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Power of peers: How effective are Indiana farmer networks?

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POWER OF PEERS: HOW EFFECTIVE ARE INDIANA FARMER NETWORKS?

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For my wife.

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PREFACE

Large Scale Agriculture

Coming from America's Dairyland, I thought I knew a thing or two about farming. My grandparents were farmers, my friends are farmers, and I grew up surrounded by the scenic farmland of Wisconsin. Moving to Indiana and undertaking a research project in the heart of the Corn Belt made me realize how much I did not know about agriculture. The scale of the farming operations, size of individual fields, and massiveness of the equipment are on a whole other level. I have a greater appreciation for the often meticulous attention to detail it takes to be a successful farmer. Through this research I have learned about nutrient management and farming practices that were previously unknown to me; knowledge I will take with me as I continue to work in agriculture conservation.

Rewards and Challenges of Farmer Studies

Conducting a project where I would get to interact with agricultural producers was a primary reason why I came to Purdue. I could not be more pleased with the subjects of my work. Every farmer I met was cordial and accommodating. These men were proud of their profession and were happy to talk with me. However, studying farmers was not without its challenges. Farm work is seasonal and weather driven. It

was challenging at times to find a window to interview farmers due to the business of spring planting. Additionally, there are only two good windows for administering surveys: mid-summer and mid-winter. Farmers also tend to be private individuals and do not like to share too much information, making data collection a challenge. This was very apparent when attempting to collect social network data. Very few farmers were willing to share names of friends and acquaintances. However, I feel that regardless of the challenges, this is important, rewarding work, and I will continue to work in the ag conservation field.

ABSTRACT

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Several formal farmer networks have emerged throughout the Midwest to address the issue of nitrogen runoff and eutrophication. In Indiana, the On-Farm Network and Adapt Network attempt to enable farmers to learn together about improved nitrogen management practices. The goal of this study is to determine the effectiveness of these formal farmer networks. The research was guided by two main questions; (1) Are farmers who participate in the networks actually implementing better nutrient management practices? (2) Are participating farmers spreading their knowledge of better nutrient management practices to other farmers outside the formal networks?

Interviews with select network members were conducted in early 2014 and a mail survey of the 250 network members was conducted in the summer of 2014. Survey results were compared to the results of a statewide Indiana Nutrient Management Survey conducted during the winter of 2014.

The results show that network farmers vary significantly from non-network farmers in multiple ways. Network farmers have more positive attitudes towards water

quality, perceive water pollution as a more severe problem, and utilize more conservation practices than non-network farmers. Network farmers also vary in demographic characteristics. These network farmers were not different because of their involvement in the networks, but appear to have been different from non-network farmers prior to their involvement in the networks. Few farmers say that they have changed their nitrogen management practices because of what they have learned through their involvement with a network. Diffusion of nutrient management practices outside the networks seems very limited.

The findings do not suggest that farmer networks are a bad idea, but rather point to ways that they can be improved. For example, instead of targeting the farmers who have already adopted improved nitrogen management practices, a more effective arrangement would be to find a handful of progressive, influential farmers in each group and surround them with farmers who need to adopt better nitrogen management practices. The few progressive farmers serve as examples to the others, and the farmers that need help receive the data and assistance they need to improve their farming practices. Another recommendation is to increase the number of group meetings during the year. One meeting is insufficient to build the trust and report necessary for farmers to accept and adopt the technologies being shared by others. Finally, outreach should focus on economic arguments for improved nitrogen management. The network farmers are motivated by economics than environmental concerns and outreach efforts should reflect that.

CHAPTER 1. INTRODUCTION

Agricultural yields have skyrocketed during the post-World War II era. Advances in farming technology, such as widespread availability of hybrid seed and the development of synthetic chemical pesticides and fertilizers, have resulted in a doubling of global cereal crop production (Tilman et al., 2002). However, this increase in production has come at the cost of environmental degradation. Specifically, the increase in nitrogen inputs to cropland has resulted in severe impairments to the quality of the nation's surface and ground waters.

Nitrogen runoff and leaching are a severe problem in row crop systems (Randall and Mulla, 2001). Over application of nitrogen fertilizer, poor timing of application, and low nitrogen use efficiencies of crops allows nitrogen to migrate to groundwater via leaching and surface waters via runoff (Randall and Mulla, 2001; Cassman et al., 2003; Xiao-Tang Ju et. al., 2009).

Eutrophication of water bodies is the primary concern of nitrogen loss (Heathwaite et al., 1996; Caswell et. al., 2001). The availability of excessive nitrogen in aquatic systems leads to algal blooms. When algae die, the decomposition of their bodies consumes the oxygen from the water, leading to hypoxia (Hessen et al., 1997; Tilman et al., 2002). The most widely known example of hypoxia is occurring in the Gulf of

Mexico, commonly referred to as the "Gulf Dead Zone". The primary cause of Gulf hypoxia is agricultural nitrogen from Midwest farms (Mitsch, 2002).

Reducing nitrogen loss is most effectively accomplished through the implementation of nutrient management practices. A variety of nutrient best management practices are available, but all aim to increase nitrogen use efficiency (Tilman, 2002; Roberts, 2008). The most promising of practices involve site-specific management techniques, such as soil testing, split application, and variable rate application (Buresh and Witt, 2007). Nitrogen management practices generally consist of decisions regarding soil and plant assessment and management and application techniques (Sharpley et al., 2006). In addition to reducing nitrogen runoff, nutrient best management practices can potentially increase farm profitability (Matson et al., 1998; McCann et al., 2006; Valentin et al., 2004).

While practices have been identified that improve nitrogen use efficiency and reduce nitrogen content in runoff, widespread adoption of these practices by farmers has not occurred. Lack of perceived off farm impacts (Reimer et al., 2011), lack of environmental awareness (Prokopy et al., 2008), farmer age (Baumgart-Getz et al., 2011), lack of knowledge and skill regarding practices (Lambert et al., 2006), and lack of information about practices (Daberkow and McBride, 2003) are factors that have all been suggested to explain the lack of management practice adoption among farmers. Factors that increase the likelihood of adoption include the trialability of the practice (Pannell et al., 2006), a practice's positive impact on profitability (Beegle et al., 2000), and a farmer's sense of stewardship towards the land (Reimer et al., 2011). Additionally, the

role of networking has been shown to be a positive factor on adoption of conservation practices.

There are two basic types of social networks: formal and informal networks. Formal networks are organizational or structured networks (Monge & Contractor, 2003). There is organization and explicit purpose to a formal network with defined members. Examples of formal networks include members of a club, church body, or team of coworkers. Informal networks are unstructured, natural interrelations of individuals who interact on their own terms (Krackhardt & Hanson, 1993). Informal networks often consist of family, neighbors, and friends. Members of informal networks associate without organizational prompting.

Prokopy et al. (2008) explored the impact of networks on conservation practice adoption in their vote count review of adoption literature. Local networks were characterized as farmer-to-farmer interactions, business networks as the interactions between farmers and agribusiness, and agency networks as interactions between farmers and agency personnel. Local farmer-to-farmer networks diffuse knowledge and innovations horizontally, while business and agency networks represent a vertical diffusion of information. The results of that study show networks to have a significant positive impact on adoption of conservation practices.

Baumgart-Getz et al. (2011) conducted a meta-analysis of the management practice adoption literature, examining the size of the effect of each variable. Network effects were included in the analysis. In addition to Prokopy's three categories of local, business, and agency networks, Baumgart-Getz et al. included the additional category of university networks. The results of this analysis again illustrate the positive impact that

networks have on farmer adoption of conservation practices. Most compelling from this study, however, is the large size of the effect that local networks have on adoption. Both Prokopy et al. (2008) and Baumgartz-Getz et al. (2011) indicate that networks have a positive influence on conservation practice adoption by farmers, but more detailed inquiry is required.

The literature is richer in examples of the role of social networks in the field of forestry. Forest landowner networks are gaining in popularity in the US, (Blinn et al., 2007; Rickenbach, 2009) and especially in Scandinavia (Rickenbach, 2009; Korhonen et al., 2012). In all these studies, the people involved in a forestry network or cooperative are owners of forestland who are interested in improved forest management. Their participation is voluntary. The relationship between landowners and forestry professionals play a role in landowner decision making (Gass et al., 2009; Knoot et al., 2011; Rickenbach, 2009). The interaction among peers provided the opportunity to share knowledge and insights concerning management decisions (Hujala & Tikkanen, 2008; Schraml, 2005). The combination of information sources from both professionals and fellow landowners have impacts on management decisions. These studies suggest social networks influence adoption of practices.

The exact source of influence can be varied in social networks. Rickenbach (2009) found that landowners utilize a combination of expert and peer advice when making management decisions. The forestry cooperative in the Rickenbach study was considered to be trustworthy by its members. However, the cooperative was not the "sole source provider" of information (Rickenbach 2009). Coop members were very likely to seek advice outside the cooperative from among their nonmember peers. Hujala et al.

(2007) documented that not all landowners weigh advice from others the same way. Some landowners were eager for professional advice, while others were unlikely to utilize the expertise. This discrepancy was suggested by a variance in the level of landowner expertise and interest in forest management.

These previous studies have described the effect that social networks have on forest landowner decision making. Hujala and Tikkanen (2008) suggested that social networks could be utilized to diffuse management information among landowners. The results of Kornhonen et al. (2012) "suggest that these forest owners could be channels to reach passive forest owners" (Kornhonen et al, 2012). Knoot and Rickenbach (2011) showed that increased social ties resulted in greater adoption of forestry best management practices. Kueper et al. (2013), in a case study of five landowner cooperatives in the United States and Australia, reveals that social networks provide a means of transmitting expert derived information, as well as peer knowledge among landowners. The recent forestry literature shows that social networks are a viable opportunity for spreading information and advice among forest landowners and impacts their decision making.

What remains to be further explored is the role of social networks on farmer decision making, specifically on the decision to adopt a nutrient management practice. Widespread adoption of nutrient management practices is necessary to reduce the tremendous impact nitrogen runoff is having on water resources (Tomer et al, 2013). Social networks may be a means of increasing adoption of these practices.

Two formal farmer networks in Indiana have the express purpose of improving nitrogen management practice adoption, the On-Farm Network and Adapt Network. These networks are formal because they have a structured organization and have defined

roles and purposes. However, they potentially have an influence on the informal networks of their members. The farmers, advisors, and agency staff that make up these formal networks may disseminate information gained by these interactions with the members of their individual informal networks.

Theory

The influence of social networks on adoption of nutrient management practices can be explained by two theories, the Reasoned Action Approach (Fishbein and Ajzen, 2010) and the Diffusion of Innovation (Rogers, 2003). Both of these theories are widely used to explain adopter behavior. Reimer et al. (2012), finding that both theories have their strengths and weaknesses, combined the two, by utilizing the five acceptability characteristics (relative advantage, compatibility, complexity, trialability, and observability) of Rogers' (2003) Diffusion of Innovation theory as influences on the attitudes, norms, and perceived behavioral control factors in the Reasoned Action Approach.

The Reasoned Action Approach explains that a person's decision to adopt a behavior is based on: 1) attitudes toward the behavior; 2) subjective and descriptive norms; and 3) perceived behavioral control (Fishbein and Ajzen, 2010). Of the three factors, the role of social networks is most salient to establishing norms.

Subjective norms are what a person believes others want them to do, while descriptive norms are what a person believes others are doing. Norms, both subjective and descriptive, are established through observations of and interactions among peers (i.e. social networks). What is acceptable and desirable is determined by the approval of other

individuals. As more individuals adopt a behavior, the norms change to reflect the acceptability of that behavior.

Social networks can spread the adoption of nitrogen management practices by establishing norms within a network. As individuals interact and observe a management practice being adopted by a few farmers, the descriptive norms may change due to individuals believing that others are adopting the practice. Subjective norms are also changed by the perception that because others are adopting the nutrient management practices, they also want me to adopt the practices.

This flow of adoption from few to many is explained by Rogers' (2003) Diffusion of Innovation. Rogers categorizes people into five categories: innovators, early adopters, early majority, late majority, and laggards. A small number of people, innovators, are willing to adopt new practices and technologies as soon as they become available. "They are the gatekeepers bringing the innovation in from outside the system" (Rogers, 2003). After the innovators have adopted a practice, the early adopters take hold of it. Early adopters are often respected leaders within a community. Their influence is instrumental in disseminating the practice to the rest of the community. "Early adopters put their stamp of approval on a new idea by adopting it" (Rogers, 2003). If the early adopters find a practice is beneficial and desirable, others will follow suit.

Innovations, such as nutrient management practices, are disseminated from the innovators to the early adopters and then on down to the early and late majorities, and finally the laggards. The influence of early adopters is crucial to the successful spread of a practice. Social networks can act as conduits of innovation. Many of the farmers who participate in the formal networks are suspected to be innovators and early adopters. By

providing a forum for those innovators and early adopters to share their experiences and knowledge with other farmers, the speed of diffusion between network members and then to outside farmers could be accelerated.

Indiana On-Farm Network

The On-Farm Network originated in Iowa in 2000. The purpose of the program is to help farmers understand how well they manage their nitrogen, in an effort to reduce nitrogen losses to surface and ground water. The concept was brought to Indiana in 2010 and is funded by the Indiana State Department of Agriculture, along with industry groups like the Indiana Soybean Alliance and Indiana Corn Marketing Council. As of the 2013 growing season, the network's membership consists of approximately 250 member farmers in 18 grower groups. In 2015, the Indiana On-Farm Network changed its name to INfield Advantage.

Participants are recruited by the group leaders, usually a county soil & water staff member. There are 8 to 20 farmers in a network group. Farmers sign up their participating fields for the coming growing season in late winter. Typical enrollment is two fields approximately 40 acres in size each. The group leader then digitizes the fields in a GIS shapefile. This geographic information is sent to an aerial photography contractor who then flies over all the group participants' fields in the same day in early August.

Three different camera/sensors are utilized for the photography. A true color photo is taken of each field, along with a near-infrared and a multispectral image. The near-infrared image makes differences in crop color more apparent, and the multispectral

image measures the photosynthetic level of the plants. These images magnify variations in the crops which could signal nitrogen deficiencies.

The images are then sent to an analyst. The analyst selects three points in each field that represent typical crop growth in different soil types, along with a single fourth point in an area that appears to have a deficiency or irregularity. The geographic coordinates of these points are sent to the group leader.

After the corn reaches physiological maturity, black layer, the group leader or their staff walk out to the four points in each farmers' fields to collect corn stalk samples for corn stalk nitrate tests. Collecting ten stalks at each point, the samples are sent to a lab for analysis. The corn stalk nitrate test measures how much nitrogen is remaining in the corn stalk at the plant's maturity. In conjunction with yield data, the corn stalk nitrate test is used to evaluate the amount of fertilizer applied to a field (Kyverga et al., 2011). The ideal level of remaining nitrate is 500-2000 parts per million (ppm). If the levels are lower than 500ppm and the yield was low, there is a chance that the corn grain did not grow as large as it potentially could have if more nitrogen had been available. If yield was typical and nitrate levels are below 500ppm, then the level of fertilization was near ideal, the plant having used up all the available nitrogen. If levels are above 2000ppm and yield was typical, it is likely that an excess of nitrogen was available, more than the crop could utilize.

Another data source comes from conducting nitrogen rate replicated strip trials. Farmers who wish to conduct these trials work with their group leader to mark off the fields into narrow strips prior to planting. Generally, three different nitrogen rates are applied three times each in alternating strips. This helps reduce the influence of location,

soil type, etc., on the results of the trials. Yield data is collected by the on-board yield monitor at harvest, and the most efficient fertilizer rate can be calculated.

All of this information; the aerial imagery, corn stalk nitrate test results, and replicated strip trial results, are collected by the group leaders and analyzed and organized for distribution back to the participating farmers. At an annual winter meeting, each farmer receives a binder containing all the aggregated data from their group's fields, as well as the maps and specific corn stalk nitrate test results to every farmers' fields.

During the meeting, a representative from the Indiana State Department of Agriculture (ISDA) provides a summary of the past year's weather, growing conditions, and the nitrogen management regimes utilized by the farmers. Then an analyst goes through the field images and discusses potential problems and solutions with the farmers. This is the part of the meeting that is fairly interactive, with other farmers chiming in with their questions and opinions.

Adapt Network

The Environmental Defense Fund funds and organizes the Adapt Network. Launched in 2004 to combat agricultural nitrogen loss affecting the Chesapeake Bay Watershed, the Adapt Network has since expanded to five project areas, including one that covers a small portion of Indiana. The Maumee Adapt Network was started in 2008 to address algal blooms in western Lake Erie. This project area includes 100 farms, of which 30 are in Indiana and the rest in Ohio. These farmers also have small group meetings, but all have the same group leader, a private crop advisor. The mechanisms by which the network operates are the same as On-Farm (aerial imagery, corn stalk nitrate

tests, and replicated strip trials), but with a much greater emphasis on strip trials. All participants are expected to conduct replicated strip trials.

These two formal networks and the impact they have on farmers' adoption of conservation practices are the focus of this study.

Research Questions and Hypotheses

The overarching question posed in this thesis is: Are formal farmer networks effective at increasing adoption of nutrient best management practices? This research is guided by several sub-questions and hypotheses.

The first question concerns whether the farmers participating in these formal networks are adopting better nutrient management practices at a greater rate than other farmers in general across Indiana. The Natural Resources Social Science Lab at Purdue University conducted a statewide survey in the winter of 2014 to assess the baseline adoption of nutrient management practices among farmers in Indiana. This provided the opportunity to do a comparison of adoption rates between the network population and the general population. I hypothesize that network farmers are inherently different than non-network farmers. Specifically, I believe network farmers to be better educated, have more positive attitudes towards improving water quality, and be more aware of water quality impairments than non-network farmers. I also hypothesize that farmers who participate in formal networks are more likely to adopt nitrogen management practices than farmers who do not participate.

The second set of questions is about diffusion of practices. There are two different types of diffusion of interest; diffusion within the networks and diffusion

outside the networks. Are farmers in the formal networks teaching each other about nitrogen management? Are farmers in the networks spreading their knowledge of nitrogen management to farmers outside the formal network?

Another subject to be explored is how well the networks operate. This is more a matter of how satisfied participating farmers are with the programs. Do farmers find the networks to be useful? Are farmers happy with the information they receive?

Methods

The study is a mixed method design. The first phase involved conducting in-depth interviews with members of the On-Farm Network and Adapt Network. The information gathered during these interviews was then used to inform the design of a mail distributed survey instrument that was used to conduct a census of the entire Indiana On-Farm Network and Adapt Network populations.

Semi-structured interviews with network members took place from March through May, 2014. Fifteen interviews were conducted with Indiana On-Farm Network members and five with Adapt Network members. The interviewees in the Indiana On-Farm Network were chosen from a list of all network members, provided by ISDA after the signing of a Memorandum of Understanding. The contact list for the Adapt Network was provided by the Indiana group coordinator. Network farmers were solicited by phone for an interview, with 13% of contacts made refusing to participate. When scheduling a day of interviews, the first contact was chosen at random. Once the first interview was scheduled, other network members in the vicinity were lined up for subsequent interviews for the day.

An interview guide was utilized to ensure that the relevant topics were addressed during the interviews. The guide was created in February of 2014 and tested and reviewed by members of the Natural Resource Social Science Lab. The revised interview guide was then piloted with a member of the On-Farm Network to test its validity with real subjects. That pilot interview went well, therefore the guide was considered ready for widespread use.

The questioning began with requests for general background on the farmer and his farm. These were mostly for warm up purposes, with little of this information relevant for analysis purposes. The questions then transitioned to more in-depth inquiries regarding the reasons for joining the network (either On-Farm or Adapt), the benefits of participating in the network, diffusion of practices within and outside of the network, and ways that the network could be improved. These conversations were recorded using a small audio recorder. The audio files were then transferred onto a flash drive to be transcribed by undergraduate employees from the Natural Resources Social Science Lab.

Once transcriptions were competed, the interviews were coded using NVivo 10 software. The codebook (see Appendix D) was initially developed on the main questions I was attempting to answer. Four major categories of themes were identified; reasons for joining a network, benefits of participation, whether change in management has occurred or not, and farmer feedback about the networks. After an initial round of coding, several more themes were added based on responses gleaned from the interviews. Intercoder reliability testing was conducted with one other reader. Six of the 20 interviews were tested, resulting in a Cohen's kappa of 0.93, indicating high intercoder reliability.

The network survey was based upon a previous survey developed in the fall of 2013 for a coalition of agriculture organizations. That survey was distributed to a statewide sample of farmers to assess their knowledge and use of nutrient management practices. The survey was pretested with an advisory group from the Indiana Farm Bureau, and distributed during January and February of 2014.

Development of the network specific survey began in earnest in April, 2014. Questions attempted to gather information on why farmers joined a network, their level of participation, feedback regarding the usefulness of the networks, and to document changes in nitrogen management. Answer options were developed based on interview responses to similar questions. These were in addition to the questions regarding awareness and attitudes towards water quality and questions about nutrient management that were identical to those on the statewide nutrient management survey. These identical questions were used to facilitate a comparison between network and non-network farmers.

I attempted to gather data to perform a social network analysis using a method utilized by Rickenbach (2009). Participants were asked to list five members of their network group with whom they discuss nitrogen management. This was chosen over providing a roster of all group members' names due to privacy concerns. Unfortunately, most respondents did not answer the question, so the network analysis could not be performed. Implications of this will be discussed further in later chapters.

The survey was conducted during July and August of 2014. The survey, a census of all Adapt Network and On-Farm Network participants in Indiana, was administered to the farmers on the complete list received from the Indiana State Department of

Agriculture (ISDA) and the Adapt Network group coordinator. The group leaders from both Indiana On-Farm Network and the Adapt Network were contacted by the ISDA and urged to encourage their growers to participate in the survey. Individual responses were not reported to ISDA, only the response rates. Groups that exceeded 75% response rate were rewarded with $250 from the Indiana Corn Marketing Council to be used for future programing.

The survey was administered using the five wave Dillman Method (Dillman, 2000). Two slightly different versions were for the On-Farm Network and Adapt Network, the wording reflecting the respective networks the surveys were sent. A letter was mailed to all members informing them that they would be receiving a survey soon. Additionally, this letter also contained a web address so those who preferred to take the survey online could do so. This web option was included on all further mailings as well. Five days following the letter, a first copy of the survey was mailed, including a prepaid, preaddressed return envelope.

Between the first and second mailings, it was discovered that there were two questions in the 'Network Opinions' section of the survey that were double barreled; asking two questions in one. These questions were amended on all future mailings, as well as rectified in the online versions.

Two weeks after the first survey, a second was distributed to those who had not yet completed it. A week after the second survey, a postcard reminder was sent to unresponsive addresses, and two weeks after the postcard, a final survey was sent to the last of the nonparticipating farmers. This final survey also contained a note informing the

farmers that this would be the final contact from us and they would receive no further surveys.

After accounting for bad addresses an overall response rate of 61.3% was achieved. The response rates for the On-Farm Network and Adapt Network were 62.8% and 50.0% respectively. Responses were received from all 19 grower groups in the mailing list.

In addition to the interviews and survey, I also attended four of the Indiana On-Farm Network group meetings, three in the winter of 2012 and one in the winter of 2015. I observed the meeting proceedings to gain a better understanding of how these groups actually operate. Any notes or anecdotes regarding the meetings mentioned in the results and discussion stem from these observations.

CHAPTER 2. RESULTS

While chronologically the interviews took place prior to the survey, the survey results will be reported first. The data from of the survey will raise questions that the interview data will be able to address more completely. For all results, unless noted, the responses of the Indiana On-Farm Network members and Adapt Network members have been aggregated. There were not enough responses (15) from the Adapt Network alone for reliable analysis.

Survey

The results of the survey fall into two main categories: (1) comparative and (2) network farmers only. The comparative findings show the similarities and differences in the attitudes and practices of network farmers and 'typical' farmers. The network farmers only findings provide a look at who the network farmers are, why network members participate, their opinions of the networks, and the outcomes of participation.

Comparing Network Farmers and Typical Farmers

By utilizing some identical questions from the 2014 statewide survey of Indiana farmers, comparisons can be drawn between network farmers and non-network Indiana farmers.

Comparisons were conducted with the Mann-Whitney U nonparametric comparative mean test. This test is equivalent to a t-test that would be used to compare

means for parametric data. Effect sizes were calculated using the formula r=Z/sqrt(N); where Z is the standardized test statistics and N is the combined number of observations from both surveys (Field 2013). Two proportion z-tests were used to compare adoption rates of nutrient management practices of network and non-network farmers. For all statistical analyses, $P< 0.05$ is considered significant.

Demographic Comparison

Demographic and basic farm information was collected during the survey. The data provide a snapshot of the types of people participating in the networks.

All but one of the network farmer respondents are male, while 94% of non-network farmers are male. The network farmers are well educated, with 48.3% possessing a bachelor's degree or higher. This far exceeds the state average comparable level of educational attainment of 22.7% (US Census, 2011) and the non-network farmers, of whom 31.3% have bachelor's degrees or higher. Network farmers are younger than non-network farmers, average age 54 and 62, respectively. Average farm size for network farmers is 1,911 acres, while average farm size is 1,583 acres for non-network farmers. Nearly 60% of network participants are full-time farmers, working no days off farm, verses 52.2% of non-network farmers who are full time farmers.

Awareness and Attitudes

Two series of questions sought to measure the network farmers' awareness of water pollutants and their sources. These questions were not intended as a quiz of the respondents' knowledge but were included in the surveys to understand how farmers perceive water pollution in their area.

Examining the awareness of network farmers and non-network farmers revealed some significant findings. Sediment, nitrate, phosphorus, and bacteria were all considered more of a problem by network farmers than non-network farmers (see table 1). The network farmers are more likely to be aware of water pollutants than non-network farmers. Additionally, the percentage of respondents selecting "don't know" was much higher among non-network farmers than network farmers. This indicates that network farmers may be better informed about water quality problems in their area than non-network farmers.

Table 1: Awareness of Water Pollutants: Network vs. Non-Network Farmers[1]

In your opinion, how much of a problem are the following pollutants in the area where you own farmland?	Network Mean	Non-Network Mean	P-value (Mann-Whitney U)	Effect Size	Network "don't know"	Non-Network "don't know"
Sedimentation/silt	2.69	2.00	.000***	-0.13491	0.6%	9.6%
Nitrate	2.54	1.88	.000***	-0.08961	5.7%	15.3%
Phosphorus	2.45	1.80	.000***	-0.07115	6.3%	16.6%
Bacteria (E. coli)	2.08	1.60	.000***	-0.05768	12.0%	17.2%

[1]Answer options: not a problem (1), slight problem (2), moderate problem (3), severe problem (4), don't know (9). *Statistically significant at the .05 level, ** .01 level, and *** .001 level.

Similarly, significant differences were found between network farmers and non-network farmers concerning their awareness of 13 pollutant sources (see table 2). Network farmers are more likely to be aware of pollutant sources than non-network farmers. All differences were significant beyond the .000 level.

Table 2. Awareness of Pollution Sources: Network Farmers vs Non-Network Farmers[2]

In your opinion, how much of a problem are the following pollutant sources in the area where you own or rent farmland?	Network Mean	Non-Network Mean	P-value (Mann-Whitney U)	Effect Size	Network "don't know"	Non-Network "don't know"
a. Discharges from industry into streams and lakes	2.07	1.68	.000***	-0.17825	8.2%	8.9%
b. Discharges from sewage treatment plants	2.36	1.78	.000***	-0.20548	8.9%	8.0%
c. Soil erosion from farm fields	2.66	2.19	.000***	-0.20223	1.3%	4.1%
d. Soil erosion from shorelines and/or streambanks	2.38	1.86	.000***	-0.20183	6.3%	6.6%
e. Lawn fertilizers and/or pesticides	2.49	1.92	.000***	-0.21357	7.0%	8.6%
f. Fertilizers or manure used for crop production	2.20	1.77	.000***	-0.20364	1.9%	6.7%
g. Improperly maintained septic systems	2.46	1.79	.000***	-0.26291	7.0%	10.8%
h. Manure from farm animals	1.96	1.58	.000***	-0.2099	2.5%	6.1%
i. Littering/illegal dumping of trash	2.45	2.16	.000***	-0.11734	3.2%	4.9%
j. Pesticides or herbicides used for crop production	1.94	1.76	.000***	-0.12035	3.8%	7.7%
k. Animal feeding operations	1.81	1.52	.000***	-0.18347	3.8%	6.5%
l. Urban stormwater runoff (e.g. highways, rooftops, parking lots)	2.43	1.90	.000***	-0.19567	5.1%	7.7%
m. Removal of streambank vegetation	2.06	1.71	.000***	-0.17193	3.2%	9.2%

[2]Answer options: not a problem (1), slight problem (2), moderate problem (3), severe problem (4), don't know (9). *Statistically significant at the .05 level, ** .01 level, and *** .001 level.

The final question series in this section measured farmers' attitudes toward water quality. Network farmers are similar to non-network farmers in most respects, but differ significantly in three important factors (see table 3). Network farmers are likely to have a less positive attitude towards using recommended management practices to improve water quality. However, network farmers are more likely to believe that their actions have an impact on water quality and they are much more likely to be willing to change their management practices to improve water quality.

Table 3. Attitudes Towards Water Quality: Network Farmers vs Non-Network Farmers[3]

Please indicate your level of agreement or disagreement with the statements below.	Network Mean	Non-Network Mean	P-value (Mann-Whitney U)	Mann-Whitney U	Z-score	Effect Size
a. Using recommended management practices on farms improves water quality.	3.96	4.09	.021*	59657.000	-2.314	-0.07189
b. It is my personal responsibility to help protect water quality.	4.33	4.20	.113	62056.500	-1.586	-0.04918
c. It is important to protect water quality even if it slows economic development.	3.94	3.93	.753	64596.500	-.315	-0.00984
d. My actions have an impact on water quality.	4.21	4.04	.036*	59485.500	-2.101	-0.06543
e. I would be willing to pay more to improve water quality (for example: through local taxes or fees).	2.65	2.60	.581	64800.000	-.552	-0.01713
f. I would be willing to change the way I manage my property to improve water quality.	3.75	3.50	.000***	54877.500	-3.733	-0.11587
g. The quality of life in my community depends on good water quality in local rivers, streams, and lakes.	4.00	3.95	.739	65589.000	-.333	-0.01034

[3]Answer options: strongly disagree (1), disagree (2), neither agree nor disagree (3), agree (4), strongly agree (5). *Statistically significant at the .05 level, ** .01 level, and *** .001 level.

Decision Making

Respondents were asked to rate how important each given factor is when they make nutrient management decisions on their farm. Network farmers differed significantly in six out of the 10 factors, however, the network farmers rated every factor as more important than non-network farmers (see table 4). The most differential decision making factors were 'a lack of available information about a practice' and 'soil health'.

Table 4. Importance of Decision Making Factors: Network Farmers vs Non-Network Farmers[4]

When you make decisions about nutrient management on your farm operation, how important is each of the following?	Network Mean	Non-Network Mean	P-value (Mann-Whitney U)	Z-score	Effect Size
a. Personal out-of-pocket expense	4.31	4.01	.049*	-1.969	-0.06248
b. Lack of government funds for cost share	2.79	2.67	.322	-.990	-0.03159
c. Not having access to the equipment I need	3.29	3.05	.064	-1.850	-0.05968
d. Lack of available information about a practice	3.37	2.99	.001***	-3.270	-0.10489
e. No one else I know is implementing the practice	2.36	2.35	.710	-.372	-0.01194
f. Concerns about reduced yields	4.19	3.86	.012*	-2.521	-0.08033
g. Soil health (organic matter, soil biological functions, nutrient retention, etc.)	4.39	4.09	.001***	-3.346	-0.10694
h. Evidence of the economic benefits	4.25	4.05	.041*	-2.048	-0.06539
i. Evidence of the environmental benefits	4.04	3.87	.077	-1.770	-0.0566
k. Not being able to see a demonstration of the practice before I decide	3.01	2.75	.012*	-2.514	-0.08105

[4]Answer options: not at all important (1), somewhat important (2), undecided (3), important (4), very important (5). *Statistically significant at the .05 level, ** .01 level, and *** .001 level.

Management Practices

Farmers were asked to rate their familiarity with or use of various conservation practices (see table 5). Network farmers are more likely to be familiar with or currently use conservation practices than non-network farmers. Figure 1 shows the percentage of both network and non-network farmers who are currently using conservation practices. For all practices, far more network farmers than non-network farmers are using conservation practices.

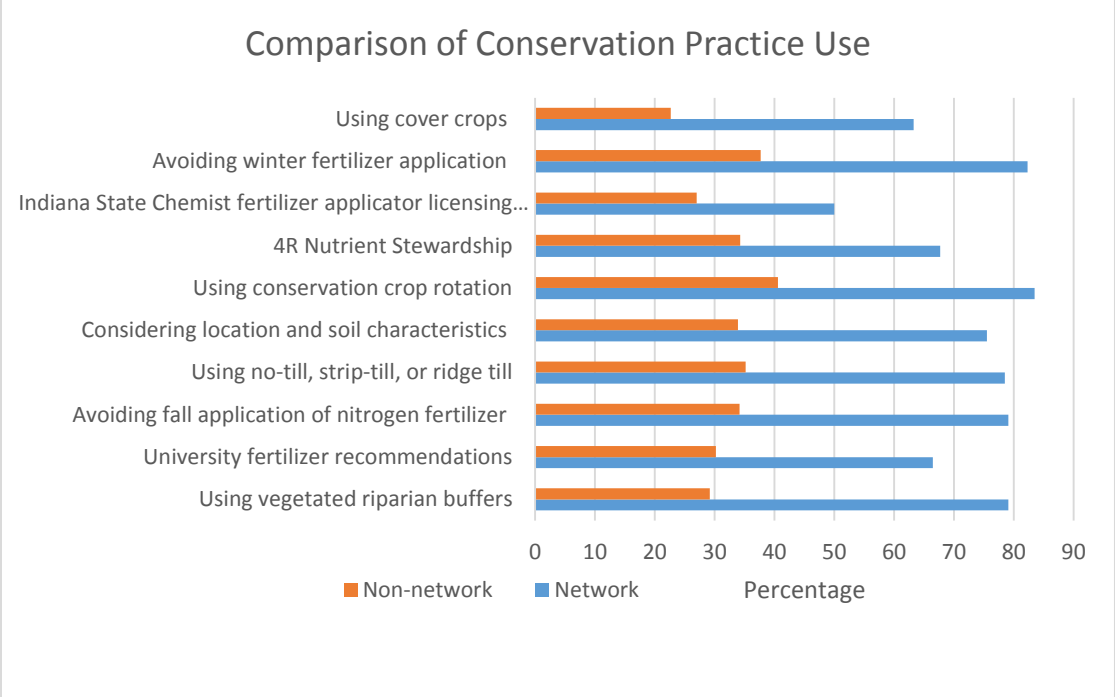

Figure 1. Comparison of Conservation Practice Use: Network vs Non-Network farmers.

Table 5. Familiarity & Use of General Practices: Network Farmers vs Non-Network Farmers[5]

Please indicate which statement most accurately describes your level of experience with each practice or rule listed below.	Network Mean (% currently use)	Non-Network Mean (% currently use)	P-value (Mann-Whitney U)	Z-score	Effect Size
a. Planting a vegetated buffer along streams, ditches, ponds, etc.	3.78 (79.1%)	3.38 (29.2%)	.000***	-5.442	-0.19374
b. Following university recommendations for fertilization rates	3.60 (66.5%)	3.33 (30.2%)	.007**	-2.694	-0.09573
c. Avoiding fall application of nitrogen fertilizer to reduce environmental losses	3.80 (79.1%)	3.57 (34.2%)	.001***	-3.230	-0.11655
d. Using no-till, strip-till, or ridge till	3.76 (78.5%)	3.62 (35.2%)	.011*	-2.559	-0.09042
e. Considering location and soil characteristics to minimize leaching or runoff of fertilizers	3.67 (75.5%)	3.48 (33.9%)	.029*	-2.190	-0.07777
f. Using conservation crop rotation to improve soil nutrient content	3.81 (83.5%)	3.71 (40.6%)	.058	-1.896	-0.06597
g. 4R Nutrient Stewardship – using the Right fertilizer source at the Right rate, at the Right time, and in the Right place	3.46 (67.7%)	3.33 (34.3%)	.351	-.932	-0.03253
h. The Indiana State Chemist fertilizer applicator licensing rule	3.18 (50.0%)	3.06 (27.0%)	.525	-.636	-0.02319
i. Avoiding fertilizer application on frozen and/or snow-covered soil	3.82 (82.3%)	3.66 (37.7%)	.022*	-2.289	-0.08249
j. Using cover crops for erosion protection and soil improvement	3.60 (63.3%)	3.31 (22.7%)	.000***	-4.538	-0.16115

[5]Answer options: never heard of it (1), somewhat familiar with it (2), know how to use it (3), currently use it (4). *Statistically significant at the .05 level, ** .01 level, and *** .001 level.

Farmers were also asked more specific question regarding four important nutrient management practices; regular soil testing, variable rate fertilizer application, split rate fertilizer application, and utilizing a nutrient management plan. Farmers were first asked if they used the practice or not. If they responded, 'yes', a follow-up question asked what percentage of their cropland they used the practice on. Farmers that said they used a practice on 76-100% of their cropland are considered to be full adopters.

Network farmers are more likely than non-network farmers to utilize all four of these nutrient management practices (see figure 1). Significance testing was conducted using the two-proportion z test. All four differences in practice adoption are significant at the .001 level or more (see tables 6-9).

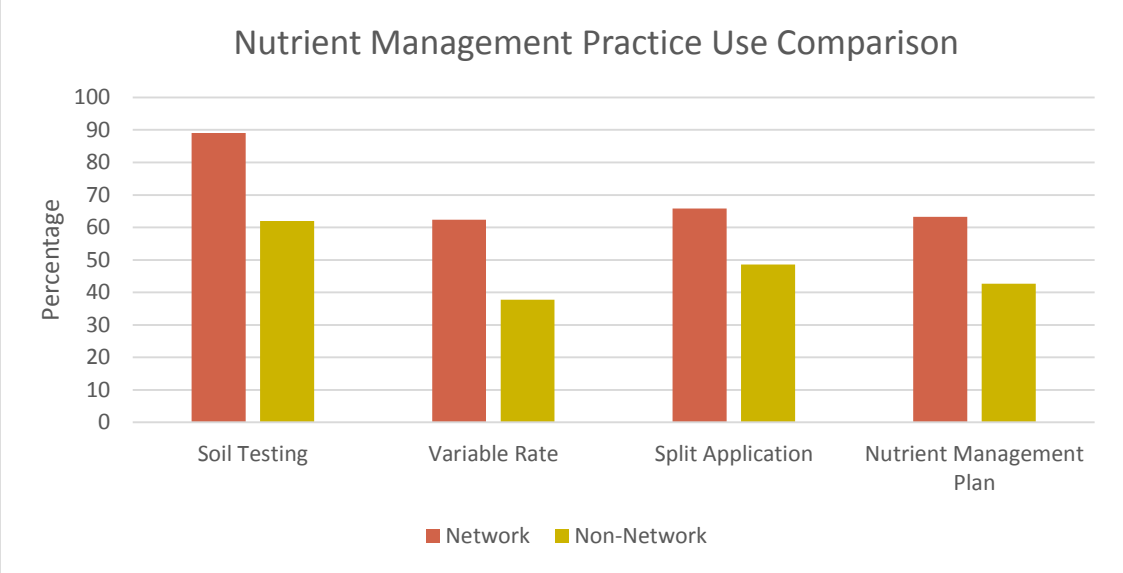

Figure 2. Nutrient Management Practice Use Comparison: Network vs Non-Network Farmers.

Table 6. Use of Regular Soil Testing

Soil Testing	Network	Non-Network	Total
No	17	327	344
%	10.98	38.02	51.27
Yes	138	533	671
%	89.03	61.97	66.11
Total	155	860	1015
%	100	100	100

P<.000

Table 7. Use of Variable Rate Application

Variable Rate	Network	Non-Network	Total
No	58	501	559
%	37.66	62.24	58.29
Yes	96	304	400
%	62.34	37.76	41.71
Total	154	805	959
%	100	100	100

P<.000

Table 8. Use of Split Fertilizer Application

Split Application	Network	Non-Network	Total
No	51	398	449
%	34.23	51.42	48.65
Yes	98	376	474
%	65.77	48.58	51.35
Total	149	774	923
%	100	100	100

P<.000

Table 9. Use of Nutrient Management Plan

Nutrient Management Plan	Network	Non-Network	Total
No	32	276	308
%	36.78	57.26	54.13
Yes	55	206	261
%	63.21	42.74	45.87
Total	150	838	569
%	100	100	100

P<.000

Trust of Information Sources

Farmers were asked to rate how much they trust sources of nitrogen management information. The typical distrust of the EPA and environmental groups was evident in both network and non-network farmers. However, network farmers differed significantly in their level of trust in six of 14 information sources (see table 10). Network farmers were less trusting of information sources than non-network farmers in all but two instances. Network farmers are significantly more trusting of crop consultants than non-network farmers, trusting crop consultants more than other information source. Network

farmers are also more trusting of the Natural Resource Conservation Service. The second most trusted information source by network farmers is Extension, which is the most trusted source by non-network farmers.

Table 10. Trust of Information Sources: Network Farmers vs Non-Network Farmers[6]

To what extent do you trust the organizations listed below as a source of information about nutrient management?	Network Mean	Non-Network Mean	P-value (Mann-Whitney U)	Z-score	Effect Size
a. Farm Service Agency (FSA)	2.64	3.06	.000***	-4.516	-0.14353
b. Soil and Water Conservation District (SWCD)	3.32	3.24	.612	-.508	-0.01617
c. Natural Resources Conservation Service (NRCS)	3.36	3.09	.004**	-2.841	-0.09094
d. Purdue University Extension	3.44	3.35	.368	-.900	-0.02869
e. Indiana State Department of Agriculture (ISDA)	2.86	2.89	.704	-.379	-0.01209
f. Indiana Department of Natural Resources (IDNR)	2.63	2.78	.065	-1.843	-0.05878
g. Indiana Department of Environmental Management (IDEM)	2.40	2.55	.108	-1.608	-0.05152
h. Environmental groups	1.58	1.75	.073	-1.793	-0.05739
i. Agricultural organizations	2.86	2.98	.025*	-2.239	-0.0713
j. Fertilizer representatives	3.02	3.02	.569	-.570	-0.0181
k. Crop consultants	3.67	3.23	.000***	-5.303	-0.16931
l. Other landowners/ friends/farmers	2.86	3.10	.001***	-3.439	-0.10952
m. U.S. Environmental Protection Agency (EPA)	1.84	2.11	.009**	-2.608	-0.08318
n. Office of the Indiana State Chemist	2.61	2.74	.076	-1.772	-0.0566

[6] Answer options: not at all (1), slightly (2), moderately (3), very much (4). Never heard of it (9) coded out as a separate variable. *Statistically significant at the .05 level, ** .01 level, and *** .001 level.

Network Farmer Findings

Participation

Participating farmers have been in the networks an average of 2.8 years, with a small number being involved five years. All Adapt Network participants conduct nitrogen rate strip trials, as do 35.4% of On-Farm Network participants.

Why Network Members Participate

Farmers were asked how much certain factors influenced their decision to join a network. The most popular reason farmers gave for joining a network was to increase their nitrogen use efficiency, with a mean of 3.91 (see table 11). Related to nitrogen use efficiency, wanting to increase profitability and the opportunity to learn new nitrogen management practices were the second and third provided reasons (means 3.79 and 3.63, respectively). This emphasis on improving fertilizer use efficiency and reducing costs echoes the results of the farmer interviews. Concern for water quality was the next most common reason for joining a network (m=3.40), followed by collecting data to defend against regulation (m=3.28). Both of these reasons for joining were also discovered during interviews. The opportunity to interact with other farmers was not considered an important reason to join a network.

The questions regarding Certified Crop Advisors (CCA), district conservationists, and group leaders asking participants to join were included because these are the people who actively recruit farmers into the networks. A CCA is the leader of the Adapt Network group, and District Conservationists are the group leaders for the On-Farm Network.

Table 11. Reason for joining a network.[7]

How much did the following factors influence your decision to join the network?	Mean	Std. Deviation	N
a. Opportunity to learn new nitrogen management practices.	3.63	.576	146
b. My concern for water quality.	3.40	.681	146
c. I want to improve my nitrogen use efficiency.	3.91	.332	145
d. My CCA advised me to join.	1.87	1.294	141
e. My district conservationist advised me to join.	2.64	1.236	143
f. The group leader asked me to join.	2.33	1.402	141
g. I want to increase my profitability.	3.79	.469	146
h. I want to collect data to defend against regulation.	3.28	.900	146
i. Opportunity to interact with other farmers.	2.83	.964	146
j. The program is free.	2.93	1.045	145

[7]Responses to questions are based on a 1-4 scale. 1-Not at all, 2-A little, 3-Some, 4-A lot.

Farmer Opinions of the Networks

The purpose of this series of questions was to find out what participating farmers think about the network they are involved in. Do they find participation is useful and valuable? Respondents indicate that they are pleased with the information they receive about their farms (see table 12). Unsurprisingly, the farmers do not rank the information about other farmers' fields as useful. The most valued information received through the networks is data from nitrogen strip trials. While not as highly regarded as photography and data about their fields, the farmers still value the opportunity to meet and share their experiences with each other. Strip trials are generally not seen as an inconvenience to set up.

Questions b. and d. have fewer responses because the questions were altered after the advanced letter with the web address option was mailed. These questions were double-barreled and were revised on subsequent mailings and on the web version. Questions e. and h. have fewer responses because not all farmers conduct strip trials and a 'not applicable' option was given.

Table 12. Network Participant Opinions of Network Value. [8]

Please indicate your level of agreement or disagreement with the statements below.	Mean	Std. Deviation	N
a. The aerial photography from my own fields is useful to me.	4.25	.677	149
b. The corn stalk nitrate tests from my own fields are useful to me.	4.25	.708	123
c. The aerial photography from other farmers' fields is useful to me.	3.77	.940	149
d. The corn stalk nitrate tests from other farmers' fields are useful to me.	3.74	.876	123
e. The results of the nitrogen strip trials in my own fields are useful to me.	4.31	.928	114
f. The knowledge and experiences shared by other farmers in the network is useful to me.	4.19	.736	150
g. The winter meetings help me learn about nitrogen management.	4.18	.751	150
h. The nitrogen strip trials are inconvenient to set up.	2.96	1.371	123
i. The group leader is important to the success of the network.	4.11	.856	150

[8]Responses based on a 1-5 Likert Scale. 1-Strongly Disagree to 5-Strongly Agree. Questions 'b.' and 'd.' are the revised questions.

Network Outcomes

A series of nine questions assessed how well the networks are achieving their ultimate goals; spurring changes in nitrogen management and the spreading of practices to farmers outside the networks (See table 13). The farmers responded to all but one of the statements in a positive manner, but none overwhelmingly so. Sharing knowledge

and experiences with nitrogen management with other farmers received the highest agreement. This is understandable given that the farmers are in a network group whose purpose is to do just that. The one statement that received the most negative response concerned the influence of friends and neighbors on farmers' nitrogen management.

Table 13. Network Outcomes[8]

Please indicate your level of agreement or disagreement with the statements below.	Mean	Std. Deviation	N
j. I have changed the nitrogen management practices on my farm based on what I learned through the network.	3.38	1.060	150
k. I have changed my nitrogen rates because of what I learned through the network.	3.34	1.029	150
l. My friends and neighbors influence how I manage nitrogen on my farm.	2.40	1.019	149
m. Participating in the network has changed the standard for nitrogen management among me and my peers.	3.17	.833	150
n. I share my knowledge and experiences concerning nitrogen management with other farmers.	3.83	.755	150
o. Those farmers have changed their nitrogen management practices.	3.17	1.041	150
p. I use information learned through the network to adapt my nitrogen management from season to season.	3.59	.928	150
q. Participating in the network has increased my profitability.	3.25	.845	150
r. I have recommended joining the network to other farmers.	3.57	1.054	149

[8]Responses are based on a 1-5 Likert Scale. 1-Strongly Disagree to 5-Strongly Agree.

Interviews

During the development of the interview guide, several key topics were identified for exploration. We wanted to find out why farmers were joining the networks, what benefits they derive by participating, what changes they had made to their nitrogen management, and if they were disseminating their knowledge to other farmers.

Reason for Joining

The farmers were asked why they decided to join a network. A variety of answers were received, but the most popular responses were to understand their nitrogen use efficiency and a desire to stave off regulation.

Nitrogen Use Efficiency

The most common answer given for why a farmer joined a network was to improve their nitrogen use efficiency. Farmers said they wanted to find out if they were over or under applying fertilizer to their crops and attaining maximum economical yields.

> "I just wanted to see where we stood on our nitrogen usage. If we were close to applying what we needed to apply and hopefully not over-applying."

> "We wanted to see how we were actually doing nitrogen wise to the stalks. To see if we had enough nitrogen that we were putting on to carry it through the complete maturity of the corn. You know, this was an opportunity because of taking the stalk samples that they do and then being able to analyze what's in the plant and then know what our yields are we're getting off of it."

Fear of possible regulation

Many of the farmers spoke of their dislike or fear of possible future regulation as a motivation for joining the network. A few farmers mentioned regulation immediately when asked why they joined a network.

> "I think primarily we see what's coming, in terms of regulation, and for our own benefit of just utilizing nitrogen efficiently and judiciously."

> "At least we're trying to do something, see what the results are before EPA comes after you, at least we can go 'Well here's what Indiana is doing.' Some of the states I know they are hard on. Without having any real data to say differently and anybody out there knows the EPA likes to swing their long arm as much as they can. "

Other farmers mentioned regulation when asked about water quality or as unsolicited responses.

> "I mean, cause I know if we don't improve our water qualities here, we're gonna maybe be mandatory, told what to do and that worries me, that part of it does."

> "…at the same time we start getting all kind of flak from Lake Erie and the Gulf of Mexico for nitrogen. So far they haven't really bugged us about nitrogen in Erie, it's phosphate up there. But you start getting that pressure and so the idea was 'hey, we need to get ahead of this and get guys dialed in.'"

Concern for Water Quality

A specific probe utilized during the interviews questioned the farmers' concern for water quality as a motivation for joining the network. Concern for water quality was

never mentioned as motivation to join a network until I specifically asked. It was anticipated that farmers who had a higher concern about water quality would be more willing to join a network. That seemed to be the case with a few farmers, but such sentiments were not widespread.

> "Yeah I like to fish and I wade a lot in cricks and I like clean water. And you know I'm a- I wanna say a naturalist but I don't- we've been given great responsibilities as stewards to this ground. And you know, you get one shot at it."

> " Well, my decision to participate is based on the big picture. I mean I want water quality in my neighborhood but I want water quality everywhere so I joined for that reason. Because I don't want to put on too much nitrogen because I don't want to pollute the waters of the United States that I'm going to drink and swim in. So I don't want to do that. So that was part of the reason for joining."

In reality, that question elicited few responses of genuine concern for water quality. Farmers said that they didn't want to put nitrogen into the water, but it was mainly for other reasons, such as economics or regulation.

> "Yeah. I worry about that. I'm worried about economics more than I am about water quality, but those two kind of go hand-in-hand. If you just put too much nitrogen on, it affects the water quality. It will also affect the economics."

> "Well, it's basic time factor economics in all reality. There's no point in washing stuff if we're getting too much, whether it's phosphorus or nitrogen or nitrates into the water, it means we're not utilizing what we're putting out there in the field. So it's tight economics."

One farmer, when asked if concern for water quality was motivation for joining the network, simply responded, “No”.

Benefits of Participation

Farmers were asked what the benefits of participating in a network are. Responses ranged from personal benefits, such as economic gains and increases in knowledge, to widely dispersed benefits, such as defense against wide sweeping regulation.

Understand Nitrogen Use Efficiency

By far, farmers said the greatest benefit they derived from participating in a network was gaining a better understanding of their nitrogen use efficiency.

> “Yeah. It’s helped us try to understand our nitrogen management a little more, which is probably the biggest key right now. Trying to dial in on this nitrogen issue has always been the biggest issue we’ve got anyway.”

> “You start to see those numbers and begin to think that there’s a reason you need to be moving toward that set of numbers instead of just being out on what you think you need. What you think is probably not a good way to make the decision, it takes some analysis and reference data and that kind of stuff to be able to put together an educated guess.”

> “It’s interesting to see how your usage is. I mean without going out and taking the tissue samples and then putting the maps together with the satellite images, you don’t really see everything that’s happening in different areas of fields and in different fields completely. So that part’s interesting.”

For some farmers, the benefit is simply being shown that they are already applying nitrogen properly.

> "I believe that it's helped us with the peace of mind knowing that we're doing it close to being right."

For others, the data provided by the network gave the farmer his first real view of how efficient he was.

> "I always didn't know for sure and I said that's one thing nice about me having to do the stalk test. In the fall, they come back and, you know, give you your rate card basically and how well did you do, you know, and that's what I think is interesting there. Most of the time we've done very well, but last year, last year we had a lot more nitrates in the stalk."

> "I mean we had no clue where we were at come harvest time 'til we started in this. So that is maybe one good thing that gets us thinking."

Defense Against Regulation

Many of the participating farmers see the nitrogen data they are collecting as a defense against future regulation. If they have years' worth of tests showing that they are not overusing nitrogen, then there will be no need to regulate their inputs or practices.

> "I believe the consensus of the group was that we were all within a tolerable range of our usage, which was good news, being proactive at someone pointing a finger at you and saying 'your area is guilty of over usage.'"

> "There's concern at the environmental end of it too. The sampling of creeks and stuff keeps getting closer and closer and there's more on this creek than there used to be and how long is it going to be until they have one on my tile

> outlet and people are really trying to get an idea of what we can do and how can we find out where that magic number is so we're not dumping a bunch of it that we don't need to have out there."
>
> "But the second part of the On-Farm Network is to have that database of information that when the environmentalist whackos, we might call them as the public radio, oh not the public radio, Rush Limbaugh or whoever else might say, they start coming in you things to do different but you say, 'Well this information says that what you're telling me is not right.'"

For some farmers, defense against future regulation was the most important benefit of participation.

> "I think letting the public know we're trying to get this figured out and just having an image out there. I think the biggest part isn't- you know we are getting stuff out of the research but it's telling IDEM or EPA or IDEM Indiana. Letting them know we're trying to get it figured out and we're being stewards of what we're- of the nitrogen and I think the biggest thing out of it is the image part of it. Letting Washington or whoever- we're, we're trying. We can be self-regulated. I think that's the biggest thing out of On-Farm."

Networking with Other Farmers

Another benefit of participating in a farmer network is the opportunity to talk with and listen to other farmers. Sharing experiences and ideas with one another is central to the social network ideal of the On-Farm and Adapt Networks. Farmers often are unwilling to share information about their operations, but the networks provide a friendly forum to share.

In reference to the difficulties in getting farmers to share information, one farmer said:

> "Yeah, they can be stinkers. And because of that, it can be a challenge even getting farmers to share data. Which is kind of unique about this group and I appreciate the group because they are willing to share and we see our problems, they're exposed right out there, and it's been a neat group to be with for that reason."

Some farmers appreciated the opportunity to talk with successful farmers with good ideas.

> "It was kind of a meeting trying to get ideas on how to get more people to try cover crops and do conservation type practices. There were a lot of ideas thrown around to encourage others to do it and the success that some of us have had it with it. There were a lot of intelligent people at that meeting so it was very informational so it was good."

> "A lot of your guys in there are season veterans. Most of the people that are in that are innovators and they're successful. They're innovators for a reason. They're signed up for on-farm networks because they're interested in data and want to do better. You're getting this group of guys in the room that has devoted an exorbitant amount of time to doing the best they can with what they've got. I think it's absolutely awesome to compare notes and to really go back and forth on that."

Some farmers stated that they appreciated the opportunity to interact and learn from other farmers that were farther away than people they would typically associate with, but close enough for the information to be relevant. The wider scope of the

information gathered at a meeting allows participating farmers to see what the greater trends are.

> "I think hearing what other people have to say is beneficial. If you have an open mind to listen to them. You know, and sometimes the good thing about these is it's not the neighbors in my township that I'm getting to hear from, it's the neighbors that are in other parts on the county or the county next door that I might not farm right next to. So I might give them more credence than the people that I farm next to that I watch and don't watch. You know, so it gives you a little bit of diversity but it's still in your area versus going to a meeting in Indianapolis and the guy from Fort Wayne and the guy from Louisville, Kentucky, you know close to Louisville, and the guy from Evansville are all at the meeting giving you advice. Well, maybe they work and maybe they don't. At least it's somebody in your general vicinity that you could drive by their field and see it if you wanted to."

> "There's been a trend in the industry, over the last decade, of more independent agronomists and less reliance on your fertilizer, your coop, your CFS, or whatever the fertilizer company/dealer. And the dealers responded to that as well, and said "Well, we understand it's a conflict of interest." And they've tried to separate their agronomy from their recommendations. The advantage of have an agronomist, for example look at your farm; is that the agronomist covers 2 or 3 or 4 counties and so they can actually pick up trends long before you'll ever see it. If you're just looking at your farm, they'll pick up trends long before you ever see it on your farm. So, there's a lot of value in participating in groups."

Other farmers were not as enthusiastic about the benefits of networking with other farmers, but still thought it was useful.

> "I think most of all you learn talking about your own field and sharing, but there is definitely benefit with discussing with other farmers."

> "Well just the sharing of ideas, even though we don't maybe gain a lot from some of those ideas, you never know when one little piece of it might fit into your puzzle too."

Aerial Imagery

The final aspect farmers valued from participating in the networks is the aerial imagery they receive of their fields.

> "I mean you can see tillage patterns a lot from the maps and that's kind of interesting to see. Compaction areas. And compaction is going to effect the nitrogen usage as well. So it all plays into it. And, like I said, seeing those aerial maps, you can see what's going on in that field, where you can't see it driving down the road, in season."

> "I think that it's very interesting that you can take an aerial photo of the image and you can see patterns of things that may or may not have happened and you investigate. So, if you've got your thinking cap on and can think back and you know kind of put a pin point on yeah that why that strip looks like it does, you know the row starter was off or you just kind of-. It jogs your memory as well as brings it to light that everything does matter."

Network Outcomes

Management Changes

The ultimate outcome of participation in these networks is a change in management. Farmers were asked if they had made any changes to their nitrogen

management as a result of participating in a network. Some of the farmers made desired changes in management by cutting rates.

> "We decided to back off ten pounds of nitrogen this year."

> "Well I'm not putting as much nitrogen on the corn, on my corn on corn, as I was before. I was shooting around for 220 lbs. and I'm only shooting to about 200-205."

One farmer was looking to more innovative practices to improve his nitrogen management.

> "After 2012 and seeing nitrogen that was still left in the soil, we've been more inclined to look into the cover crop industry to retain any residual unused nitrogen in the soil."

Instead of decreasing nitrogen application rates, some farmers increased their rates.

> "The lighter soil types, I'm maybe putting on a little more than I was. I know they're probably not wanting to go that way."

> "We probably have increased nitrogen rates a little bit as a whole."

Still more farmers said that their test results have given them no reason to change. The network has simply confirmed that they are already doing a good job managing their nitrogen.

> "This has just been a confidence builder in what we were doing already."

> "For ours, we found out that the amount of anhydrous ammonia that we're putting on, according to the information, their feedback, we must be hitting it about right. You know, right wrong or otherwise we seem to be hitting it about right. So the one thing we did is not change anything."

Other farmers felt that they didn't have enough years of data collected to have the confidence to make a management change.

> "There's no way I'm going to make a huge change on the farm with just two years' worth of data that I know one's a drought and one's had an equipment issue. If we can get 7 years of – 5 to 7 years of consistent data, I could start to consider that as fact to start to make a change in the operation."

> "A lot of questions I don't have an answer for, but just to jump and say, 'That's the way you've gotta go.' I'm not ready to do that yet either."

> "We aren't ready to change yet. And it's just we're still trying to figure out what is best."

One farmer said he wasn't ready to make a change in management yet, but was optimistic that he would soon.

> "Because you don't make major changes in management from one event, so it's really about the accumulation of a body of knowledge you begin to see develop. So, I can't say from last year's meeting, which was my first meeting. I can't say that, "Yeah, I've changed." But I'm telling you that hanging with those people and interacting with that information over periods of time, we're going to learn how to get better at this and we're going to adapt equipment based on interactions we're having with the guys that are experimenting."

The role of weather in the unwillingness of farmers to change their management practices is readily apparent in the interviews. Unable to predict the coming season's weather, some farmers decide to simply stick to what they are already doing.

> "Something specifically that's changed; maybe trying to do variable rate nitrogen. I've abandoned that idea. Mother Nature varies our rate on her own. But we just got to keep up with what the plant needs. If we get 5 inches of rain in one area and an inch and a half in another, we've lost some of our nitrogen where we had 5 inches."

> "The problem was in adjustment you don't what the year's precipitation is going to be."

> "So it's been reassuring, but without that weather model up and running yet we haven't changed anything. It's got to get more data."

Diffusion of Knowledge

Within the Network

The farmers were asked if they had learned anything from the other farmers in the network. This was to see if participants were diffusing their knowledge and practices within the network. Many of the farmers said they had learned from the other farmers.

> "I suppose you could say it has from the standpoint that it has convinced us that sidedressing is the best way to put on our nitrogen, because we've looked at the data that other people give who don't do sidedressing and like I said, it seems like sidedressing is the favorable thing to do."

> "A lot of talk about the cover crops and what different guys are doing and different strategies and it was kind of a meeting trying to get ideas on how to get more people to try cover crops and do conservation type practices. There

> were a lot of ideas thrown around to encourage others to do it and the success that some of us have had it with it. There were a lot of intelligent people at that meeting so it was very informational so it was good."

> "Oh yes. We've always had the question concerning manure and how much value they put onto the crop. This is giving us a lot more information on that. And we're to the point where we're considering maybe contracting with a CAFO and allowing the manure to be placed on the farms in certain fields. That will allow us the opportunity to utilize that manure a little bit more and get the maximum without having to use commercial fertilizer and stuff like that as well. But we see that there's a value there. We've also seen where there has been some livestock producers who have over used with what they use with manure and then they use commercial fertilizer, its overkill. They're wasting some money. And you wouldn't have seen that without having these kind of studies."

Some of the farmers said that hearing what other people have to say is interesting, but doesn't change how they conduct their nitrogen management.

> "It's always interesting to hear what other people have different management practices they're using for their operations, but normally we use management practices because they best suite our operation."

> "Sometimes you can see some interesting things from the maps and then a lot of the time the farmer will explain why that might be and it's interesting, but I'm not sure I really learn anything from it."

Survey results show that the farmers aren't influenced by friends and neighbors when making nutrient management decisions. However, during interviews, farmers suggested that other people do influence them, directly or indirectly.

> "Well yeah. If they came up with something that sounds reasonable and you know, you got to look at your neighbors and say, 'ok do you consider him a good operator or good producer?' And kind of value his judgment that way and then-. We've tried some different things that neighbors have thought were great."

More than being influenced by friends and neighbors, however, several farmers discussed the role input dealers and crop consultants have as purveyors of information. Crop consultants and input dealers interact with dozens, if not hundreds, of farmers in the area, so they are viewed as collectors and disseminators of information.

> "And with using a crop consultant you try to get those things all aligned. He's doing the same for all the neighbors he works with. You're not maybe getting the data from the neighbor, but you're getting the data from the central clearing houses working with all the neighbors."

> "It seems silly but we don't get together very often and actually talk about those things but how that information gets shared back a lot of times through our input suppliers. The guy that I got that anhydrous ammonia tank from at the coop? He sells anhydrous ammonia to all my other neighbors that I can see out of my bedroom window or my kitchen window or I drive down the road. And it seems like if you share your information with those people typically they're a good conduit to get it back out to the other people because how I work is I say '(name retracted)', my supplier at the coop you know, 'we're… how much N are other people putting on? And this is what I'm thinking about. Are we in the ball park with what our neighbors are?' and he'll say Joe or Billy-Bob or whoever down the way usually puts on 'X' and then you can, you know, get a little bit of information like that and at the same time he shares that information with other people."

Diffusion Outside Network

The farmers were asked if they share information about nitrogen management with farmers that do not participate in a farmer network. This was to judge if the knowledge about nutrient management practices were not only spreading amongst network members, but also spreading to the wider agricultural community. Were these farmers acting as early innovators that would introduce new practices to their neighbors and friends? Some network farmers seemed to think so.

> "Oh, I think a lot of them ask me about it, yes. You know, how much nitrogen they should be putting on and things like that. Then I tell them what I'm doing and then look at their situation, yeah. I think very much so, yes. We're looked at as far as a resource for information around here. That helps because being in the seed business, not just being a farmer."

> "I think we've had some influence on the deal, I don't know for a fact, but the one neighbor is the Beck's dealer down here and he was in that a couple of different times and looked at it. This year was his first year with (group leader name) so I imagine he'll get involved in the deal. It's the combination of pressure from the environmental end of it and the cost of nitrogen, everybody is starting to scratch their head a little more and start to ask around about what are you doing and why do you think you're doing what you're doing and that type of stuff."

> "We were talking nitrogen rates, as far as whether it was efficient, whether it had enough nitrogen to grow the plant to maximum production or whether it was undercut or over. We talked about a lot of things on it. And the guy that I'm thinking of, yeah that's what we were mainly talking about was, you know, well how do you really know what you're putting on? How do you

> really know, unless you're taking unless you're taking some of those tissue samples and finding out where you're at?"

However, some other farmers say they have not spread their knowledge outside of the networks, either because they only talk with other farmers already in the network, or they simply don't share that sort of information period.

> "I guess I really don't. Probably the couple of neighbors that we talk to the most, frankly, are in the network."

> "Not really, honestly. I've done some informal advertising for the On-Farm Network, but the guys that aren't interested in participating and coming to the meetings and whatnot probably aren't interested in talking about what we found out. So far we have kind of kept it to ourselves."

> "No, I haven't. We've not really talked with our neighbors about it."

Only one farmer was able to give a specific example of how he influenced another farmer to change their nitrogen management regime.

CHAPTER 3: DISCUSSION

This study revealed some important findings regarding the participants of the networks, as well as the utility of the network programs. Here I further discuss the most important and interesting results and their implications, as well as offer recommendations for improving the farmer networks.

Differences between network and non-network farmers

It could be argued that these network farmers are 'elite'. They are markedly different than non-network farmers in multiple ways. They are far more aware of water pollution problems and the sources of pollution. They know that their actions have an impact on water quality and are willing to change their management practices to improve water quality. Network farmers do more conservation practices than non-network farmers. They use conservation tillage, cover crops, riparian buffers, follow university recommended fertilizer rates, and don't apply fall fertilizer as often. Network farmers conduct soil tests, use variable rate nitrogen applicators, split their fertilizer applications, and follow a nutrient management plan more than non-network farmers. They are generally less trusting of information sources than non-network farmers, with the important exceptions of crop consultants, Extension, and NRCS. Network farmers are better educated than other farmers and the state population as a whole. They are younger than non-network farmers and manage bigger farms.

Were these farmers already predisposed to being 'exceptional' farmers or did their involvement in the network change or influence them? While not a longitudinal study, the drastic nature of the differences between network and non-network farmers leads me to believe that is was not the networks that changed the farmers, but rather they were different before they joined.

The qualitative data support the survey results. Several interviewees mentioned that they serve on the board of their local Soil & Water Conservation District. Others told of their regular attendance at the No-Till Conference in Iowa. These are activities that the average farmer doesn't undertake.

The differences in adoption rates can also be explained by these pre-existing differences. Judging from the interviews, there doesn't seem to be enough spread of new practices within the network to credit network involvement with the dramatic differences in adoption rates. As one farmer put it,

> "A lot of your guys in there are seasoned veterans. Most of the people that are in that are innovators and they're successful. They're innovators for a reason. They're signed up for on-farm networks because they're interested in data and want to do better. You're getting this group of guys in the room that has devoted an exorbitant amount of time to doing the best they can with what they've got."

The network farmers are among the most progressive producers in the state. They should be lauded for their adoption of nutrient best management practices, however, it is fair to ask whether this is the audience that is most in need of the services provided by the networks or if the networks should be targeting a different type of farmer.

Lack of Management changes

The survey respondents say that they have made changes to their management and nitrogen rates because of what they learned in the networks. However, the interviews show a general hesitation to change management practices due to distrust of the data. The farmers are unconvinced by the corn stalk nitrate test data for two reasons. First, they say they need more years' worth of consistent data. The 2012 drought was often cited as a year of meaningless data, so that year's data doesn't even count to some farmers. Secondly, according to my interviews, some farmers have a general distrust of the corn stalk nitrate test results. This distrust comes from the lack of farmer involvement in the testing and the role that weather plays in the results of the test.

Weather feeds into the farmers' lack of perceived behavioral control. Farmers are unwilling to change because they believe they are at the mercy of the unpredictable weather. They feel that regardless of how much nitrogen and how it is applied, the weather trumps all.

This helplessness is reinforced by the leaders and analysts at the meetings. They say things like, 'well, it was a funny year with the rainfall' when a field tests high for nitrogen. This is an attempt to avoid pointing the finger at the farmer, but results in the continued belief that most nitrogen management is out of their control.

Diffusion of practices

Farmers indicated on the survey that they talk about nitrogen management with other people outside the networks. They even said that other people they talk to are adopting the management changes that were discussed. However, the interviews indicate

that diffusion of practices may not be very widespread. In fact, only one interviewed farmer could give a concrete example of how he influenced a neighbor to change their nitrogen management. Do the farmers think they are having a greater influence than they really do, or do they not wish to respond negatively to the survey question?

During the interviews, I was able to probe deeply for a response. Seldom would the question be asked without any follow up. On the contrary, I suspect that many farmers hurriedly completed the survey without a second thought. When confronted with an inquiry that seemingly questioned their independence as decision makers on their farm, the farmers likely responded negatively.

Fear of Regulation

The second most common reason for joining a network and benefit of participation was the fear of regulation and the need to defend against it. This concern about future regulation on non-point source pollution and farm fertilizers is a powerful force. However, the utility of this motivation is questionable. Fear of regulation may motivate some farmers to change, but regulatory threats will not be effective for all management concerns. Nor is this practical. Farmers will soon figure out if regulatory agencies are 'crying wolf' or not. At that point, the threat of regulation becomes worthless, and follow through on those threats will be required unless other outreach methods are more effectively utilized.

Constraint of Networks

The network farmers do not seem to talk with each other very much. The purpose of the networks is to facilitate communication and innovation flow between farmers, but

instead they get their information from a central source, be it the meeting analyst or a crop consultant.

Figure 3 represents the current configuration of the farmer networks. These are constrained networks. The farmers get their information from the analyst or crop consultant, but do not talk to each other. Hoang et al. (2006) described how the diffuse networks found among Vietnamese farmers facilitated the spread of technology and innovations. A subset of the farming population gained their knowledge of new practices from a central source, an extension agent. Those farmers then discussed the knowledge with each other and then spread the knowledge to other farmers who did not speak with the central extension agent. Figure 4 represents an ideal social network. In this case, the farmers not only get information from the central authority, but also from each other. The farmers then, in turn, share that information with other farmers outside the formal networks.

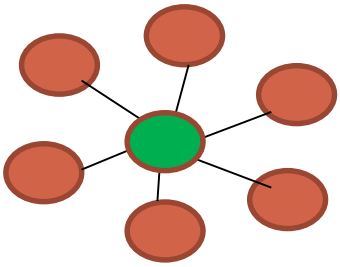

Figure 3. Representation of current constrained farmer social network configuration.

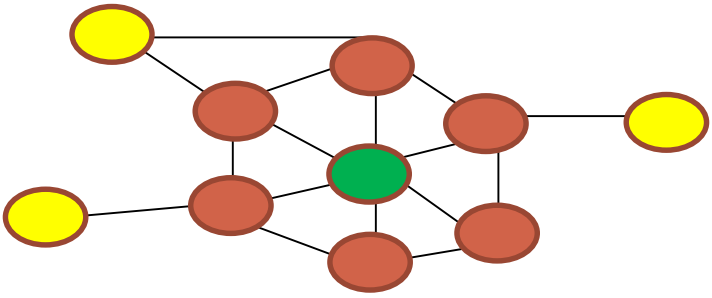

Figure 4. Representation of ideal farmer social network configuration.

Connection to Theory

Prokopy et al. (2008) and Baumgartz-Getz et al. (2011) demonstrated that social networks have a positive influence on the adoption of conservation practices by farmers, but the actual mechanism by which that influence manifests was not identified.

Social norms, as described in the Reasoned Action Approach, (Fishbein & Ajzen, 2010), were the primary behavior influencing mechanism examined in this study. It is unclear if participation in the networks had an effect on the social norms of the participating farmers. The survey suggests that other farmers have little impact on the nitrogen management decisions of network farmers. This is in contrast to the expectation that the networks would provide a strong means to reinforce social norms of meticulous nitrogen management. However, interview responses suggested that other farmers' opinions are not so quickly disregarded. Anecdotes from farmers about their neighbors or about how the farmers believe their neighbors perceive them that social norms have some influence on their practices, but to what extent is uncertain.

I was unable to establish clear evidence that the farmer networks are changing or establishing social norms regarding nitrogen management. The survey results indicate that other farmers have little influence on the nutrient management practices of network farmers. However, the interview results suggests that there may be more influence from other farmers than the survey respondents were willing to admit.

Perceived behavioral control was not the portion of the Reasoned Action Approach that this study focused on. However, the number of times that weather was used as an excuse for subpar nitrogen management suggests that perceived behavioral

control is an area where more interventions may be needed. The unpredictability of weather events and their impacts on plant nitrogen availability is a severe limitation to farmers' perceived behavioral control. Tools like AdaptN and products of the USDA's Useful 2 Usable project may help farmers overcome their lack of perceived behavioral control regarding weather impacts on nitrogen management.

This study confirms one of the findings of Rickenbach's (2009) study of forest cooperative members. He found that members were very likely to seek management advice from people outside the cooperative network. In the case of these farmer networks, network farmers seem more likely to seek advice from outside sources, particularly from crop consultants and input dealers.

As previously illustrated, the network farmers are more progressive in their use of conservation practices than non-network farmers. It is fair to say that these farmers would constitute the 'innovators' and 'early adopters' of Rogers' Diffusion of Innovation theory (2003). If these farmers are to spread their knowledge of nitrogen management to other farmers, however, they need access to farmers who are not already conducting the same practices. Identifying the key innovators (influential, trusted, respected farmers) and surrounding them with farmers who have yet to adopt nitrogen management practices may result in a more rapid diffusion of those practices.

Recommendations

I have two sets of recommendations. The first set aim to improve the operation of the networks. These are specific changes that will improve data collection and

dissemination and create more value for participating farmers. The second set of recommendations focus on broadening network participation.

Improving Network Operation

Strip Trials

The survey results show that the network farmers value the replicated strip trial data more than the corn stalk nitrate test data and the aerial imagery. However, only 36% of participating farmers conduct strip trials through their network. The On-Farm Network, in particular, should put a greater emphasis on conducting strip trials than they currently do.

On-farm strip trails provide valuable, location specific data regarding the best nitrogen management regime to utilize (Yan et al., 2002). Farmers see for themselves how their crops respond to different nitrogen rates and timing of applications. This learn by doing approach is well supported in the adaptive management literature (Allen et al., 2001; Roling & Wagemakers, 2000).

This push for more strip trials is all the more pressing in light of the limited utility of the corn stalk nitrate test (CSNT). Farmer suspicion of the CSNT is supported by research. Studies have found that the CSNT is highly affected by weather conditions, impairing its ability to inform future decisions (van Es et al., 2007; Kyveryga et al., 2011). If farmers want the best, most valuable data to inform management decisions, there should be a much greater emphasis on conducting strip trials.

Making Data Useful

Several farmers stated that they want their aerial imagery and corn stalk nitrate data returned as a geocoded file for use in a Geographic Information System software. Many farmers use this type of system to organize all their field data, and the pdf files they receive at the winter meetings are of little value to them. It is my understanding that this concern is being addressed for this years' growers.

A larger issue regarding information is understanding what the data means and what to do with it. Many farmers don't know how to interpret their corn stalk nitrate test results. During interviews, several farmers pulled out their binders from previous meetings to show me their test results. They were flummoxed how the test could vary so much within the same soil type of the same field. Lack of understanding in these situations leads to distrust in the test results and not knowing what next steps to take.

The farmers need someone to work with them one on one. The group leader, or a cooperating crop consultant, should interpret the test results and provide recommendations for management changes. There is currently a disconnect between information and action, and having someone provide specific recommendations will serve to bridge the gap.

Involving Consultants

Network farmers are more skeptical than non-network farmers. They trust crop consultants more than any other information source. This could play a role in who should be disseminating information to them.

Both network and non-network farmers trust crop advisors, and network farmers even more so. The networks should capitalize on this inherent trust. Have them analyze corn stalk nitrate test results, aerial imagery, or strip trials with the farmers. Make them group leaders. They are more influential than anyone else, inside or outside the networks, so get them involved.

Efficiency Measures

Under the current data collection and dissemination system used by the networks, the only information collected from the farmers is the type and amount of fertilizer used on the enrolled fields. Yields from those fields are not reported. While farmers are able to calculate their nitrogen use efficiency individually from their own yield maps, they are unable to compare their performance with other farmers.

Sharing specific yield information can be a sensitive subject for farmers. Asking what someone's yield was is equivalent to asking how much money they make. However, there is a way to sidestep the faux pas. Farmers should submit their yield to the group leader who can then calculate this efficiency ratio index: pounds of N per acre/bushels of corn per acre. This ratio, called the 'Partial Factor Productivity', is recommended to measure nitrogen use efficiency by others (Dobermann, 2007; Yadav, 1998; Cassman et al., 1996). This number provides a means to compare the efficiency of various nitrogen management regimes. If certain types of management result in higher efficiency ratios, they will be plainly visible to all.

The use of efficiency measures is supported in other areas of agriculture. Water use efficiency measures are utilized to evaluate the use of water for irrigation (Howell,

2001; Wallace, 2000). Fuel use efficiency measures are used to determine productivity per unit of fuel expended (Lal, 2004; Hoeppner, et al., 2006).

The use of efficiency ratios may assist in the transition from competition for highest yield to competition for the highest efficiency. The continual pursuit of the highest yield has resulted in inefficient use of inputs, especially nitrogen. We must change the conversation between farmers from comparing yields to comparing efficiency.

Broadening Involvement

Fostering Greater Diffusion

The networks are supposed to be a formal social network, like a business or club is a formal social network. Yet, these farmer network groups only formally interact once a year. This may help explain why there is an underwhelming amount of idea dissemination and diffusion of practices occurring.

The network groups should meet more often. While the importance of not taking up too much of the farmers' time is understood, the goals of the network are not being met under the current one meeting system. Meeting even just two or three times per year would foster stronger relationship building among the network farmers. The stronger relationships may increase trust among the participants, and farmers may be more likely to try a practice touted by their fellow network members.

Targeting Recruitment

The most important finding of this study is that the farmer networks are not reaching the farmers that need to change the most. It is easy to get the progressive farmers involved in the programs. In fact, how the farmers are recruited into the

networks may play a role in why they are more progressive than non-network farmers. Many of the network farmers are involved because the group leader, a Soil & Water District Conservationist, recruited them. District conservationists are likely to have a rapport with the elite farmers in their area. They are the farmers who will show up to a field day, serve on the Soil & Water board, or are members of the Indiana Soybean Alliance so they are low hanging fruit to recruit into the network.

Having a few of these progressive farmers in each group is a good thing. They can be examples of nutrient management done right that the other farmers can aspire to be. However, having these kinds of farmers comprise the majority of the network membership is ineffective. They don't need help. It is the other farmers who are not doing proper nutrient management who need to be involved. As one network farmer put it:

> "I mean the meeting that (group leader) had is good, but then again, he's preaching to the choir because it's his customers that show up and most of them are involved in the network anyway and we've got the maps and we've got all of this stuff now. When you try to break over that hump and get to the guys and I don't know how many it turns out to be, but you know there are a fair number that are just farming."

A more effective arrangement would be to find the handful of progressive, influential farmers in the area and surround them with farmers who need to adopt better nitrogen management practices. The few progressive farmers serve as examples to the others and the ones that need help receive the data and assistance they need to improve their farming practices. This arrangement has been suggested by Subedi et al. (2003) as a way to promote the diffusion of diverse crops amongst farmers in Nepal.

Framing Outreach

The seemingly biggest motivation for joining a network is economics. Even when asked directly about concern for water quality, most farmers responded with sentiments regarding the balance between water quality and yields or how keeping nitrogen out of runoff made good economic sense. While this doesn't mean that network farmers are not altruistic or have a concern for the environment, the most important motivation for changing farming practices is money.

This has policy implications for outreach efforts. Time after time, the network farmers said that their first concern is well being of their farm business, with environmental concern secondary. Attempts to convince farmers to adopt a new practice via an appeal to their environmental attitudes will be less successful than economic arguments for this elite set of farmers.

CHAPTER 4: CONCLUSION

Lessons Learned

I had hypothesized that the network farmers would be different than non-network farmers, but I didn't think the difference would be so dramatic. In all the interviews, the farmers seemed to be on the cutting edge of agriculture, aware of the newest technology and considering investing in new equipment and practices. However, when I asked them about nutrient management changes brought on by the network, they had little to say. At the time, this did not make sense to me. How could these progressive farmers not be changing their management practices? The survey revealed the answer. The stark contrast in adoption rates between network and non-network farmers was eye-opening. The network farmers were not changing their nutrient management practices because they had already done so before the networks even started.

Direction for Future Studies

Social Network Analysis

The attempt to gather names of fellow network members to conduct a social network analysis failed. The farmers were unwilling to write the names of the other farmers in their group on a survey. I am sure that many of the farmers were uncomfortable giving such information to an unknown researcher. For future studies, I would select a sample of the network groups and conduct interviews with as many

members of each group as possible. I believe that far more farmers would have provided that information to me in person, as opposed to a written response on a survey.

Information on the structure of the network groups could prove very insightful. Social network analysis may reveal if there are one or more central individuals in each group that are more influential than the rest. Engaging these particularly influential farmers to adopt conservation practices may encourage others in the group to do the same. Targeting these influential early innovators and surrounding them with farmers who are in need of conservation practices could streamline the dissemination of conservation practices.

Social Norms

Farmer networks may be able to influence the social norms surrounding nutrient management, as well as other farming practices. While I asked about the influence of friends and neighbors on the farmers' nitrogen management decisions, this study missed the opportunity to fully address the question. Conflicting responses between the survey and interviews to questions about the influence of friends and neighbors on nutrient management decisions made it impossible to draw clear conclusions. However, interview responses and anecdotal conversations with farmers suggests that there may be more social norms issues to explore. Careful and tactful survey questions and interview probes may be able to reveal more information about farmers' social norms than I was able to extract.

Role of Climate Change

Many of the farmers expressed weather variability as a barrier to adopting advanced nutrient management practices. Without knowing the coming season's rainfall, some farmers continue to use their typical nitrogen rates and practices. As weather continues to become more variable and unpredictable in the face of climate change, will this excuse become even more prevalent and insurmountable? Future studies should further explore the role of weather variability and climate change on farmer decision making regarding nitrogen management.

Incentives for Adoption

Most of the farmers in the networks seem to already be doing proper nutrient management. However, there is still a substantial portion that are not. Future studies could seek to understand what it takes to get these farmers to change their practices. Are there certain financial barriers, such as expensive equipment, that need to be overcome? Is there a level of financial incentive that would make changing management practices irresistible? Similarly, are there market forces that would induce change? For example, what would the price of nitrogen fertilizer have to be to force a farmer to change their nutrient management practices? These and similar questions should be addressed.

On-Farm Research

These networks currently represent some of the most progressive farmers in the state. The farmers are collecting a sizeable amount of data on nutrient management and crop yields across all areas of the state. This could be an opportunity for university researchers to access data sets much larger and representing more diverse site conditions

than is possible with traditional university applied research resources. Many of the farmers are interested in experimenting with more complex management regimes beyond what they are currently testing.

Looking to Other States

This study is representative of the existing farmer networks in the state of Indiana, but the findings are not necessarily generalizable to other states, nor to the newest networks currently forming. There are other farmer networks in Iowa, Ohio, Pennsylvania, Maryland, and other places. Rigorous program evaluation of the networks in those states would add to the sparse body of knowledge surrounding farmer networks. This one study in one state is insufficient to determine the true value of these network programs.

Final Thoughts

With the challenges facing the environment and agriculture, swift change is a necessity. Both ecologically and economically, it is no longer prudent to continue to apply fertilizer with little regard for loss and the impacts that lost fertilizer will have on water quality. These farmer networks are a step in the right direction toward alleviating both of these problems.

While the farmers in the current networks did not change their practices as a result of their participation, this does not mean the networks are not valuable. The lack of change is attributable to the elite farmers that participate in the networks who do not have much to change. If farmers who currently are not as progressive are recruited into the networks, then there is potential for more change to occur.

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APPENDICES

Appendix A Network Survey

Dear On-Farm Network member,

This partnership of organizations is conducting this survey with Purdue University. These groups are trying to help farmers improve their nitrogen use efficiency through the On-Farm Network. We want your input on how effective the network is, how you participate in the network and how beneficial participating is to you and your farm operation.

There are two ways in which you can complete our survey. The most convenient way is for you to enter the following website address into your web browser: **http://tinyurl.com/NetworksSurveyOFN** and provide your responses securely online. If you choose to complete the survey online, you will need to enter the following code: _____. This will let us know that you have completed the survey so that we will stop sending reminders. We have also enclosed a paper version with a postage-paid return envelope if you prefer to respond by mail. **The information you provide is confidential and will never be linked to your name**, only to this code, which is used only for the purpose of knowing who has responded to the survey.

Your voluntary participation in this survey will help us understand the needs and concerns of Indiana farmers and landowners. Your answers will be kept confidential and will be released only as summaries where answers cannot be linked to individual respondents.

Unless otherwise instructed, please check the box that corresponds to the answer category that best describes you and your situation or opinion. The survey should take approximately 15-20 minutes to complete. Please read each question carefully. Thank you!

For more information about this survey, please call Linda Prokopy or Aaron Pape at (765) 494-0825. Thank you in advance for your help!

Sincerely,

Linda Prokopy, PhD
Purdue University

Aaron Pape
Purdue University

This project is funded by Indiana corn farmer checkoff funds.

PLEASE READ BEFORE BEGINNING THIS SURVEY:

The survey must be completed by an adult member of your household 18 years of age or older. Please mark all answers clearly, in pen or pencil, as indicated below.

Example "A" ☐ ☐ ☒ Example "B" ☐ ☐ ☑

Network Involvement

1. **How many years have you participated in the On-Farm Network?** _____

2. **How many acres do you have enrolled in the program?** _____

3. **Do you conduct nitrogen rate strip trials as part of the network?**
   - ☐ Yes
   - ☐ No

4. How much did the following factors influence your decision to join the On-Farm Network?	Not at all	A little	Some	A lot	Don't know
a. Opportunity to learn new nitrogen management practices.	☐	☐	☐	☐	☐
b. My concern for water quality.	☐	☐	☐	☐	☐
c. I want to improve my nitrogen use efficiency.	☐	☐	☐	☐	☐
d. My CCA advised me to join.	☐	☐	☐	☐	☐
e. My district conservationist advised me to join.	☐	☐	☐	☐	☐
f. The group leader asked me to join.	☐	☐	☐	☐	☐
g. I want to increase my profitability.	☐	☐	☐	☐	☐
h. I want to collect data to defend against regulation.	☐	☐	☐	☐	☐
i. Opportunity to interact with other farmers.	☐	☐	☐	☐	☐
j. The program is free.	☐	☐	☐	☐	☐

Water Impairments

5. Below is a list of water pollutants that can become a problem when present in excessive amounts. In your opinion, how much of a problem are the following pollutants in the area where you own or rent farmland?

	Not a problem	Slight problem	Moderate problem	Severe problem	Don't know
a. Sedimentation/silt	☐	☐	☐	☐	☐
b. Nitrate	☐	☐	☐	☐	☐
c. Phosphorus	☐	☐	☐	☐	☐
d. Bacteria in the water (such as E. coli)	☐	☐	☐	☐	☐

6. The items listed below are sources of water quality pollution across the country. In your opinion, how much of a problem are the following sources in the area where you own or rent farmland?

	Not a problem	Slight problem	Moderate problem	Severe problem	Don't know
a. Discharges from industry into streams and lakes	☐	☐	☐	☐	☐
b. Discharges from sewage treatment plants	☐	☐	☐	☐	☐
c. Soil erosion from farm fields	☐	☐	☐	☐	☐
d. Soil erosion from shorelines and/or streambanks	☐	☐	☐	☐	☐
e. Lawn fertilizers and/or pesticides	☐	☐	☐	☐	☐
f. Fertilizers or manure used for crop production	☐	☐	☐	☐	☐
g. Improperly maintained septic systems	☐	☐	☐	☐	☐
h. Manure from farm animals	☐	☐	☐	☐	☐
i. Littering/illegal dumping of trash	☐	☐	☐	☐	☐
j. Pesticides or herbicides used for crop production	☐	☐	☐	☐	☐
k. Animal feeding operations	☐	☐	☐	☐	☐
l. Urban stormwater runoff (e.g. highways, rooftops, parking lots)	☐	☐	☐	☐	☐
m. Removal of streambank vegetation	☐	☐	☐	☐	☐

Network Opinions

7. Please indicate your level of agreement or disagreement with the statements below.

		Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree	Not Applicable
a.	The aerial photography from my own fields is useful to me.	☐	☐	☐	☐	☐	☐
b.	The corn stalk nitrate tests from my own fields are useful to me.	☐	☐	☐	☐	☐	☐
c.	The aerial photography from other farmers' fields is useful to me.	☐	☐	☐	☐	☐	☐
d.	The corn stalk nitrate tests from other farmers' fields are useful to me.	☐	☐	☐	☐	☐	☐
e.	The results of the nitrogen strip trials in my own fields are useful to me.	☐	☐	☐	☐	☐	☐
f.	The knowledge and experiences shared by other farmers in the network is useful to me.	☐	☐	☐	☐	☐	☐
g.	The winter meetings help me learn about nitrogen management.	☐	☐	☐	☐	☐	☐
h.	The nitrogen strip trials are inconvenient to set up.	☐	☐	☐	☐	☐	☐
i.	The group leader is important to the success of the network.	☐	☐	☐	☐	☐	☐
j.	I have changed the nitrogen management practices on my farm based on what I learned through the network.	☐	☐	☐	☐	☐	☐
k.	I have changed my nitrogen rates because of what I learned through the network.	☐	☐	☐	☐	☐	☐
l.	My friends and neighbors influence how I manage nitrogen on my farm.	☐	☐	☐	☐	☐	☐
m.	Participating in the network has changed the standard for nitrogen management among me and my peers.	☐	☐	☐	☐	☐	☐
n.	I share my knowledge and experiences concerning nitrogen management with other farmers.	☐	☐	☐	☐	☐	☐
o.	Those farmers have changed their nitrogen management practices.	☐	☐	☐	☐	☐	☐
p.	I use information learned through the network to adapt my nitrogen management from season to season.	☐	☐	☐	☐	☐	☐
q.	Participating in the network has increased my profitability.	☐	☐	☐	☐	☐	☐
r.	I have recommended joining the network to other farmers.	☐	☐	☐	☐	☐	☐

Your Opinions

8. Please indicate your level of agreement or disagreement with the statements below.

		Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
a.	Using recommended management practices on farms improves water quality.	☐	☐	☐	☐	☐
b.	It is my personal responsibility to help protect water quality.	☐	☐	☐	☐	☐
c.	It is important to protect water quality even if it slows economic development.	☐	☐	☐	☐	☐
d.	My actions have an impact on water quality.	☐	☐	☐	☐	☐
e.	I would be willing to pay more to improve water quality (for example: through local taxes or fees).	☐	☐	☐	☐	☐
f.	I would be willing to change the way I manage my property to improve water quality.	☐	☐	☐	☐	☐
g.	The quality of life in my community depends on good water quality in local rivers, streams, and lakes.	☐	☐	☐	☐	☐

Decision Making

9. When you make decisions about nutrient management on your farm operation, how important is each of the following?

		Not at all important	Somewhat important	Undecided	Important	Very important
a.	Personal out-of-pocket expense	☐	☐	☐	☐	☐
b.	Lack of government funds for cost share	☐	☐	☐	☐	☐
c.	Not having access to the equipment I need	☐	☐	☐	☐	☐
d.	Lack of available information about a practice	☐	☐	☐	☐	☐
e.	No one else I know is implementing the practice	☐	☐	☐	☐	☐
f.	Concerns about reduced yields	☐	☐	☐	☐	☐
g.	Soil health (organic matter, soil biological functions, nutrient retention, etc.)	☐	☐	☐	☐	☐
h.	Evidence of the economic benefits	☐	☐	☐	☐	☐
i.	Evidence of the environmental benefits	☐	☐	☐	☐	☐
j.	Not being able to see a demonstration of the practice before I decide	☐	☐	☐	☐	☐
k.	Fear of regulation	☐	☐	☐	☐	☐
l.	Saving money	☐	☐	☐	☐	☐

Management Practices

10. Please indicate which statement most accurately describes your level of experience with each practice or rule listed below.

		Never heard of it	Somewhat familiar with it	Know how to use; not using it	Currently use it	Not applicable
a.	Planting a vegetated buffer along streams, ditches, ponds, etc.	☐	☐	☐	☐	☐
b.	Following university recommendations for fertilization rates	☐	☐	☐	☐	☐
c.	Avoiding fall application of nitrogen fertilizer to reduce environmental losses	☐	☐	☐	☐	☐
d.	Using no-till, strip-till, or ridge till	☐	☐	☐	☐	☐
e.	Considering location and soil characteristics to minimize leaching or runoff of fertilizers	☐	☐	☐	☐	☐
f.	Using conservation crop rotation to improve soil nutrient content	☐	☐	☐	☐	☐
g.	4R Nutrient Stewardship - using the Right fertilizer source at the Right rate, at the Right time, and in the Right place	☐	☐	☐	☐	☐
h.	The Indiana State Chemist fertilizer applicator licensing rule	☐	☐	☐	☐	☐
i.	Avoiding fertilizer application on frozen and/or snow-covered soil	☐	☐	☐	☐	☐
j.	Using cover crops for erosion protection and soil improvement	☐	☐	☐	☐	☐
k.	Using variable rate planters	☐	☐	☐	☐	☐
l.	Conducting replicated strip trials to find optimum nitrogen rates	☐	☐	☐	☐	☐

Each box contains a set of questions that refer to a specific nutrient best management practice.

For each question, please select the answer choice that best represents your experience or opinion.

11. Conducting regular soil tests (at least every 4 years)

To determine the appropriate rate of fertilizer or manure application, farmers can **conduct regular soil tests** for pH, phosphorus, nitrogen, and potassium. This promotes efficient fertilizer use, which may save money and reduces leaching and runoff.

a. Please select the option that best describes your experience with *conducting regular soil tests*.

Not relevant - don't have pasture or crops (skip to # 12)	Never heard of it and not willing to try it (skip to # 12)	Never heard of it, but might be willing to try it (skip to # 12	Heard of it and not willing to try it (skip to # 12)	Heard of it and might be willing to try it (skip to # 12)	Used it in the past and not willing to try it again (skip to # 12)	Used it in the past and might be willing to try it again (skip to # 12)	Currently use it (continue to "b")
☐	☐	☐	☐	☐	☐	☐	☐

b. On what percentage of your agricultural land do you *conduct regular soil tests*?

0-25% ☐	26-50% ☐	51-75% ☐	76-100% ☐

c. I use the results of my *soil tests* to determine the application rate of: (check all that apply)

Manure	Phosphorus fertilizer	Potassium fertilizer	Nitrogen fertilizer	Agricultural lime	None	Other (please specify): _____
☐	☐	☐	☐	☐	☐	☐

12. Variable rate application

Variable rate application is a method of applying varying rates of nutrients in appropriate zones throughout a field. This technology allows for more precise application of fertilizer, which promotes efficiency, saves money, and reduces leaching and runoff.

a. Do you have access to the equipment needed for *variable rate application*?

Yes ☐	No ☐	Don't Know ☐	

b. Please select the option that best describes your experience with *variable rate application*.

Not relevant - don't have pasture or crops (skip to # 13)	Never heard of it and not willing to try it (skip to # 13)	Never heard of it, but might be willing to try it (skip to # 13)	Heard of it and not willing to try it (skip to # 13)	Heard of it and might be willing to try it (skip to # 13)	Used it in the past and not willing to try it again (skip to # 13)	Used it in the past and might be willing to try it again (skip to # 13)	Currently use it (continue to "c")
☐	☐	☐	☐	☐	☐	☐	☐

c. On what percentage of your cropland do you use *variable rate application*?

0-25% ☐	26-50% ☐	51-75% ☐	76-100% ☐

13. Application timing

Application timing refers to the application of fertilizer and/or manure to coincide as closely as possible to the period of maximum crop uptake. Partial application of fertilizer in the spring, followed by small additional applications as needed, can improve nitrogen uptake and reduce leaching and runoff.

a. Please select the option that best describes your experience with *application timing*.

Not relevant - don't have pasture or crops (skip to # 14)	Never heard of it and not willing to try it (skip to # 14)	Never heard of it, but might be willing to try it (skip to # 14)	Heard of it and not willing to try it (skip to # 14)	Heard of it and might be willing to try it (skip to # 14)	Used it in the past and not willing to try it again (skip to # 14)	Used it in the past and might be willing to try it again (skip to # 14)	Currently use it (continue to "b")
☐	☐	☐	☐	☐	☐	☐	☐

b. On what percentage of your cropland do you use *application timing*?

0-25% ☐	26-50% ☐	51-75% ☐	76-100% ☐

14. Nutrient Management Plan

A nutrient management plan (i.e., Comprehensive Nutrient Management Plan, Manure Management Plan, or Fertilizer Action Plan) is a customized document that describes a farm's livestock production practices and outlines strategies for addressing its potential water quality impacts. It includes plans for handling, transferring, storing, treating, and spreading manure.

a. Please select the option that best describes your experience with *nutrient management plans*.

Not relevant - don't own livestock (skip to # 15)	Never heard of it and not willing to try it (skip to # 15)	Never heard of it, but might be willing to try it (skip to # 15)	Heard of it and not willing to try it (skip to # 15)	Heard of it and might be willing to try it (skip to # 15)	Used it in the past and not willing to try it again (skip to # 15)	Used it in the past and might be willing to try it again (skip to # 15)	Currently use it (continue to "b")
☐	☐	☐	☐	☐	☐	☐	☐

b. Who helped you to develop your *nutrient management plan*? (check all that apply)

SWCD or NRCS	University Extension	A private sector agronomist or crop consultant	I created my own plan	Don't know	Other (specify):
☐	☐	☐	☐	☐	☐

c. What is included in your *nutrient management plan*? (check all that apply)

Commercial nutrients	Livestock manure	Septic waste	Municipal sludge	Industrial sludge	Don't know	Other (specify):
☐	☐	☐	☐	☐	☐	☐

d. I follow all the guidelines set forth by my *nutrient management plan*.

Strongly agree	Agree	Neutral	Disagree	Strongly disagree
☐	☐	☐	☐	☐

Information Sources

15. People get information about nutrient management from a number of different sources. To what extent do you trust the organizations listed below as a source of information about nutrient management?

	Not at all	Slightly	Moderately	Very much	Not familiar
a. Farm Service Agency (FSA)	☐	☐	☐	☐	☐
b. Soil and Water Conservation District (SWCD)	☐	☐	☐	☐	☐
c. Natural Resources Conservation Service (NRCS)	☐	☐	☐	☐	☐
d. Purdue University Extension	☐	☐	☐	☐	☐
e. Indiana State Department of Agriculture (ISDA)	☐	☐	☐	☐	☐
f. Indiana Department of Natural Resources (IDNR)	☐	☐	☐	☐	☐
g. Indiana Department of Environmental Management (IDEM)	☐	☐	☐	☐	☐
h. Environmental groups	☐	☐	☐	☐	☐
i. Agricultural industry organizations	☐	☐	☐	☐	☐
j. Fertilizer representatives	☐	☐	☐	☐	☐
k. Crop consultants	☐	☐	☐	☐	☐
l. Other landowners/friends/farmers	☐	☐	☐	☐	☐
m. U.S. Environmental Protection Agency (EPA)	☐	☐	☐	☐	☐
n. Office of the Indiana State Chemist	☐	☐	☐	☐	☐

16. Where did you first hear about the On-Farm Network? Select one.

- ☐ NRCS staff
- ☐ SWCD staff
- ☐ ISDA staff
- ☐ A farmer in the network
- ☐ A farmer NOT in the network
- ☐ Agricultural advisor
- ☐ Magazine/newspaper article
- ☐ Internet
- ☐ Other (specify)_____

Feedback

17. How much do you think the following perceived factors keep other farmers from joining the network?	Not at all	A little	Some	A lot	Don't know
a. The time commitment of the winter meeting.	☐	☐	☐	☐	☐
b. The additional time and preparation required to conduct strip trials.	☐	☐	☐	☐	☐
c. Lack of required equipment to conduct strip trials.	☐	☐	☐	☐	☐
d. The potential for yield loss due to strip trials.	☐	☐	☐	☐	☐
e. Lack of a tangible benefit to participating.	☐	☐	☐	☐	☐

18. Do you have one-on-one meetings with your group leader to further discuss your data?

☐ Yes How often?_____

☐ No

19. Will you continue to participate in the On-Farm Network?

☐ Yes Why?_____

☐ No Why?_____

☐ Maybe Why?_____

Who You Talk To

20. One of the purposes of the On-Farm Network is to provide a forum for farmers to discuss nitrogen management with each other. Please rank in order up to 5 people in your group that you talk to the most about nitrogen management.

Name

1. **(Talk to the most)**_____
2. _____
3. _____
4. _____
5. **(Talk to the least)**_____

You and Your Farm

21. What is your gender?

- ☐ Male
- ☐ Female

22. What is the highest level of school you have completed?

- ☐ Some formal schooling
- ☐ High school diploma/GED
- ☐ Some college
- ☐ 2 year college degree
- ☐ 4 year college degree
- ☐ Post-graduate degree

23. In what year were you born? 19_____

24. Where do you seek information about land or farm management (check all that apply)?

- ☐ Newsletters/brochures/fact sheets
- ☐ Internet
- ☐ Radio
- ☐ Workshops/demonstrations/meetings
- ☐ Conversations with family, friends, or neighbors
- ☐ Conversations with land or farm management professionals
- ☐ Trade publications/magazines
- ☐ Other (specify): _____
- ☐ Not applicable - I do not seek this type of information

25. Are you a Certified Crop Advisor?

- ☐ Yes
- ☐ No

26. In 2013, how many acres of the following did you manage? *If none, please enter a zero.*

Total	_____ acres
Corn	_____ acres
Soybeans	_____ acres
Small grains	_____ acres
Canning crops	_____ acres
Clover/Alfalfa	_____ acres
Pasture	_____ acres
Conservation set aside/ CRP	_____ acres
Forest/woodland	_____ acres
Non-row crops for energy	_____ acres

27. How many of the following animals are part of your farming operation? *If none, please enter a zero.*

_____	Dairy cattle, including heifers and young stock
_____	Beef cattle, including young stock
_____	Hogs
_____	Poultry
_____	Other livestock (specify): _____

28. **How many years have you been farming?**
_____ years

29. **Does the property you manage touch a stream, river, lake, or wetland?**
- ☐ Yes
- ☐ No

30. **In the last year, how many days did you work at least 4 hours off-farm? (Include work on someone else's farm for pay)**
- ☐ None
- ☐ 1 - 49 days
- ☐ 50 - 99 days
- ☐ 100 - 199 days
- ☐ 200 days or more

31. **Do you consider yourself retired from your farm operation?**
- ☐ Retired
- ☐ Partially retired
- ☐ Not retired

If you would like to receive a copy of the findings from this statewide survey, please enter the following website address into your web browser: **http://tinyurl.com/NetworkSurveyResults** and provide your email address securely online. If you do not have an email address, please call (765) 494-8025 and leave your name and mailing address. To ensure confidentiality, your personal information will not be linked to your survey answers.

Thank you for your time and assistance!

Please return your completed questionnaire in the postage-paid envelope provided.
Please use the space below for any additional comments about this survey or farmer networks.

Appendix B Statewide Nutrient Management Survey

Dear agricultural landowner and/or producer,

Indiana's agricultural organizations are conducting this survey in coordination with Purdue University Extension. The information collected will help these groups develop a statewide, non-regulatory strategy for increasing soil health and nutrient use efficiency. We want your input whether you are an agricultural producer or a non-farming owner of agricultural land.

There are two ways in which you can complete our survey. The most convenient way is for you to enter the following website address into your web browser: **http://tinyurl.com/NutrientSurvey** and provide your responses securely online. If you choose to complete the survey online, you will need to enter the following code: _____. This will let us know that you have completed the survey so that we will stop sending reminders. We have also enclosed a paper version with a postage-paid return envelope if you prefer to respond by mail. **The information you provide is confidential and will never be linked to your name**, only to this code, which is used only for the purpose of knowing who has responded to the survey.

We ask that this survey be completed by the person in your household who makes most of the land management decisions. The respondent must also be at least 18 years old. Your voluntary participation in this survey will help us understand the needs and concerns of Indiana farmers and landowners. Your answers will be kept confidential and will be released only as summaries where answers cannot be linked to individual respondents.

Unless otherwise instructed, please check the box that corresponds to the answer category that best describes you and your situation or opinion. The survey should take approximately 15-20 minutes to complete. Please read each question carefully. Thank you!

For more information about this survey, please call Linda Prokopy at (765) 494-0825. Thank you in advance for your help!

Sincerely,

Linda Prokopy
Purdue University

This project is funded by Indiana corn and soybean farmer checkoff funds.

PLEASE READ BEFORE BEGINNING THIS SURVEY:

The survey must be completed by an adult member of your household 18 years of age or older. Please mark all answers clearly, in pen or pencil, as indicated below.

Example "A" ☐ ☐ ☒ Example "B" ☐ ☐ ☑

About You

1. **What is your gender?**
   - ☐ Male
   - ☐ Female

2. **What is the total acreage of farmland you own? _____ acres**

3. **What is the highest level of school you have completed?**
   - ☐ Some formal schooling
   - ☐ High school diploma/GED
   - ☐ Some college
   - ☐ 2 year college degree
   - ☐ 4 year college degree
   - ☐ Post-graduate degree

4. **In what year were you born? 19_____**

5. **Where do you seek information about land or farm management (check all that apply)?**
   - ☐ Newsletters/brochures/fact sheets
   - ☐ Internet
   - ☐ Radio
   - ☐ Workshops/demonstrations/meetings
   - ☐ Conversations with family, friends, or neighbors
   - ☐ Conversations with land or farm management professionals
   - ☐ Trade publications/magazines
   - ☐ Other (specify): _____
   - ☐ Not applicable - I do not seek this type of information

Landowners

6.	**Do you own farmland that you rent to someone else?**	
☐	No →	**Skip to question #10**
☐	Yes →	**How many acres? _____ acres**

7. How much do the following factors influence you when making decisions regarding who you rent your land to?

	Not at all	A little	Some	A lot	Don't know
a. Aesthetics (they keep the land looking nice)	☐	☐	☐	☐	☐
b. Tradition (that's who we've always rented to)	☐	☐	☐	☐	☐
c. Their concern for conservation/the environment	☐	☐	☐	☐	☐
d. Income (they pay fair value and on time)	☐	☐	☐	☐	☐

8. What percentage of your income comes from renting agricultural land?

☐ None
☐ 1-20%
☐ 21-40%
☐ 41-60%
☐ 61-80%
☐ 81-100%

9. Who is responsible for making decisions about the following agricultural practices on the land you rent to others?

	Primarily tenant	Landowner and tenant	Primarily landowner	Farm manage-ment firm and landowner	Farm manage-ment firm and tenant	Primarily farm manage-ment firm	Does not apply
a. Crops grown/rotation	☐	☐	☐	☐	☐	☐	☐
b. Tillage practices	☐	☐	☐	☐	☐	☐	☐
c. Fertilizer application	☐	☐	☐	☐	☐	☐	☐
d. Installation of structures (i.e., buffers, ponds, grassed waterways, tile, and two-stage ditches)	☐	☐	☐	☐	☐	☐	☐
e. Manure management	☐	☐	☐	☐	☐	☐	☐

If you are an agricultural producer, please continue on the next page. If you are not an agricultural producer, please stop here and return the survey in the enclosed stamped envelope. Thank you.

Tenants

10.	Do you rent farmland from someone else?	
☐	No →	Skip to question #17
☐	Yes →	How many acres? _____ acres How many landlords? _____

11. Select the option that best describes the landowner from whom you rent the most land.

- ☐ A former farmer who used to farm the land
- ☐ The spouse of a former farmer who used to farm the land
- ☐ An inheritor of farmland
- ☐ Investor(s) with family ties to the land
- ☐ Investor(s) with no direct family ties to the land
- ☐ A farmland management firm
- ☐ Other (specify): _____

12. Select the option that best describes your relationship with the landlord from whom you rent the most land.

- ☐ We're related
- ☐ We're friends
- ☐ We're neighbors
- ☐ We're business associates
- ☐ No relation
- ☐ Other (specify): _____

13. How many years have you rented land from this landlord?

_____ **years**

14. Who is responsible for making decisions about the following agricultural practices on the land you rent from others?

	Primarily tenant	Landowner and tenant	Primarily landowner	Farm manage-ment firm and landowner	Farm manage-ment firm and tenant	Primarily farm manage-ment firm	Does not apply
a. Crops grown/rotation	☐	☐	☐	☐	☐	☐	☐
b. Tillage practices	☐	☐	☐	☐	☐	☐	☐
c. Fertilizer application	☐	☐	☐	☐	☐	☐	☐
d. Installation of structures (i.e., buffers, ponds, grassed waterways, tile, and two-stage ditches)	☐	☐	☐	☐	☐	☐	☐
e. Manure management	☐	☐	☐	☐	☐	☐	☐

15. How much do you think the following factors influence your landlord's decision to rent land to you?

	Not at all	A little	Some	A lot	Don't know
a. Aesthetics (I keep the land looking nice)	☐	☐	☐	☐	☐
b. Tradition (they've always rented to me)	☐	☐	☐	☐	☐
c. My concern for conservation/the environment	☐	☐	☐	☐	☐
d. Income (I pay fair value and on time)	☐	☐	☐	☐	☐

16. What type of lease agreement do you have with the landowner from whom you rent the most land?

- ☐ Written cash rent agreement
- ☐ Written crop share agreement
- ☐ Written hybrid cash rent agreement
- ☐ Don't know
- ☐ Verbal cash rent agreement
- ☐ Verbal crop share agreement
- ☐ Verbal hybrid cash rent agreement

Your Opinions

17. Please indicate your level of agreement or disagreement with the statements below.

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
a. Using recommended management practices on farms improves water quality.	☐	☐	☐	☐	☐
b. It is my personal responsibility to help protect water quality.	☐	☐	☐	☐	☐
c. It is important to protect water quality even if it slows economic development.	☐	☐	☐	☐	☐
d. My actions have an impact on water quality.	☐	☐	☐	☐	☐
e. I would be willing to pay more to improve water quality (for example: through local taxes or fees).	☐	☐	☐	☐	☐
f. I would be willing to change the way I manage my property to improve water quality.	☐	☐	☐	☐	☐
g. The quality of life in my community depends on good water quality in local rivers, streams, and lakes.	☐	☐	☐	☐	☐

Water Impairments

18. Below is a list of water pollutants that can become a problem when present in excessive amounts. In your opinion, how much of a problem are the following pollutants in the area where you own or rent farmland?

	Not a problem	Slight problem	Moderate problem	Severe problem	Don't know
a. Sedimentation/silt	☐	☐	☐	☐	☐
b. Nitrate	☐	☐	☐	☐	☐
c. Phosphorus	☐	☐	☐	☐	☐
d. Bacteria in the water (such as E. coli)	☐	☐	☐	☐	☐

19. The items listed below are sources of water quality pollution across the country. In your opinion, how much of a problem are the following sources in the area where you own or rent farmland?

	Not a problem	Slight problem	Moderate problem	Severe problem	Don't know
a. Discharges from industry into streams and lakes	☐	☐	☐	☐	☐
b. Discharges from sewage treatment plants	☐	☐	☐	☐	☐
c. Soil erosion from farm fields	☐	☐	☐	☐	☐
d. Soil erosion from shorelines and/or streambanks	☐	☐	☐	☐	☐
e. Lawn fertilizers and/or pesticides	☐	☐	☐	☐	☐
f. Fertilizers or manure used for crop production	☐	☐	☐	☐	☐
g. Improperly maintained septic systems	☐	☐	☐	☐	☐
h. Manure from farm animals	☐	☐	☐	☐	☐
i. Littering/illegal dumping of trash	☐	☐	☐	☐	☐
j. Pesticides or herbicides used for crop production	☐	☐	☐	☐	☐
k. Animal feeding operations	☐	☐	☐	☐	☐
l. Urban stormwater runoff (e.g. highways, rooftops, parking lots)	☐	☐	☐	☐	☐
m. Removal of streambank vegetation	☐	☐	☐	☐	☐

Management Practices

20.	Do you grow crops, pasture, and/or hay?	
☐	No →	Skip to question #22
☐	Yes →	Continue with question #21

21. Please indicate which statement most accurately describes your level of experience with each practice or rule listed below.

		Never heard of it	Somewhat familiar with it	Know how to use; not using	Currently use it	Not applicable
a.	Planting a vegetated buffer along streams, ditches, ponds, etc.	☐	☐	☐	☐	☐
b.	Following university recommendations for fertilization rates	☐	☐	☐	☐	☐
c.	Avoiding fall application of nitrogen fertilizer to reduce environmental losses	☐	☐	☐	☐	☐
d.	Using no-till, strip-till, or ridge till	☐	☐	☐	☐	☐
e.	Considering location and soil characteristics to minimize leaching or runoff of fertilizers	☐	☐	☐	☐	☐
f.	Using conservation crop rotation to improve soil nutrient content	☐	☐	☐	☐	☐
g.	4R Nutrient Stewardship - using the Right fertilizer source at the Right rate, at the Right time, and in the Right place	☐	☐	☐	☐	☐
h.	The Indiana State Chemist fertilizer applicator licensing rule	☐	☐	☐	☐	☐
i.	Avoiding fertilizer application on frozen and/or snow-covered soil	☐	☐	☐	☐	☐
j.	Using cover crops for erosion protection and soil improvement	☐	☐	☐	☐	☐

22.	Do you have any livestock or horses (even as a hobby)?	
☐	No →	Skip to question #24
☐	Yes →	Continue with question #23

23. Please indicate which statement most accurately describes your level of experience with each practice or rule listed below.

		Never heard of it	Somewhat familiar with it	Know how to use; not using	Currently use it	Not applicable
a.	Composting manure prior to land application	☐	☐	☐	☐	☐
b.	Constructing a waste storage facility	☐	☐	☐	☐	☐
c.	Applying manure at agronomic rates based on the nutrients in the manure, soil test levels, and crop nutrient requirements	☐	☐	☐	☐	☐
d.	Diverting surface water away from feedlots	☐	☐	☐	☐	☐
e.	Avoiding fall application of manure to reduce environmental losses	☐	☐	☐	☐	☐
f.	Avoiding manure application on frozen and/or snow-covered soil	☐	☐	☐	☐	☐
g.	Considering location and soil characteristics to minimize leaching or runoff of manure	☐	☐	☐	☐	☐

EACH BOX CONTAINS A SET OF QUESTIONS THAT REFER TO A SPECIFIC NUTRIENT BEST MANAGEMENT PRACTICE.

For each question, please select the answer choice that best represents your experience or opinion.

24. Conducting regular soil tests (at least every 4 years)

To determine the appropriate rate of fertilizer or manure application, farmers can **conduct regular soil tests** for pH, phosphorus, nitrogen, and potassium. This promotes efficient fertilizer use, which may save money and reduces leaching and runoff.

a. Please select the option that best describes your experience with *conducting regular soil tests*.

Not relevant - don't have pasture or crops **(skip to # 27)**	Never heard of it and not willing to try it **(skip to # 25)**	Never heard of it, but might be willing to try it **(skip to # 25)**	Heard of it and not willing to try it **(skip to # 25)**	Heard of it and might be willing to try it **(skip to # 25)**	Used it in the past and not willing to try it again **(skip to # 25)**	Used it in the past and might be willing to try it again **(skip to # 25)**	Currently use it **(continue to "b")**
☐	☐	☐	☐	☐	☐	☐	☐

b. On what percentage of your agricultural land do you *conduct regular soil tests*?

0-25%	☐	26-50%	☐	51-75%	☐	76-100%	☐

c. I use the results of my *soil tests* to determine the application rate of: (check all that apply)

Manure	Phosphorus fertilizer	Potassium fertilizer	Nitrogen fertilizer	Agricultural lime	None	Other (please specify): _____
☐	☐	☐	☐	☐	☐	☐

25. Variable rate application technology

Variable rate application technology is a method of applying varying rates of nutrients in appropriate zones throughout a field. This technology allows for more precise application of fertilizer, which promotes efficiency, saves money, and reduces leaching and runoff.

a. Do you have access to the equipment needed for *variable rate application*?

Yes	☐	No	☐	Don't Know	☐

b. Please select the option that best describes your experience with *variable rate application technology*.

Not relevant - don't have pasture or crops **(skip to # 27)**	Never heard of it and not willing to try it **(skip to # 26)**	Never heard of it, but might be willing to try it **(skip to # 26)**	Heard of it and not willing to try it **(skip to # 26)**	Heard of it and might be willing to try it **(skip to # 26)**	Used it in the past and not willing to try it again **(skip to # 26)**	Used it in the past and might be willing to try it again **(skip to # 26)**	Currently use it **(continue to "c")**
☐	☐	☐	☐	☐	☐	☐	☐

c. On what percentage of your cropland do you use *variable rate application technology*?

0-25%	☐	26-50%	☐	51-75%	☐	76-100%	☐

26. Application timing

Application timing refers to the application of fertilizer and/or manure to coincide as closely as possible to the period of maximum crop uptake. Partial application of fertilizer in the spring, followed by small additional applications as needed, can improve nitrogen uptake and reduce leaching and runoff.

a. Please select the option that best describes your experience with *application timing*.

Not relevant - don't have pasture or crops **(skip to # 27)**	Never heard of it and not willing to try it **(skip to # 27)**	Never heard of it, but might be willing to try it **(skip to # 27)**	Heard of it and not willing to try it **(skip to # 27)**	Heard of it and might be willing to try it **(skip to # 27)**	Used it in the past and not willing to try it again **(skip to # 27)**	Used it in the past and might be willing to try it again **(skip to # 27)**	Currently use it **(continue to "b")**
☐	☐	☐	☐	☐	☐	☐	☐

b. On what percentage of your cropland do you use *application timing*?

0-25% ☐	26-50% ☐	51-75% ☐	76-100% ☐

27. Nutrient Management Plan

A nutrient management plan (i.e., Comprehensive Nutrient Management Plan, Manure Management Plan, or Fertilizer Action Plan) is a customized document that describes a farm's livestock production practices and outlines strategies for addressing its potential water quality impacts. It includes plans for handling, transferring, storing, treating, and spreading manure.

a. Please select the option that best describes your experience with *nutrient management plans*.

Not relevant - don't own livestock **(skip to # 28)**	Never heard of it and not willing to try it **(skip to # 28)**	Never heard of it, but might be willing to try it **(skip to # 28)**	Heard of it and not willing to try it **(skip to # 28)**	Heard of it and might be willing to try it **(skip to # 28)**	Used it in the past and not willing to try it again **(skip to # 28)**	Used it in the past and might be willing to try it again **(skip to # 28)**	Currently use it **(continue to "b")**
☐	☐	☐	☐	☐	☐	☐	☐

b. Who helped you to develop your *nutrient management plan*? (check all that apply)

SWCD or NRCS	University Extension	A private sector agronomist or crop consultant	I created my own plan	Don't know	Other (specify): _____
☐	☐	☐	☐	☐	☐

c. What is included in your *nutrient management plan*? (check all that apply)

Commercial nutrients	Livestock manure	Septic waste	Municipal sludge	Industrial sludge	Don't know	Other (specify): _____
☐	☐	☐	☐	☐	☐	☐

d. I follow all the guidelines set forth by my *nutrient management plan*.

Strongly agree	Agree	Neutral	Disagree	Strongly disagree
☐	☐	☐	☐	☐

Decision Making

28. When you make decisions about nutrient management on your farm operation, how important is each of the following?

		Not at all important	Somewhat important	Undecided	Important	Very important
a.	Personal out-of-pocket expense	☐	☐	☐	☐	☐
b.	Lack of government funds for cost share	☐	☐	☐	☐	☐
c.	Not having access to the equipment I need	☐	☐	☐	☐	☐
d.	Lack of available information about a practice	☐	☐	☐	☐	☐
e	No one else I know is implementing the practice	☐	☐	☐	☐	☐
f	Concerns about reduced yields	☐	☐	☐	☐	☐
g	Soil health (organic matter, soil biological functions, nutrient retention, etc.)	☐	☐	☐	☐	☐
h.	Evidence of the economic benefits	☐	☐	☐	☐	☐
i.	Evidence of the environmental benefits	☐	☐	☐	☐	☐
j.	I do not own the property	☐	☐	☐	☐	☐
k.	Not being able to see a demonstration of the practice before I decide	☐	☐	☐	☐	☐
l.	Environmental benefit of practice	☐	☐	☐	☐	☐
m.	Saving money	☐	☐	☐	☐	☐

Information Sources

29. How familiar are you with the following management networks?

		Unfamiliar	Somewhat familiar	Familiar; don't participate	Participate
a.	Indiana's On-Farm Network (OFN)	☐	☐	☐	☐
b.	Indiana Conservation Cropping Systems Initiative (CCSI)	☐	☐	☐	☐
c.	Adapt Network	☐	☐	☐	☐
d.	Purdue Collaborative On-Farm Research	☐	☐	☐	☐

30. People get information about nutrient management from a number of different sources. To what extent do you trust the organizations listed below as a source of information about nutrient management?

	Not at all	Slightly	Moderately	Very much	Not familiar
a. Farm Service Agency (FSA)	☐	☐	☐	☐	☐
b. Soil and Water Conservation District (SWCD)	☐	☐	☐	☐	☐
c. Natural Resources Conservation Service (NRCS)	☐	☐	☐	☐	☐
d. Purdue University Extension	☐	☐	☐	☐	☐
e. Indiana State Department of Agriculture (ISDA)	☐	☐	☐	☐	☐
f. Indiana Department of Natural Resources (IDNR)	☐	☐	☐	☐	☐
g. Indiana Department of Environmental Management (IDEM)	☐	☐	☐	☐	☐
h. Environmental groups	☐	☐	☐	☐	☐
i. Agricultural organizations	☐	☐	☐	☐	☐
j. Fertilizer representatives	☐	☐	☐	☐	☐
k. Crop consultants	☐	☐	☐	☐	☐
l. Other landowners/friends/farmers	☐	☐	☐	☐	☐
m. U.S. Environmental Protection Agency (EPA)	☐	☐	☐	☐	☐
n. Office of the Indiana State Chemist	☐	☐	☐	☐	☐

Your Farm

31. In 2013, how many acres of the following did you manage? *If none, please enter a zero.*

Corn _____ acres
Soybeans _____ acres
Small grains _____ acres
Canning crops _____ acres
Clover/Alfalfa _____ acres
Pasture _____ acres
Conservation set aside/ CRP _____ acres
Forest/woodland _____ acres
Non-row crops for energy _____ acres
Other (specify): _____ _____ acres

32. How many of the following animals are part of your farming operation? *If none, please enter a zero.*

_____ Dairy cattle, including heifers and young stock
_____ Beef cattle, including young stock
_____ Hogs
_____ Poultry
_____ Other livestock (specify): _____

33. **How many years have you been farming?**
_____ years

34. **Does the property you manage touch a stream, river, lake, or wetland?**
- ☐ Yes
- ☐ No

35. **Does your operation have an IDEM CFO approval or CAFO permit?**
- ☐ Yes
- ☐ No

36. **Are you certified as a "Distributor and User of Fertilizer Materials" by the Office of the Indiana State Chemist?**
- ☐ Yes
- ☐ No

37. **In the last year, how many days did you work at least 4 hours off-farm? (Include work on someone else's farm for pay)**
- ☐ None
- ☐ 1 - 49 days
- ☐ 50 - 99 days
- ☐ 100 - 199 days
- ☐ 200 days or more

38. **Do you consider yourself retired from your farm operation?**
- ☐ Retired
- ☐ Partially retired
- ☐ Not retired

If you would like to receive a copy of the findings from this statewide survey, please enter the following website address into your web browser: **http://tinyurl.com/NutrientSurveyResults** and provide your email address securely online. If you do not have an email address, please call (765) 494-8025 and leave your name and mailing address. To ensure confidentiality, your personal information will not be linked to your survey answers.

Thank you for your time and assistance!

Please return your completed questionnaire in the postage-paid envelope provided.
Please use the space below for any additional comments about this survey or nutrient management.

Appendix C: Interview Guide

Warm Up Questions

1. How long have you been farming?
2. How long have you been involved in the network?
3. Who is responsible for making management decisions on your farm?

Specifics

4. How many fields do you have enrolled?
5. Do you do replicated strip trials as part of the network?
    a. If so, what are you trialing?
6. Do you use variable rate planters?
7. Do you use variable rate fertilizer applicators?
8. Do you apply your own nitrogen or hire someone else?
9. On how much of your acreage do you use these practices?

Network Whys and Hows

10. What made you join the network?
11. Has concern for water quality influenced your decision to join the network?

Network Effects

12. Do you find the opinions, knowledge, and experiences shared by other network farmers to be beneficial?
13. Do you feel learning about the practices of other farmers have had an impact on your Nitrogen management practices?
14. Have you shared knowledge or advice about nitrogen management with your friends and neighbors who are not involved with the network?
    b. Why or why not?
    c. If so, what types of information have you shared?
15. Have you noticed that those farmers have implemented Nitrogen management practices?
16. How do your friends and neighbors influence your nitrogen management practices?
17. How do the management techniques the other network members employ influence you?
18. Has being in the network changed the standard for nitrogen management among you and your peers?

Outcomes

19. What is the most useful aspect of being involved with the network?

20. What have you learned, if anything, about Nitrogen management from being involved with the network?
21. Have you implemented any nitrogen management practices on your farm that you learned about through the network?
    d. Why or why not?
22. Has your participation in the network led you to make any changes in Nitrogen management?
23. Do you use the information from the network to adapt your Nitrogen management from season to season?
24. Has being involved with the network influenced how you plan for the coming season?
25. Has involvement in the network increased your profitability?

Appendix D: Nitrogen Networks Code Book

1. **Reasons for Joining:**
   a. **Understand Nitrogen Use Efficiency:** learn how to better manage crops and fertilizer
   b. **Fear of Regulation**
   c. **Stewardship**: intrinsic care for the water and land
   d. **Free program/cost**: Program was free
   e. **Water Quality**: Concerned about the impact they are having on water quality
   f. **Reduce inputs**: Want to save money by reducing fertilizer use
   g. **Interested in Research/Data**
   h. **Know coordinator**
2. **Water Quality Concern**
   a. **Enthusiastic concern**
   b. **Begrudging concern:** seems like they only say it is because they were primed to say so.
   c. **No**: Asked if water quality was a concern and said no.
   d. **Water Quality vs Yield**: Are not willing to sacrifice yield for water quality
3. **Network Benefits**
   a. **Understand Nitrogen Use Efficiency**
   b. **Aerial Imagery**
   c. **Defend Against Regulation**
   d. **Networking:** Able to talk with other farmers
   e. **Personal Interaction with Coordinator**
   f. **Help understanding data**
4. **Criticisms**
   a. **Criticisms:** Displeasure with testing, data, procedures, leadership, etc.
   b. **Improvements:** Recommendations for improving the data collected and the data usability
      a. CSNT improvements
      b. Data improvements
      c. Expanded testing
      d. Include Yield Data
      e. Involving New Partners
      f. Provide Recommendations
      g. Strip Trials
5. **Coordinator:** Comments about role of coordinator in the network.
6. **Network Outcomes**
   a. **Change:** Say they have changed their practices due to learning through the network
   b. **No Change**: Say they haven't changed their practices
   c. **Observed Change**: See others changing their practices
   d. **No observed change:** Don't see others changing their practices
   e. **Confirmed they're already doing the right thing**
   f. **Considering change**
   g. **Think change will eventually come**
7. **Peer Learning**

   a. **Within Network**: Have learned things about N management from other farmers in the network
      I. Yes
      II. No

   b. Diffusion Outside Network: Knowledge and practices spreading to farmers outside the network
      I. -Yes
      II. -No

   c. **Social Norms/Influences**: Say that other farmers/friends/neighbors/CCA influence their practices

8. **<u>Profitability</u>**: Farmers are making and/or saving money because of involvement with the network