the self" (p. 245). Stern et al. (1993) apply the NAT to pro-environmental norms that are motivated by egoistic (concerning the self and/or family), social/altruistic (concerning others), and/or biospheric (concerning the environment) values. Furthermore, they state that motivation (M) for environmental concern results from combining potential adverse consequences (AC) on egoistic ($_{ego}$), social/altruistic ($_{soc}$), and biospheric ($_{bio}$) values (V) (Figure 2).

Figure 5. Stern et al.'s (1993) motivation for environmental concern

$$M = V_{ego}AC_{ego} + V_{soc}AC_{soc} + V_{bio}AC_{bio} ,$$

Harland, Staats, and Wilke (1999) acknowledge Stern's categorizations as "closely related to Schwartz's (1977) conceptualization of personal normative influence" (p. 2508). Blake (1999) cites the concept of environmental concern as the prerequisite for environmental action in his Value-Action Gap Model (Figure 3). The model also includes other elements of the NAT, such as responsibility to act, ability to act, and the efficacy of the action.

Figure 6. Blake's (1999) Value-Action Gap model



NAT is a well-respected theory of social behavior. Studies of various environmental issues associated with toxic chemical release (Vandenbergh, 2005), off-road vehicle impact on seashores (Noe, Hull, & Wellman, 2009), and curbside recycling (Guagnano, Stern, & Dietz, 1995) have used NAT to understand human behaviors. The theory has also been used to account for moral drivers in past studies (Harland, Staats, &

Wilke, 1999; Johansson & Heningsson, 2011; Parker, Manstean & Stradling, 1995; Wall et al, 2007).

In summary, study results have been mixed as to which factors positively influence farmers' conservation adoption behaviors. Furthermore, much of the literature addresses *what* factors influence conservation adoption (i.e. awareness of programs and economic incentives), but few delve into *why* farmers were motivated to act. Two theoretical frameworks for understanding motivations for environmental behaviors provide a more holistic understanding of why farmers choose to adopt or not adopt agricultural conservation practices. TPB views environmental behavior as rationally motivated, grounded in self-interests. This study was guided by the notion that agricultural conservation practices are not predominantly a self-interested behavior but are also driven by personal norms consistent with the Norm Activation Theory.

Methods

The tenets of qualitative research are to, "…describe, understand, and explain," the phenomena studied (Wagenet & Pfeffer, 2008, p. 805). As Charmaz (2006) describes, "Qualitative interviewing provides an open-ended…exploration of an aspect of life about which the interviewee has substantial experience" (p. 29). When dealing with subjective concepts such as personal norms, interviews allow important participant description and detail. Interviewing farmers will allow researchers to, "…learn about their views and actions and to try to understand their lives from their perspectives" (Charmaz, 2006, p. 19).

The interview guide was designed to address three research questions: 1) What drives nitrogen best management practice adoption among farmers in the study watersheds? 2) What constrains nitrogen best management practice adoption among farmers in the study watersheds? and, 3) What role do personal norms play in influencing decisions concerning best management practices? A stakeholder inventory generated a list of agricultural producers in the two watersheds. Resource professionals and agricultural experts from county SWCD, NRCS, Minnesota Pollution Control Agency, Board of Water and Soil Resources, Minnesota Farm Bureau, Minnesota Department of Agriculture, and non-profit groups were consulted.

Community Profiles

The Rush River watershed comprises 22% of the land area of the Lower Minnesota River watershed, a sub-basin of the Minnesota River Basin which joins the Mississippi in the Twin Cities metro area (Sibley County, 2008). The watershed drains approximately 257,000 acres across Sibley, Nicollet, and McLeod counties in south central Minnesota. An estimated 9,010 people live in the watershed with 90% of the land used for agricultural production (Sibley County, 2008). Sibley and Nicollet counties rank in the top ten among Minnesota counties in poultry production and overall livestock (MDA, 2009; MDA 2009b).

The Elm Creek watershed spans approximately 87 miles across Jackson, Martin, and Faribault counties along the southwest border of Minnesota and Iowa. Land use is 90% agriculture with Martin County ranked as first and second in hog and corn production, respectively, among all Minnesota counties (MDA 2009c). Elm Creek joins the Blue Earth River (a tributary of the Minnesota River) in Winnebago, MN. Population data specific to the watershed boundaries were unavailable, but the population of Martin

County, which comprises the majority of the watershed, was estimated at 20,689 (U.S. Census, 2011).

While Total Maximum Daily Loads (TMDLs) across the state are still being assessed by the Minnesota Pollution Control Agency, the Rush River and Elm Creek are recognized as impaired for total suspended solids, suspended volatile solids, fecal coliform, phosphorus, and nitrate/nitrite/nitrogen by both government and independent assessors (MPCA, 2012; Lenhart et al., 2010; MSU, 2006). Furthermore, the degradation of the Minnesota River implicates its tributaries as likely contributors of pollutants.

Participant Profile

Of the 15 Rush River participants, all were white, 14 were male, and the median age was 57. Of the 15 Elm Creek participants, all were white, 14 were male, and the median age was 63 (Table 1).

Table 1: Participants' gender and age

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

Respondent Age	**Rush River**	**Elm Creek**	**Overall**
Min	47	42	42
Max	80	73	80
Median	57	63	57

Over half of Rush River and Elm Creek participants reported over $100,000 from all income sources before taxes in 2010 (Table 2). Respondents' property size was evenly distributed with 33% claiming less than 500 acres, 33% with 501-1000 acres, and 33% with 1001 or more acres overall. Median farm size for Rush River and Elm Creek farms was 600 acres and 900 acres, respectively. Farms ranged from 120 to 6,400 acres (Table 2).

Table 2: Participants' income and percentage of income dependent on land

Respondent Income	**Rush River**		**Elm Creek**		**Overall**	
	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
Respondent Land Size	**Rush River**		**Elm Creek**		**Overall**	
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	
Median	600		900		650	

Rush River participants have lived in their community an average of 50 years and Elm Creek participants averaged 54 years. Rush River and Elm Creek participants averaged 35 and 38 years farming experience, respectively. Both watersheds had similar longevity of farm duration in the family with Rush River and Elm Creek farmers averaging 90 years 81 years, respectively. Most participants lived less than five miles from residency to the farm (Table 4).

Table 4: Participants' farm characteristics

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

BMP adoption rates varied significantly across the two watersheds. Farmers in the Rush River watershed reported adoption of 47 BMPs (3.13 per farmer) while Elm Creek farmers reported adoption of 32 BMPs (2.13 per farmer) (Table 5).

Table 5: BMPs Implemented

Number of BMPs Adopted	Rush River Participants	Elm Creek Participants	Total BMPs Adopted
0	0	1	0
1	1	5	6
2	7	4	22
3	2	3	15
4	1	1	8
5	2	0	10
6	2	1	18
Total:	47	32	79

Data Management and Analysis

Interviews were audio recorded and transcribed verbatim using Olympus DSS Player Standard Transcription Module Version 1.0.2.0. Qualitative data derived from transcriptions were analyzed and coded using QSR NVivo 9.0. Quantitative statistics were analyzed using Statistical Package for Social Sciences (SPSS release 17.0). Grounded theory (Corbin & Strauss, 1990) was used to extract and code data relating to the three primary research questions.

Findings

The three research questions were: 1) What drives nitrogen best management practice adoption? 2) What constrains nitrogen best management practice adoption? and, 3) What role do personal norms play in influencing best management practices decisions? Overall, participants revealed three primary drivers, seven primary constraints, and varying roles of egoistic, social, and biospheric-driven norms regarding nitrogen BMP adoption.

Drivers of BMP Adoption

Five interview questions directly inquired about participants' motivations for adopting nitrogen BMPs. Analysis of the data revealed three primary drivers of BMP adoption: land stewardship, personal responsibility, and economics.

Land stewardship: Several participants who adopted BMPs saw conservation practices as complementary to their ideals of land management for production and land stewardship ethics. An Elm Creek farmer noted how BMP implementation complemented production: "Some [BMPs] I could cost share, but I just did it out of my own pocket because 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." An Elm Creek farmer spoke of the personal standards reflected in his land management: "We take great pride in what we do. You don't want it to wash away, you don't want it to blow away. 'Cause if it ever moves you can never get it back to where it was. We're very conscious of: the soil's here and we want it to be here when we're done."

Personal responsibility: Taking personal responsibility for water resource health was also expressed among a vast majority of participants. When asked whose responsibility it is to keep area water resources healthy, one Elm Creek farmer replied, "[It is] everybody's [responsibility]. Absolutely everybody. We're willing to do our best to protect [water resources] 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." One Rush River farmer spoke of improving 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.

Economics: Some agricultural producers expressed economics as a driver of BMP adoption. Maximizing efficiency of crop inputs and increasing economic return on marginal land were two reasons for implementing BMPs. Efficiency of nitrogen application was crucial in terms of economics for one farmer who noted,

> If you look at the function of every input of nitrogen giving me that amount of dollars back in return, that's pretty much aligned with the environmental aspects of nitrogen management. There are always going to

> be mishaps in the environment because we always get caught off guard, but using more intelligent management is really where we need to be. And most farmers are figuring that out because the penalties for doing it poorly are economically catastrophic.

Placing marginal lands in conservation was a way to increase profits from normally diminished crop yields. A Rush River farmer noted the value of buffer strips: “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.”

Constraints to BMP Adoption

Three interview questions asked participants about factors constraining personal BMP adoption and adoption by area farmers. Analysis of the data revealed seven primary constraints of BMP adoption: economics, knowledge, autonomy, market/demand, farm/landscape suitability, weather sensitivity, and effectiveness.

Economics: The most common constraint identified by farmers in both watersheds was economics. “Economics” included costs of adopting nitrogen BMPs and the corresponding loss of income of cropland removed from commodity production. One Rush River producer related the conflict of converting land he owned into a conservation easement: “If they [farmers] are getting $250 or $300 an acre rent, they aren’t going to jump if they’re only going to get $100 in a CRP payment. I’m concerned about the environment, but I’m not going to be generating the rent.” Another farmer mentioned lucrative commodity returns as a disincentive for adopting BMPs, stating, “I think every farmer wants to have every acre to produce. Whether it produces 120 bushel acre corn, you’re still going to make some money on it.”

Knowledge: Another constraint to BMP adoption was that of knowledge. "Knowledge" incorporates producer familiarity with BMPs, education regarding water-related issues, and outreach efforts to familiarize producers with BMPs. Familiarity was a primary constraint with newer BMPs. Bioreactors and two-stage ditches were the top two BMPs farmers reported hearing little or nothing about. Along with growing alternative energy crops, these BMPs were the least implemented among participants. Water quality education was also reported to be a constraint to BMP adoption. A Rush River farmer acknowledged, "The education part could be better, no doubt about it. This main ditch goes almost all the way up to Steward. That's 30 miles away. You ask some of those people where it drains into they probably don't even know." One Elm Creek watershed farmer emphasized the necessity of education,

> You gotta educate others. Awareness and research. The Department of Ag, University people, they will host plot tours. Those of us still farming stay abreast with the latest and greatest and have a willingness to go along with the recommendations of superiors as long as they've got the data to support it.

Autonomy: When asked what producers most enjoyed about farming, many farmers described independence. Conversely, this need for autonomy constrained BMP adoption. 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." An Elm Creek farmer mentioned loss of land control as a constraint to entering a conservation arrangement: "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 : Participants cited the lack of an established market and/or demand as a key constraint to adopting BMPs involving alternative crop production. Adding alfalfa to a crop rotation was hindered by a lack of market. Those participants who did grow alfalfa used it for livestock feed. One Rush River farmer commented on potentially adding alfalfa, noting, "Wider crop rotations are good, no doubt about it. It's whether or not you have a market for it, have the equipment and the capital to do it." Planting alternative energy crops was seen as unrealistic by many participants because of a lack of both market and cellulosic technology. One participant said,

> Economically it [planting alternative energy crops] would not be a wise choice. The technology to utilize it efficiently is not there. I think there's other renewable fuels that we can produce, and are producing, more efficiently. When you can make ethanol and utilize all the byproducts of it, why would you plant switchgrass?

Farm/Landscape suitability: Producers expressed skepticism of the suitability of their farms for BMP implementation with regard to factors of topography, farm size, and crop rotations. Topography was also mentioned in adoption of buffer and filter strips. One Elm Creek producer stated, "Filter strips are needed in places, but right around here, you can see the terrain and topography. What we farm is pretty flat." Farm size was an issue for one Elm Creek producer in discussing implementing a bioreactor: "We have way too much tile for bioreactors. Bioreactors work, but on 40 acres or something. I'm talking about tiling 1,000 acres." Perceived lack of necessity and increased management were mentioned as constraints to growing cover crops. 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: Irregularity of weather and unsuitable climactic conditions were given as primary constraints to adopting BMPs. Commenting on using nitrogen rates recommended by the University of Minnesota, one Elm Creek farmer noted, "They're generally a low threshold. 7 out of 10 years they'll be fine, but then you get too much rain and they're way too low." Climate was also a limiting factor in growing alfalfa and cover crops. Regarding moisture regimes and growing alfalfa, one participant said, "If you live in South Dakota where it doesn'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." Limited growing season was a factor as one 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: Skepticism regarding the effectiveness of several BMPs was common among farmers in both watersheds. One Rush River farmer was critical of bioreactors: "How effective are they? What's the service life of them, the maintenance costs, and things like that?" The logistics and effectiveness of newer technologies was also of concern to producers. One Rush River farmer commented on variable rate technology: "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?" Effective installation and placement was also a concern regarding buffer strips. An Elm Creek farmer explained: "On ours it [buffer strip] was kind of a waste. There's a huge ridge that holds that water so the nitrogen and runoff cannot go directly into this ditch. Whereas our other land is a huge hill that goes right into the river. A buffer strip would be more effective there."

Influence of Personal Norms

The influence of personal norms on participants' decision making processes were categorized according to awareness of need, ascription of responsibility, ability to perform conservation practices, and environmental concern expressed as values and awareness of adverse consequences concerning water resources. Results indicate low awareness of need, high ascription of responsibility, perceived ability to perform conservation behaviors, and environmental concern as indicated by the relationship between awareness of adverse consequences (i.e., impaired water resources) and value orientations (i.e., egoistic, social/altruistic, and biospheric values).

Awareness of need: To assess awareness of need, participants were asked, "How would you describe the quality of the groundwater, streams, and lakes in this area?" Nineteen of the 30 participants perceived 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." Another noted, "I think it's pretty good. I don't think anybody goes overboard anymore." Six participants described water quality as compromised in the area. "The lake is pretty much worthless now," one participant noted. Some Elm Creek participants attributed water resources impairment to livestock 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." Another participant believed nitrogen runoff was not an issue on their farm: "We use best management practices and really try to be stewards. I can, with a clear conscience, say we're not polluting our water. I would venture to say that's true for most people in this area."

Responsibility: Ascription of responsibility was examined by asking participants, "Whose responsibility is it to keep water resources in this area healthy?" Accepting responsibility for water resource health was expressed among a vast majority of participants. One Elm Creek farmer replied, "[It is] everybody's [responsibility]. Absolutely everybody. We're willing to do our best to protect [water resources] as well. That is going to become the most precious resource of any going forward along with clean air to breathe." One Rush River farmer spoke of improving 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.

Another participant specifically noted the role of farmers: "Farmers have a huge part because of the number of acres we farm. It's everyone's responsibility and everyone needs to help."

Ability: Participants were asked, "Do you have the resources you need to adopt these [BMP] practices?" A vast majority of participants expressed availability of resources, most notably through local NRCS staff. One Rush River farmer related, "I think in our county, there's a lot of people who rely on the NRCS. We've got some unbelievable technicians that make farm visits, make recommendations. They'll do anything when it comes to engineering that they can for you. And most of those are cost-share." An Elm Creek participant noted the proficiency of the NRCS: "Our NRCS is extremely helpful in anything to do with this [BMPs]. They've usually all got some kind of degree in something. I think they're burdened sometimes by government regulations. I think if they had a little freer hand it would be better."

Environmental concern: Assessment of environmental concern involved Stern et al.'s (1993) values and awareness of adverse consequences construct (Figure 2). Participants were asked, "What is your connection to the water resources in this area" to establish egoistic, social/altruistic, and biospheric values. "How important is it to you to minimize the potential impacts of nitrogen on the natural environment" was used to explore participants' awareness of adverse consequences of nitrogen impacts on the environment. Results indicated that egoistic values were strongest and most common followed by biospheric and social/altruistic. *Egoistic values:* The primary egoistic values expressed by participants were economic security, anthropocentric resource stewardship, and autonomy. Economic security was seen as complementary to healthy water resources in terms maintaining long-term crop production and efficient use of nitrogen. Long-term maintenance of land was viewed as serving water resource health through minimizing soil erosion. One participant noted, "What so many people don't give us credit for is that soil, those nutrients, are our livelihood. We want as much return out of that as we can possibly get. We don't want to see those nutrients go down the stream." Maximizing the efficiency of nitrogen was also deemed environmentally beneficial by minimizing nutrient losses. As one farmer said, "We only apply as much as we can make a profit on.

If you're applying 250lbs an acre to raise a crop, you didn't gain that much but you spent more money. It's a matter of economics." Anthropocentric resource stewardship was described as conservation of resources as beneficial for human use. While this value overlaps with economic security, it also includes recreational activities such as swimming and fishing/hunting. One participant discussed the benefits of healthy waters: "We want to protect the environment because we enjoy outdoor activities. My cousin's boys are big into hunting and fishing. We want to take care of that because we want to enjoy those." The third value of autonomy was mentioned frequently by participants. Increasing government regulation was seen as an adverse consequence of unhealthy water resources. One farmer noted, "Now they're blaming the dead zone in the Gulf of Mexico because of the high nitrates, probably from tiling. If that's the case, then we want to prevent more unnecessary regulation."

Social/Altruistic values: The primary social/altruistic environmental values expressed by participants were anthropocentric resource stewardship and relationships with community/society. While resource stewardship was also an egoistic value, it was also represented as a social/altruistic value regarding future generations. One farmer said, "I think that's one of the biggest obstacles that we face as farmers; to be stewards and care for this land. We are responsible for the future generations of our country and we can't be poisoning our land today and expect them to have a good living tomorrow." Community relationships were important to one Elm Creek producer who appreciated social recognition of conservation efforts: "At the county fair you get a river friendly farmer award. It makes you feel like you're doing the right thing, I guess." Societal relationships were valued by producers expressing pride in producing the "food, fuel, and fiber for the world." Some participants felt this relationship was threatened by poor water resource health. One farmer described the influence of interactions with, "…the public. If I talk to somebody and they're saying, 'You're poisoning the [environment],' I just don't like that aspect of it, I guess."

Biospheric values: Responses that reflected concern for the environment in regards to adopting nitrogen conservation practices were categorized as biospheric. These values were described as minimizing harmful effects to the environment. Biospheric environmental stewardship had environmental benefits as a primary objective whereas anthropocentric stewardship had human use as a primary objective. One participant noted, "As I've said in our conservation ethic, I know there's water quality benefits and that's wonderful. We wash it [water] down there so fast. If we can save water up here, that's going to help down there. I think we've got to look at the big picture, not just through our tunnel vision." Another participant spoke about the biospheric motivations and consequences for minimizing the impacts of nitrogen on the environment:

> We've all heard about the "Dead Zone" in the Gulf of Mexico and we all know that it's coming from this 25-state area. And everybody applies nitrogen in the fall. It's like, are you kidding? That's the most volatile substance known to man. Most of it gets dissolved in water and gets into the rivers, which is why all of our lakes and rivers are dead. The Minnesota River is a disaster and that's because everyone is growing corn and soybeans. I never wanted to farm that way, ever.

Discussion

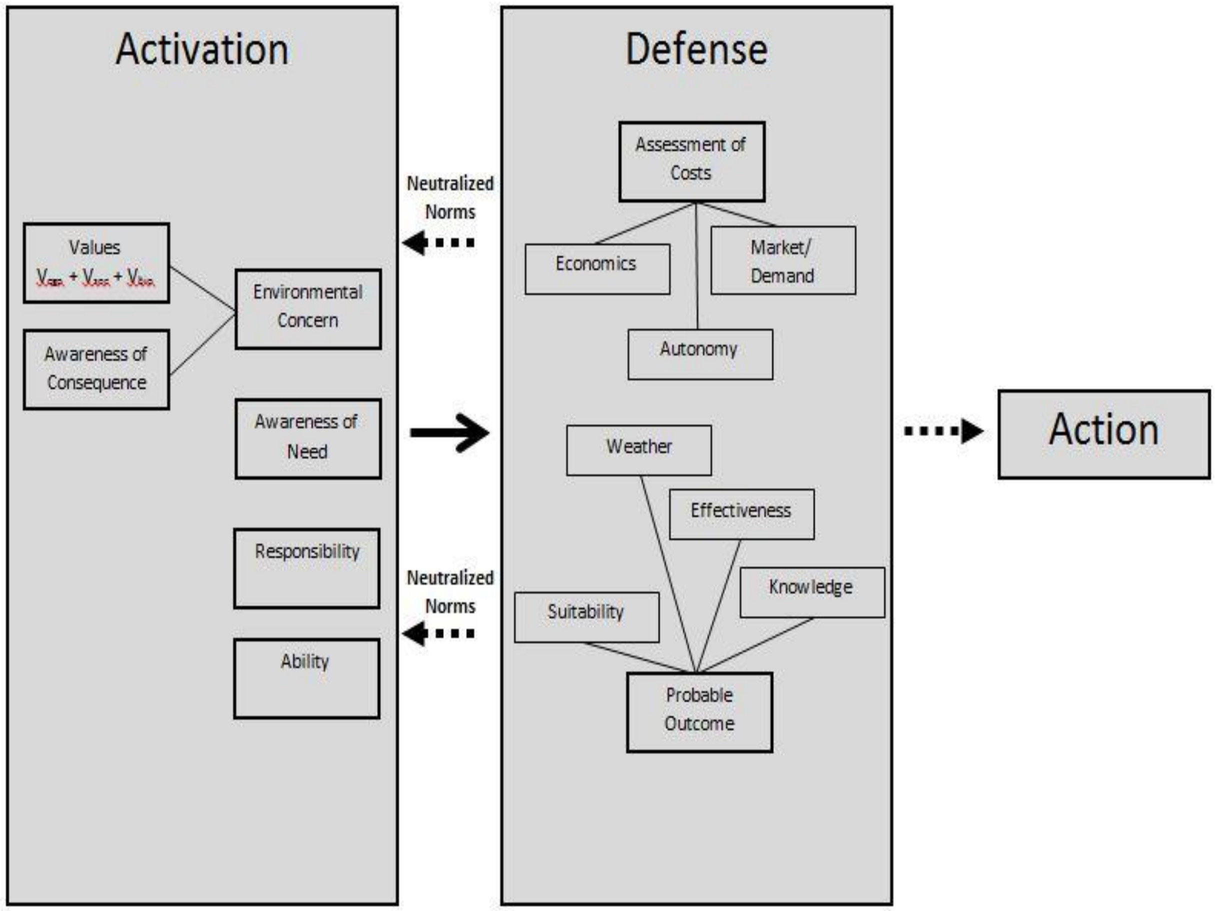
Using an inductive method, this study revealed three primary drivers (land stewardship, personal responsibility, and economics) of and seven major constraints (economics, knowledge, autonomy, market/demand, farm/landscape suitability, weather sensitivity, and effectiveness) to farmer adoption of nitrogen BMPs. Egoistic, social, and biospheric-driven norms of varying strengths also influenced farmer adoption of BMPs. Strategies for promoting BMP adoption should assess which norms are strong within an individual, determining if they are activated, and tailoring aid (information, technical assistance, financial assistance) to facilitate norm action.

Norm Activation Theory

The results indicate that the norm activation theory is an appropriate lens to interpret the environmental behaviors of farmers in this study through. Awareness of need, ascription of responsibility to self, and the ability to perform pro-environmental acts were required to activate personal norms. However, the elements of efficacy and denial of responsibility were revealed as cost and probable outcome assessments leading to norm neutralization in the defense stage of NAT. The results also suggest Blake's (1999) concept of environmental concern as a prerequisite for environmental behavior (Figure 3).

Combining Stern et al.'s (1993) awareness of adverse consequences to egoistic, social/altruistic, and biospheric values with Schwartz's (1977) factors of norm activation as summarized by Harland, Staats, and Wilke (2007) renders a conceptual model of how personal norms influence farmer decision-making processes regarding conservation behaviors in this study (Figure 4).

Figure 7. A model of farmer BMP decision making (adapted from Blake, 1999; Stern et al., 1993; Harland, Staats, Wilke, 2007)



A Model of Farmer BMP Decision Making

The first stage of NAT involves norm activation in which Schwartz's (1977) components of awareness of need, responsibility, and ability are activated. Included in this model is Blake's (1999) concept of environmental concern as defined by Stern et al. (1993) (Figure 1). Environmental concern is included in this model because it incorporates awareness of adverse consequences, which is a personality trait activator in Harland, Staats, and Wilke's (2007) model (Figure 2) while also including egoistic, social, and biospheric values. When activated, norms must "run the gauntlet" of the defense stage in which assessments of cost and probable outcomes (represented by the study's seven major constraints) act to neutralize activated norms. Norms that avoid or overcome these constraints proceed to cause action. An alternative scenario of norm neutralization is demonstrated by the dashed arrows returning a norm to inactive status. The third scenario is non-activation of a norm in which any of the key factors is not triggered. This is exemplified by an agricultural producer who values a healthy relationship with water resources and perceives healthy water quality. Nineteen of 30 research participants characterized local water resources as being of good quality. This lack of awareness of water quality impairments exemplifies norm activation failure and is consistent with Skelton and Josiah's (2005) findings that farmers perceive surface water impairments at regional and national levels but not at local levels.

Norm Strength

Behaviors that resulted in conservation practices appear to rely on norm strength. Regarding egoistic, social/altruistic, and biospheric-driven norms, Kollmus and Agyeman (2002) note that, "Every person has all three orientations but in different strengths" (p. 245). Norm strength is indicated by norm resilience against neutralization in the NAT defense stage. In Stern et al.'s (1993) motivation equation (Figure 1), stronger values and greater awareness of adverse consequences would logically result in increased norm strength. Participant responses suggest a spectrum of norm strength: egoistic-driven norms were strong and seemed least likely to be neutralized and biospheric-driven norms were weaker than egoistic but stronger than social/altruistic. Similarly, Stern et al. (1993) found that egoistic orientation was the strongest orientation. One participant expressed the prioritization of egoistic economics over biospheric norms: "If [owners] are 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." Despite being outranked by egoistic norms in most cases, biospheric norms were still strong and were able to overcome social/altruistic norms that inhibited conservation practices. One Elm Creek farmer who expressed frustration with inflexible conservation programs but continued with conservation practices exemplified this: "We did all this paperwork to apply [to the Conservation Stewardship Program] and we weren't accepted because we did all that stuff already. So we've been doing these things for years and we're disqualified from a conservation program, because you had to change your practice to get money." A Rush River farmer blamed office bureaucracy for failing to mitigate wetlands on his farm, but continued to maintain three acres of native prairie and three acres of native vegetation on his property at his own expense.

Management Implications

Strategies to promote pro-conservation behavior involve several steps. Addressing awareness of need regarding impaired water resources is first. This may be accomplished through outreach education and would be most effective in emphasizing water impairments with local data in a user-friendly manner. The next steps involve determining which norm-values (egoistic, social/altruistic, biospheric) are strong within an individual and tailoring aid (information, technical assistance, financial assistance) to overcome deactivating constraints.

However, these strategies are not easily accomplished. Inherent challenges from these results and previous research is the weakness of subjective/social norms in altering human behavior. Since tailored water quality education and outreach initiatives use social connections (on-farm visits, BMP workshops, etc.), efforts should be made to convey information that activates egoistic and/or biospheric norms, which seem to be more difficult to deactivate. Emphasis should be placed on practices and information that may be viewed as complementary to individual values and norms, such as economic efficiency of nitrogen application and land stewardship.

These strategies require significant time and resources. With staff, budget, and time limitations, strategies to prioritize stakeholders and instigate alternative means of outreach and education could prove valuable in maximizing management capabilities. Furthermore, while these results are representative of study participants, they may not be the drivers, constraints, and personal norms held by all individuals. These recommendations are not intended to be specifically applied to every stakeholder. Instead, they suggest a framework of likely drivers of and constraints to BMP adoption and the potential roles of personal norms in influencing behavior. These methods should be tailored to individuals to maximize their involvement in management decisions.

Conclusions

This study revealed three primary drivers, seven major constraints, and the influence of personal norms on farmer adoption of nitrogen BMPs. As one participant aptly stated, “There are as many ways to farm as there are farmers.” It appears that the inverse is true as well: There are as many farmers as there are ways to farm. Thus, applying a one-size-fits-all approach is not only difficult, it is counterproductive. As Valdiva and Poulos (2009) state, “If policies are not well coordinated with household decision makers, these may at best be ineffective and at worst cause social resistance” (p.

62). By identifying the drivers of and constraints to adopting nitrogen BMPs as well as the roles of personal norms, a general understanding of farmers' needs may be incorporated into conservation programs and strategies to engage farmers in conservation practices.

Participant responses to study research questions are readily understood by the norm activation theory in conjunction with Stern et al.'s (1993) and Blake's (1999) concept of environmental concern. Pro-environmental norms are activated when a sense of need is perceived, an individual ascribes responsibility to themselves for that need, there is the ability to perform a desired act, and environmental concern is expressed through values and awareness of adverse consequences. These values can be egoistic (economic, familial), social/altruistic (community, society), and/or biospheric (environmental stewardship, minimizing nitrogen impacts). However, the NAT states that norms may fail to influence behavior when they are not activated (in this case most notably by lack of awareness) or neutralized by constraints through assessments of cost and probable outcomes in the defense stage. Efforts should be directed at norm activation and minimizing neutralizing constraints.

Chapter 5

Discussion

This study revealed three primary drivers (land stewardship, personal responsibility, and economics) of and seven major constraints (economics, knowledge, autonomy, market/demand, farm/landscape suitability, weather sensitivity, and effectiveness) to farmer adoption of nitrogen BMPs. Egoistic, social, and biospheric-driven norms of varying strengths also influence farmer adoption of BMPs. Strategies for promoting BMP adoption should assess which norms are strong within an individual, determine if they are activated regarding pro-environmental behavior, and tailor aid (information, technical assistance, financial assistance) to facilitate norm action.

Norm Activation Theory

The results indicate that the environmental behaviors of farmers in this study are, to a large degree, explained by the norm activation theory. Awareness of need, ascription of responsibility to self, and the ability to perform pro-environmental acts all indicated an activation of personal norms. The elements of efficacy and denial of responsibility were revealed as cost and probable outcome assessments leading to norm neutralization in the defense stage of NAT. The results also suggest Blake's (1999) prerequisite of environmental concern (as defined by Stern et al. (1993)) as relevant to incorporating awareness of adverse consequences and egoistic, social/altruistic, and biospheric values. Together, these elements render a conceptual model of how personal norms influence farmer decision-making regarding conservation behaviors in this study.

A Farmer BMP Decision Making Model

The farmer BMP decision model suggests the procedure of norm influences on decision making. The first stage of norm activation requires awareness of need, responsibility, and ability as well as environmental concern factor, which includes value orientation and awareness of adverse consequences. It is also hypothesized that stronger ascriptions of values and a greater awareness of adverse consequences would result in increased norm strength. Alternative scenarios in which norms are not strong and neutralized or not activated result in no action. As nineteen of the thirty research participants characterized local water resources as being of good quality, this lack of awareness of water quality impairments may be a crucial element to address.

Norms

Behaviors that resulted in conservation practices appear to rely on norm strength in relation to the neutralizing constraints of the defense stage. Regarding egoistic, social/altruistic, and biospheric-driven norms, Kollmus and Agyeman (2002) note that, “Every person has all three orientations but in different strengths” (p. 245). In this study, egoistic-driven norms were strong and seemed the least likely to be neutralized and biospheric-driven norms were weaker than egoistic but stronger than social/altruistic. Similar to this study, Stern et al. (1993) found that egoistic orientation was the strongest orientation.

Dissonance

The lack of awareness of need regarding impaired local water resources is concerning. This seemed to be the most common cause of norm non-activation among participants. Possibly relevant to this issue is Festinger's (1957) concept of dissonance in which individuals selectively perceive information to achieve consistency in beliefs and mental frameworks. Individuals may avoid information that threatens basic assumptions about quality of life, prosperity, and material needs (Festinger, 1957).

Management Implications

Addressing awareness of need regarding impaired water resources may be accomplished through outreach education emphasizing local water impairments. Determination of individual norm-values (egoistic, social/altruistic, and/or biospheric) and tailoring aid to overcome deactivating constraints are also crucial to facilitating norm action.

However, the weakness of subjective/social norms in altering human behavior proves challenging. Efforts should be made not to impress conservation *on behalf* of social norms or subjective influences, but to use social norms and subjective influences to convey information that activates egoistic and/or biospheric norms. Emphasis should be placed on practices and information that may be viewed as complementary to individual values and norms, such as economic efficiency of nitrogen application and land stewardship.

With limitations on staff, budgets, and time, strategies to prioritize stakeholders and instigate alternative means of outreach and education could prove valuable in maximizing management capabilities. Furthermore, while these results are representative of the watersheds, they are not intended to be specifically applied to every stakeholder. These methods, like technical/financial/informational assistance, should be individually tailored to learn about stakeholders and involve them in management decisions as much as possible.

Study Limitations

The qualitative nature of this study successfully captured the personal perspectives and details regarding the complex dynamics between agriculture and water quality. Most importantly, this research offers an understanding of not only *what* producers perceive and the behaviors they perform, but also *why* they think and act accordingly. These drivers, constraints, and the influences of personal norms provide valuable information about the needs of agricultural producers when considering best management practices. While not applicable to every farmer in every scenario, this information may be used as a general reference for conservation outreach and BMP proliferation.

Future Research

The field of agriculture is in a perpetual, oxymoronic state of constant change. New technologies, policies, supply and demand, and a host of other variables alter the agricultural context every year. Research must doggedly keep pace pursue in order to remain updated and relevant. While differing agricultural variables will always provide new contexts for research, continued exploration of personal behaviors will remain essential. Investigation of the role and extent of dissonance in farmer decision making as well as evaluation of effective outreach strategies would complement this study by offering effective strategies for activating and operationalizing farmer norms. Exploring the effects of neutralization on norm re-activation would provide valuable information on approaching stakeholders who may have rejected previous conservation attempts.

Furthermore, farmers are not the only actors in the field of agriculture. Additional studies incorporating natural resource managers and agricultural professionals (i.e. seed providers, fertilizer applicators, farm cooperative managers, etc.) would increase understanding of the roles of multiple players in the agricultural environment. In addition to the BMPs studied here, other management practices (minimal/no-till/conservation tillage, etc.) would provide further insight into farmer decisions and better equip natural resource managers to offer a variety of conservation practices. Research involving younger farmers will also be critical as a generational turnover in agriculture seems imminent.

Conclusion

As one participant aptly stated, "There are as many ways to farm as there are farmers." Judging from the results of this study, it appears that the inverse is true as well: There are as many farmers as there are ways to farm. Thus, applying a blanketed, one-size-fits-all approach is not only difficult, it is counterproductive. As Valdiva and Poulos (2009) state, "If policies are not well coordinated with household decision makers, these may at best be ineffective and at worst cause social resistance" (p. 62). By identifying the drivers of and constraints to adopting nitrogen BMPs as well as the roles of personal norms, a general understanding of farmers' needs may be incorporated into conservation programs and strategies to engage farmers in conservation practices.

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Appendices

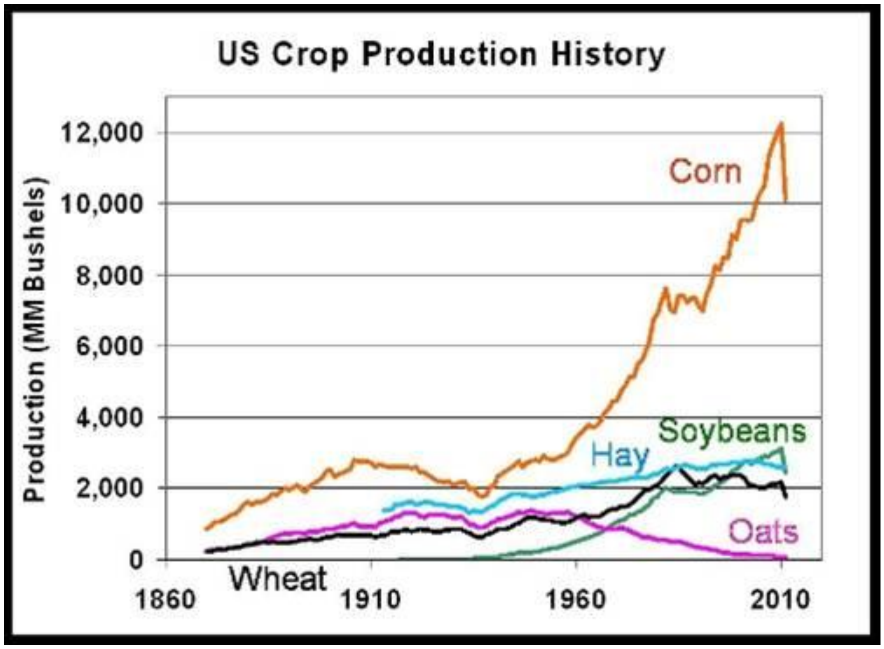
A. Map of Mississippi River Basin

Source: (EPA, 2012b)

B. A Map of the Upper Mississippi River Basin

Source: http://www.mvr.usace.army.mil/Brochures/MeetingTheChallenge.asp

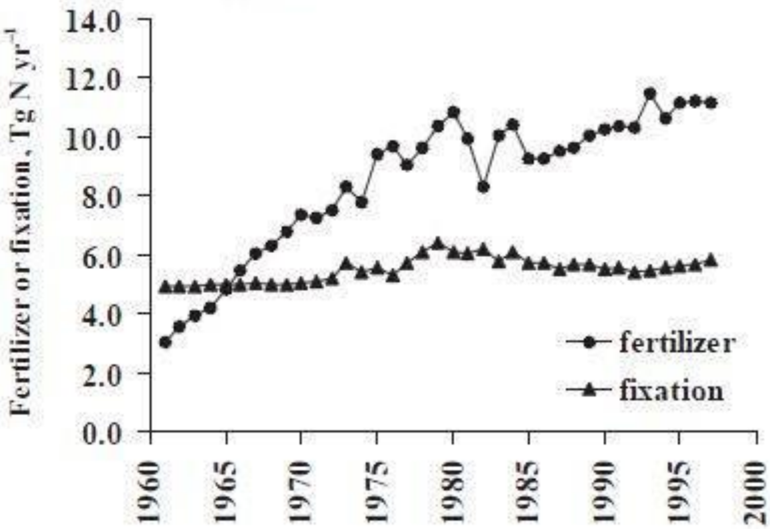
C. U.S. corn production: 1860-2010



Source: U.S. NASS (2012)

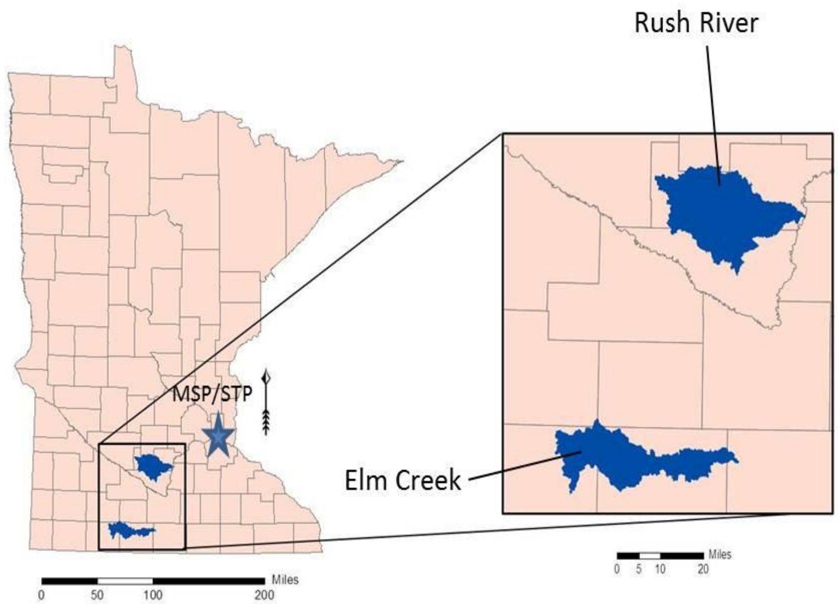
D. U.S. nitrogen inputs

Figure 2. Nr inputs to the USA from 1961–2000 from use of inorganic N fertilizer and from N fixation in agricultural systems. See text for sources and derivation of estimates.

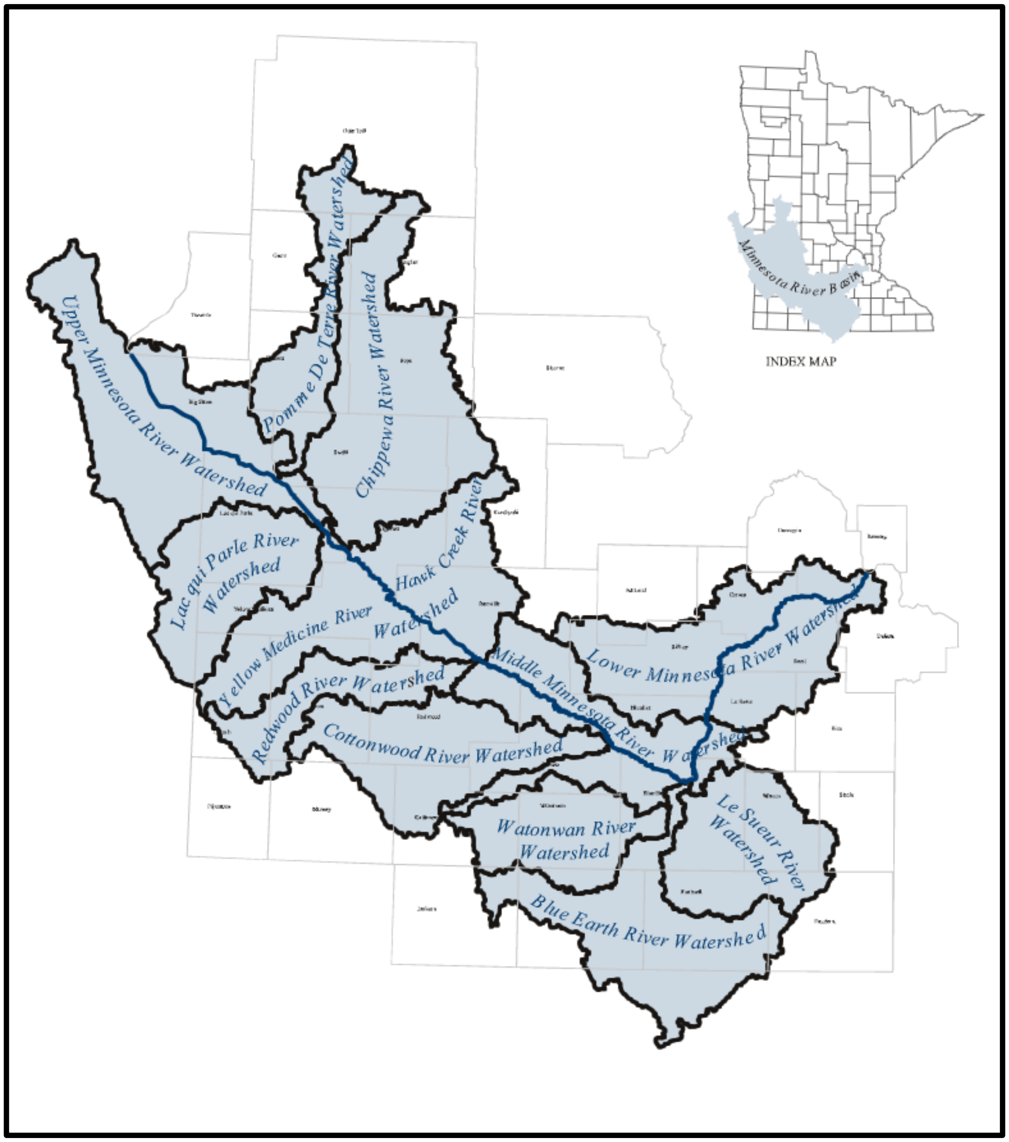


Source: Howarth et al., 2002

E. Map of Rush River and Elm Creek watersheds

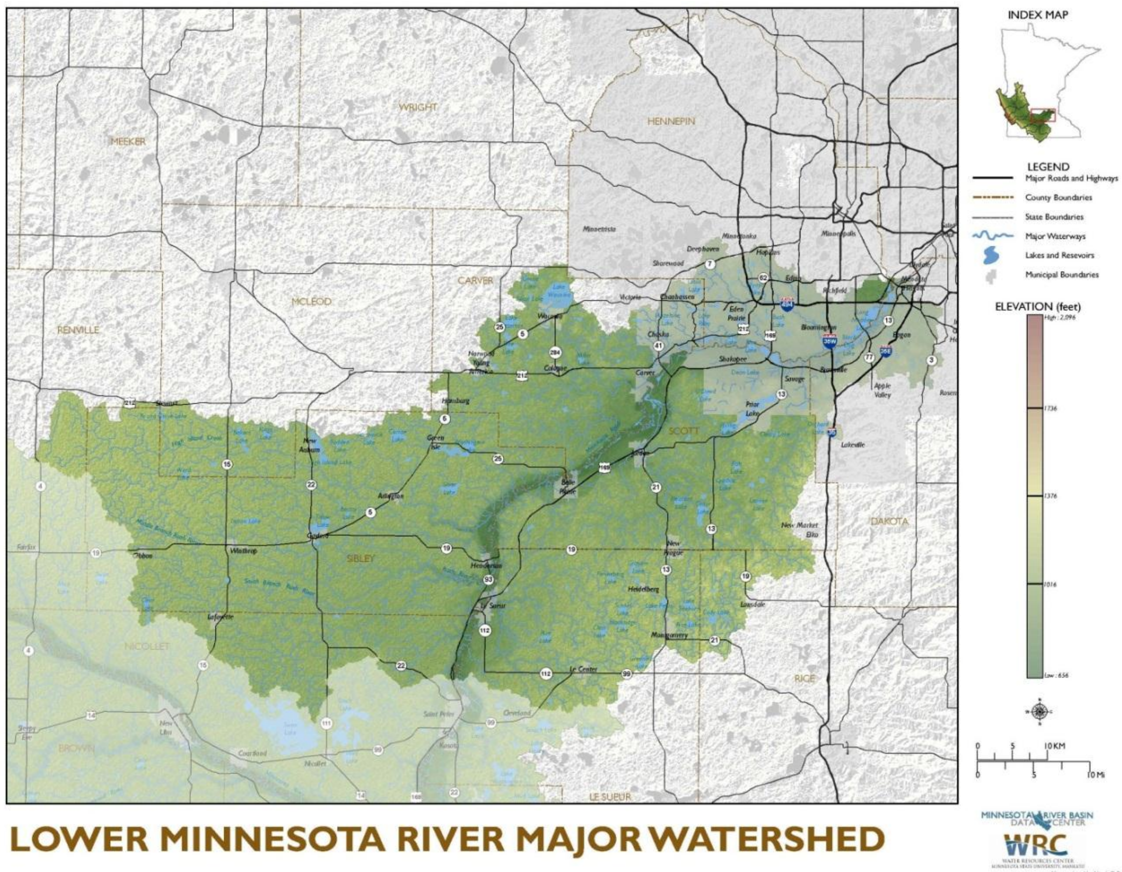


F. Map of the Minnesota River Basin

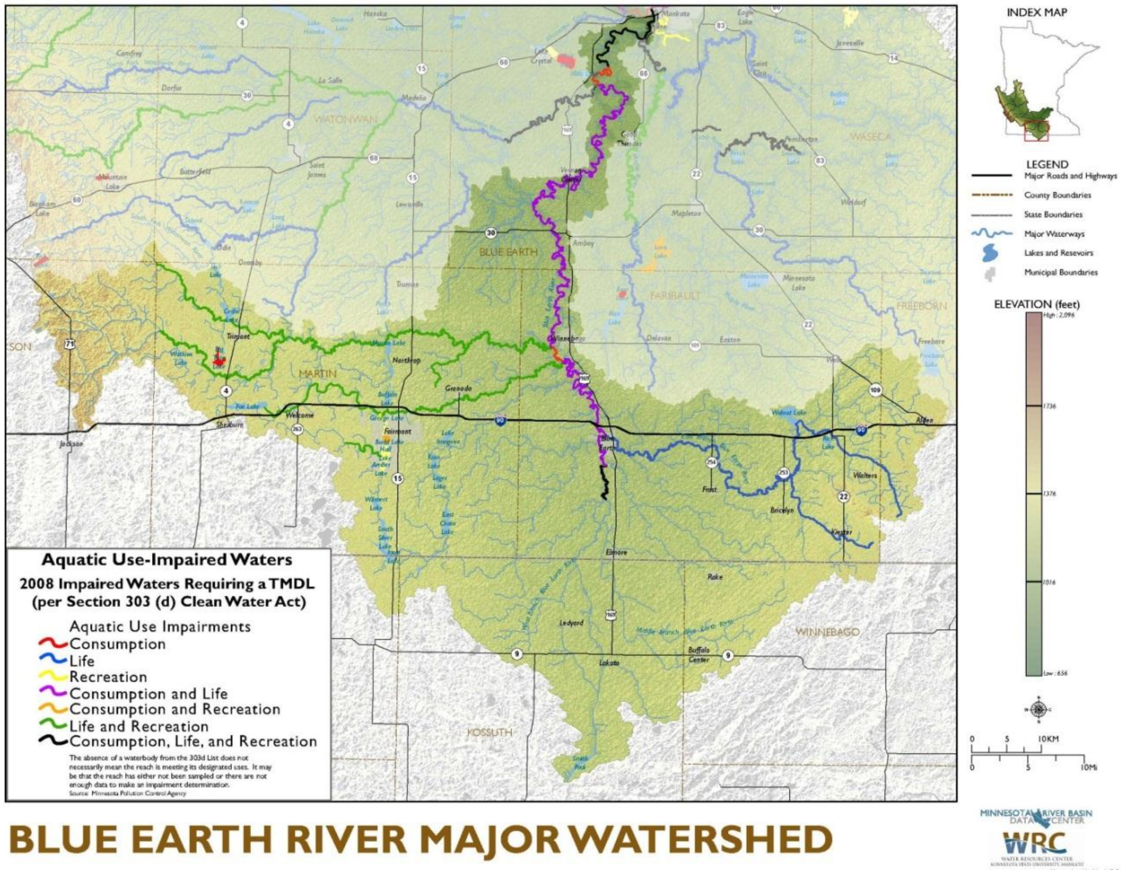


Source: MN River Basin Data Center

G. Map of the Lower Minnesota watershed



H. Map of Blue Earth watershed and impaired waters



I. Interview guide

Nitrogen BMP Interview guide
University of Minnesota

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

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?**

<u>Next, I would like you to discuss your decision-making process on your farm.</u>

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?**

<u>The following questions explore your use of nitrogen on your farm.</u>

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?

J. Interview sociodemographic form

ID# __________

Please do not put your name on this worksheet.

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**
Total	**100%**

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:

____

____

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
b. Completed high school
c. Some college but no degree
d. Associate degree or vocational degree
e. College bachelor's degree
f. Some graduate work
g. Completed graduate degree (Masters or PhD)

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

K. Nitrogen best management practice list

ID#: ______________________

Nitrogen Best Management Practices Checklist

Nitrogen BMP:	Definition/Benefit:	In Use (U)/Not in Use (N)
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	Using real-time plant-sensing technology to optimize nitrogen application while	

application	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 crops	Low maintenance, alternative crops used to generate 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

L. 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 you 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. You 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 management 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.

M. 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: _________