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TO ADOPT SUSTAINABLE
MANURE MANAGEMENT PRACTICES

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# BARRIERS TO CHANGE: FARMERS' WILLINGNESS TO ADOPT SUSTAINABLE MANURE MANAGEMENT PRACTICES

By

Robert D. Battel

A THESIS

Submitted to
Michigan State University
in partial fulfillment of the requirements
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ABSTRACT

BARRIERS TO CHANGE: FARMERS' WILLINGNESS
TO ADOPT SUSTAINABLE
MANURE MANAGEMENT PRACTICES

By

Robert D. Battel

The management of manure nutrients is important in Michigan agriculture. There is need for a better understanding of why farmers do not utilize manure nutrients in a more sustainable manner. Some livestock farms could benefit if neighboring farmers used their manure. This study explored the potential for the transfer of manure from livestock farms to crop fields of neighboring farms. The population for this study consisted of all Calhoun County farmers who reside in the Kalamazoo River watershed.

A mailed survey was used to collect data. Responses were placed into several groups, and comparisons were made between the groups. Surveys were analyzed to determine the frequencies of different responses among all respondents.

Results suggest differences in how groups of farmers perceive topics related to farm-to-farm manure exchange. The results also suggest that among all farmers in the population, a concern that neighbors may complain about manure applications and odor represent the most significant barriers to manure exchange. Concerns about spreading weed seeds and economic issues are also significant barriers.

I dedicate this thesis to my daughter, Adele Lynn Stuever Battel. With love, and appreciation, your father.

# ACKNOWLEDGEMENTS

I would like to thank my major professor, Dr. David Krueger. His guidance and advice during the writing of this thesis was much appreciated. Thanks, also to the other members of my graduate committee, Dr. S. Joseph Levine and Dr. Carrie Laboski. Their suggestions and insight helped improve this thesis, and my learning.

I also appreciate the help given by Ms. Natalie Rector. Her experience in sustainable manure management was instrumental in shaping this study.

Finally, I offer a special word of thanks to my wife, Sue Stuever Battel. Her skills in editing, and suggestions for improving my writing were invaluable. I thank her most, though for the support she offered during my graduate studies. I could not have completed this degree without that support.

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# CHAPTER I
# INTRODUCTION

## Background

The most important job of Extension agricultural educators is to help farmers change behaviors that will improve their lives and the lives of their neighbors. The sustainable management of manure nutrients, especially manure phosphorus, is a farming practice to be improved.

## Phosphorus as an Environmental Concern

The concern around agronomic phosphorus has shifted from that of a nutrient that limits crop production to that of an environmental pollutant (Foth & Ellis, 1988). Phosphorus can be the limiting nutrient for aquatic plant growth (Parry, 1998). When phosphorus levels build in surface waters, the process of eutrophication can accelerate. The U.S. Environmental Protection Agency (EPA) attributes agriculture as the primary source of between 50 and 56% of the impaired lake acres in the United States (Weitman, 1995; Parry, 1998). The EPA uses the Clean Water Act to carry out its mandate to regulate water quality in the United States. The section that applies to manure management is the Non-Point Source Pollution Program, Section 319 of the Clean Water Act (Weitman, 1995; Parry, 1998).

## State Law

Michigan's Right-to-Farm Act, Public Act 93 of 1981, provides farmers protection from nuisance lawsuits. To maintain their rights to farm, farmers must follow Generally Accepted Agricultural and Management Practices (GAAMPs) appropriate to their operations (MDA, 2003). The GAAMPs related to manure management appear in

*Generally Accepted Agricultural and Management Practices for Manure Management and Utilization* (Manure Management GAAMPs) (MDA, 2003).

Manure Management GAAMPs allow manure spreading on fields testing low in phosphorus so it satisfies the nitrogen fertilizer needs of the crop grown. When farmers apply manure in this way, phosphorus is typically over-applied (Sharpley, et. al, 1996). Whalen and Chang (2001) verified this by studying phosphorus accumulation in barley fields in Alberta, Canada, which received manure to meet nitrogen requirements for 16 consecutive years. They found barley harvests removed only 15% of the manure phosphorus from the soil.

## Phosphorus Concerns in Lake Allegan

A significant portion of Calhoun County lies within the Kalamazoo River watershed. The Kalamazoo River flows into Lake Allegan in central Allegan County. The Michigan Department of Environmental Quality (MDEQ) has identified phosphorus as the primary pollutant in Lake Allegan (MDEQ, 2001). A Phosphorus Total Maximum Daily Load has been set for the lake (MDEQ, 2001). MDEQ personnel believe reducing phosphorus loadings will achieve an average in-lake total phosphorus concentration of 60 $\mu g\ L^{-1}$ (micrograms per liter) in Lake Allegan April through September. The present concentration in these months is 96 $\mu g\ L^{-1}$ (MDEQ, 2001).

## Statement of the Problem

The management of manure-phosphorus by Calhoun County farmers within the Kalamazoo River watershed influences the quality of Lake Allegan. Farmers could better utilize manure-phosphorus on a countywide basis if they sought to adopt practices to spread manure nutrients in areas of lower phosphorus fertility. Crop farmers whose

land is near livestock facilities in Calhoun County have an opportunity to receive manure that livestock farms may not sustainably utilize.

## Purpose

This study described why Calhoun County farmers within the Kalamazoo River watershed think manure phosphorus is not distributed from areas of higher phosphorus fertility to areas of lower phosphorus fertility, decreasing the potential of Lake Allegan to further decline in quality.

## Research Questions

### Research Question 1

How do all surveyed farmers respond to the following statements?

1. Farmers feel manure is too variable (not consistent enough) to be a reliable fertilizer source
2. Farmers are concerned that neighbors may complain about manure applications on fields not usually receiving manure
3. Odor concerns cause farmers to not apply manure on certain fields
4. Farmers are concerned that manure may contain weed seeds
5. Farmers are concerned with the potential compaction caused by manure application equipment
6. Farmers are concerned that manure applications could interfere with the timeliness of spring planting or other aspects of their cropping operations
7. Farmers would be willing to accept manure from a neighboring farm only if it were available at no cost

8. Farmers would be willing to accept manure from a neighboring farm at a cost, as long as the cost was less than commercial fertilizer
9. Farmers would be willing to accept manure from a neighboring farm at a cost, even if the cost was about the same as commercial fertilizer
10. Farmers would be willing to accept manure from a neighboring farm only if none of their time or labor were required to get it applied
11. Farmers would be willing to accept manure from a neighboring farm even if they had to supply some of their time and labor to get it applied

**Research Question 2**

Are there differences between how surveyed livestock farmers and surveyed nonlivestock farmers, respond to those statements?

**Research Question 3**

Are there differences between how surveyed farmers, age 50 years and younger, and surveyed farmers, age 51 years and older, respond to those statements?

**Research Question 4**

Are there differences between how surveyed farmers who farm 250 or fewer acres and surveyed farmers who farm more than 250 acres respond to those statements?

**Research Question 5**

Are there differences between how surveyed farmers who do not currently raise livestock, but have within the past 10 years, and surveyed farmers who do not currently raise livestock, and have not for at least 10 years, respond to those statements?

**Research Question 6**

How prevalent is manure exchange among surveyed farmers?

## Definition of Terms

To facilitate a better understanding of this study, several terms will be defined.

**Eutrophication** is an excess of nutrients reducing the oxygen dissolved within a body of water, producing an environment that does not readily support aquatic life. **Cultural eutrophication** is the process of human activities accelerating eutrophication.

**Point source pollution** is pollution coming from a single identifiable source such as discharge pipes from industry or sewer plants. **Non-point source pollution** is generated by diffuse land-use activities rather than from an identifiable point. Generally, pollution associated with manure misapplication is non-point source pollution.

**Total Maximum Daily Load** is a calculation of the maximum amount of a pollutant a water body can receive and meet water quality standards, from point, non-point, and background sources.

**Situational barriers** arise from one's situation in life that precludes one from participating in learning. Situational barriers include prohibitive costs to take part in an educational program, lack of time, lack of transportation, or other situations that make it difficult or impractical to learn. **Institutional barriers** are barriers set forth by educational institutions that discourage adults from participating in learning. Institutional barriers include the time required to complete a program, inconvenient time when institutions offer programs, a lack of information about when institutions offer programs, or bureaucratic processes associated with beginning a program. **Dispositional barriers** are associated with attitudes or self-perceptions about oneself as a learner. Dispositional barriers include a belief that one is too old to continue to learn, the fact

that a potential learner received low grades in the past and is not confident enough to continue learning, or that a potential learner is tired of school or classrooms.

**No-tillage** is a system for growing crops without plowing, resulting in reduced soil erosion.

## Limitations of the Study

Results of this study can be generalized only to Calhoun County farmers within the Kalamazoo River watershed.

## Basic Assumptions

It was assumed that the survey results were an accurate portrayal of surveyed farmers' perception of potential management of manure nutrients.

# CHAPTER II

# REVIEW OF LITERATURE

## Section I

## Phosphorus in Runoff

Römkens and Nelson (1974) pursued development of a tool to document the agricultural runoff contribution to the phosphorus enrichment of surface waters. They developed a laboratory method to predict the approximate concentrations of orthophosphate in runoff from a bare, wet, silt soil.

Wendt and Corey (1980) added to Römken's and Nelson's findings by analyzing the variations in phosphorus concentrations of runoff on a loam soil under various uses. They found the greatest losses of phosphorus occurred on recently tilled soils in row crops, as compared to forested lands and cropland growing alfalfa.

Sharpley, Daniel, Sims, and Pote (1996) proposed that a 1,000 $\mu g\ L^{-1}$ concentration of dissolved phosphorus in runoff water would result in phosphorus enrichment of surface waters. They further proposed that a soil test level of 200 parts per million would relate to a 1,000 $\mu g\ L^{-1}$ concentration of dissolved phosphorus in runoff water for a silt loam soil in fescue production.

## Section II
## Barriers to Change in the Life of Adults

Adults, unlike children, take responsibility for and direct their behavior, actions, opinions, and learning (Illeris, 2002). Adult learning is therefore a function of desire (Illeris, 2002). Illeris characterized adult learning by stating:

- adults learn what they want to learn and what is meaningful for them to learn
- adults draw on the resources they already have in their learning

- adults take as much responsibility for their learning as they want to take (if allowed to)
- adults are not very inclined to learn something they are not interested in, or in which they cannot see the meaning or importance

Cross (1981) synthesized existing research and theory about adults as learners, identifying barriers to continuing learning. She reported that adult learning barriers fell into one of three categories: situational, institutional, or dispositional.

Cross (1981) discovered that researchers reported situational barriers in 10 to 50% of surveys about barriers to adult continued learning. Researchers reported institutional barriers and dispositional barriers in 10 to 25% and 5 to 15% of surveys, respectively (Cross, 1981).

She believed that adults understated the importance of dispositional barriers in prohibiting their continued education. She reported that, when responding to a survey, it would be more socially acceptable for a person to answer, "I don't have the time," or, "A session is inconveniently scheduled," than to answer, "I'm not interested in learning the material." That is, she felt that it was more convenient for a potential learner to respond to a surveyor that one's situation in life, or the inconvenience of conforming to an institution's schedule, prohibited continued learning, rather than an attitude against further learning.

Even (1987) reported that adult learners enter the learning process with their own *baggage barriers*, or aspects of the nature of the adult and the unique way adults have dealt with life. Baggage barriers affect the ways adults learn, resulting in learners learning in different ways.

## Section III

## Diffusion of Innovations

Diffusion research considers factors that increase or decrease the chance that a group, such as farmers, will adopt a new practice. Rogers (1995) wrote that innovation diffusion consists of four stages: invention, communication through the social system, time, and consequences. Information flows through networks. The nature of networks and the roles opinion leaders play in them determine the likelihood that members of the group will adopt the innovation.

Innovation diffusion research explains the variables that influence why people adopt a new practice. Opinion leaders influence group behavior through their personal contact, but additional intermediaries called change agents and gatekeepers are included in innovation diffusion.

The five adopter categories fall into a standard deviation-curve, with few innovators, 2.5%, adopting the innovation in the beginning; early adopters comprising 13.5%; the early majority 34%; the late majority 34%; and after time the laggards make up 16%.

## Section IV

## Diffusion of Conservation Innovations

The diffusion of an innovation, like manure exchange and other conservation practices is different from an innovation like the use of hybrid corn; there is not typically a short-term economic advantage to adopting a conservation practice (Pampel & Van Es, 1977). Pampel and Van Es (1977) compared profitable agricultural practices, or commercial practices and unprofitable practices, or environmental practices in

southern Illinois. They found the predictors of the adoption of commercial practices were different from those of environmental practices. Variables relating to farm size predicted commercial practice adoption well, while years farmed poorly predicted the adoption of environmental practices.

Nowak (1987) argued that both economic and diffusion factors would predict the adoption of conservation practices. He studied the adoption of contour planting, strip cropping, grass waterways, and filter strips, or unprofitable conservation practices and conservation tillage, a profitable conservation practice in two watersheds in Iowa. He determined that both economic and diffusion factors were important in predicting the adoption of conservation practices.

## Section V

## Adoption of Conservation Practices

Buttel, Gillespie, Larson, and Harris (1981) sought to account for the variation in environmental attitudes among New York and Michigan farmers. They wanted to determine if the factors that accounted for environmental attitudes among the general population were similar to those of farmers studied. They began with the premise that, among the general population, more-educated individuals in the higher classes had higher environmental expectations because they had solved their immediate economic survival problems including adequate income and housing.

What Buttel, et. al, (1981) determined was that education had little or no relation to farmers' environmental attitudes. Age and political ideology proved to be more significant. Politically liberal farmers were more concerned with industrial and agricultural environmental problems. While the relationship between age and

environmental concern varied somewhat between New York and Michigan farmers, there was a positive association between age and concern with soil erosion among both New York and Michigan farmers. They reported that stewardship was a component of traditional agrarian ideologies, typically held by older farmers in 1981. Gross farm income and other indicators of wealth showed an inverse correlation to environmental attitudes (Buttel, et. al, 1981).

Napier, Thraen, Gore, and Goe (1984) considered factors affecting the adoption of conventional and conservation tillage in Ohio. Their findings tend to agree with Buttel, et. al, (1981): As the scale of farm operations increased, farmers used soil conservation practices less frequently. They also found that livestock farmers tended to use soil conservation practices more often than did grain farmers.

In another study, Napier, Camboni, and Thraen (1986) considered environmental concern and the adoption of several farm technologies in Ohio. Napier, et. al, (1986) determined that farmers who used institutional information sources on a frequent basis tended to be more concerned about environmental issues, a diffusion factor. Farmers who were concerned about the risks attached to adopting new technologies tended to be more concerned about environmental concerns, an economic factor.

Napier, et. al, (1986) reported that age, percent grain farmer, percent livestock farmer, and acres farmed were not significant indicators of the concern of environmental issues in the adoption of farm technologies studied.

Featherstone and Goodwin (1993) studied factors that influenced Kansas farmers' decisions to invest in long-term conservation improvements. Their results suggested that farms with larger acreage had a higher probability of making

conservation expenditures. They also determined that as a farmer ages, the probability of investing in conservation practices decreases. Featherstone and Goodwin (1993) also suggested livestock farmers have a lower probability of investing in conservation practices as compared to grain farmers.

## Section V

## Adoption of Sustainable Manure Management Practices

Kelsey and Vaserstein (2000) surveyed 601 nonfarm neighbors of mushroom growers in Chester County, Pennsylvania, to gain an understanding of concerns this group had about their farming neighbors. Mushroom farming generates odors similar to livestock farming (Kelsey & Vaserstein, 2000). Machinery can cause noise and rain can cause nutrient runoff from mushroom compost windrows (Kelsey & Vaserstein, 2000). The surveyed neighbors were more than three times as likely to be concerned about odors generated by the mushroom farms, as they were to be concerned about runoff (Kelsey & Vaserstein, 2000).

Poe, Bills, Bellows, Crosscombe, Koelsch, Kreher, and Wright (2001) described New York small- and medium-sized dairy farmers' willingness to implement a Comprehensive Nutrient Management Plan (CNMP). They were interested if voluntary and educational programs would be adequate to motivate dairies to implement CNMPs. Poe, et. al, (2001) also described the state of neighbor complaints among the surveyed dairy farmers. They reported that nearly 37% had received complaints from neighbors or local public officials during the previous five years. Complainants filed significantly more complaints related to odor (42%) than any other complaint category, including water pollution.

Poe, et. al, (2001) also reported that practices on many dairy farms deviated from desired manure management practices. The four central components of a CNMP that Poe, et. al, (2001) investigated were manure handling, storage, land application, and record keeping. Related to the land application component, they found that while the average dairy farm had a more-than-adequate land base to apply manure, the majority of dairy farmers did not adopt recommended practices of soil and manure testing, calibration, accounting for manure in nutrient management planning, and application.

Finally, Poe, et. al, (2001) compared the per-cow cost at which a farmer was likely to stay in business if they adopted all the practices called for by a CNMP implementation with the per-cow cost they were likely to spend to adopt practices called for by a CNMP. When asked "If my net returns declined by $50 per cow per year, I would not stay in the dairy business," 27% of farmers strongly disagreed or disagreed. Thirty-four percent of farmers were neutral. Participants in a 1999 New York State Bankers Association seminar suggested that at least half of the neutral respondents would also be able to stay in the dairy business if their net returns decreased by $50 per cow per year (Poe, et. al, 2001).

When asked if they would likely participate in adopting CNMP practices that cost 10 cents per cow per year, 67% definitely or probably would participate. At a $5 per-cow, per-year cost, 25% definitely or probably would participate, and at a $50 per-cow, per-year cost, 3% definitely or probably would participate in adopting CNMP practices (Poe, et. al, 2001). Poe, et. al, (2001) reported a discrepancy between farmers' ability to pay and willingness to pay for costs associated with implementing a CNMP.

The estimated cost of complying with CNMP implementation was between $17.01 and $34.63 per cow per year (Heimlich & Barnard, 1995), as cited by Poe, et. al, 2001.

## Conceptual Framework

It is important to develop a clear link between the concept of the conservation innovation manure-phosphorus exchange and the perceived barriers that inhibit farmers from adopting practices to better utilize manure phosphorus.

Adult education theory states that adults direct their own learning (Illeris, 2002). Barriers exist that hinder adults from continued learning (Cross, 1981; Even, 1987), and each adult learns differently (Even, 1987).

New ideas become innovations available for groups to adopt. If an innovation is a good idea, it flows through information channels and eventually a majority of the members of a given group may adopt the idea (Rogers, 1985). U.S. agriculture has many examples of innovation diffusion among farmers. These innovations have increased agricultural productivity and efficiency (Laegrid, Bockman & Kaarstrad, 1999).

As environmental awareness grew in the United States after 1970, a new breed of innovation developed — conservation practices. These innovations differed from previous innovations in that there was not generally a short-term economic return following their implementation (Pampel & Van Es, 1977; Nowak 1987).

Since 1980, researchers have sought to explain which group of farmers is more likely to adopt conservation innovations. The literature shows mixed results. One study showed that livestock farmers were more likely to invest in conservation practices than grain farmers (Napier, et. al, 1984). In another study, Napier, et. al, (1986) reported that whether a farmer was primarily a livestock or a grain farmer had no effect on their

probability to adopt a conservation practice. A third study (Featherstone & Goodwin, 1993) determined that livestock farmers were less likely to invest in conservation practices than grain farmers.

One study showed that older farmers were more likely to adopt conservation practices than younger farmers (Buttel, et. al, 1981). Another study determined that younger farmers were more likely to adopt conservation practices than older farmers (Featherstone & Goodwin, 1993), and yet another study determined that farmer age had no effect on their likelihood to adopt conservation practices (Napier, et. al, 1986).

The effect of farm size also had dissimilar results in predicting farmer willingness to adopt conservation practices. Buttel, et. al, (1981) and Napier, et. al, (1984) found that larger farms were less likely to adopt conservation practices than smaller farms. Napier, et. al, (1986) reported that farm size had no effect on the likelihood that a farm would invest in conservation practices. In addition, finally, Featherstone and Goodwin (1993) determined that larger farms were more likely to invest in conservation practices than smaller farms.

Rural, nonfarm residents are more likely to register complaints about farm odors than they are about water quality concerns (Kelsey & Vaserstein, 2000; Poe, et. al, 2001). In addition, despite having enough land to utilize all nutrients generated on their farm, farmers may not always adopt recommended practices to utilize that manure sustainably (Poe, et. al, 2001). Finally, a farmers' ability to pay for sustainable manure practices may not match their willingness to pay to adopt those practices (Poe, et. al, 2001).

## Review of Literature Conclusion

There is a debate in the United States between proponents for large-scale, highly industrialized agriculture and proponents for an ecological, sustainable agriculture (Beus & Dunlap, 1990). The U.S. and Michigan governments recognize that farmers must utilize manure phosphorus nutrients in a sustainable manner as livestock farms continue to grow. In addition, Lake Allegan, fed in part by waters that flow from Calhoun County, is experiencing excessive phosphorus loadings.

Michigan State University Extension invests resources to help farmers manage manure nutrients in a more sustainable manner. Earlier studies have shown that diffusion factors, as well as economic factors, can predict the adoption of conservation practices. These considerations lead toward a need to describe, from the perspective of Calhoun County farmers within the Kalamazoo River watershed, why they do not utilize manure-phosphorus nutrients better. MSU Extension agents and other educators can develop programming to help livestock farmers with excess manure transfer their manure to areas of lower phosphorus fertility, and encourage farmers with phosphorus deficits to receive manure with these barriers identified.

# CHAPTER III

# METHODOLOGY

## Section I

## Methods Used

This study utilized both quantitative and qualitative research. The quantitative portion of this study utilized a survey that was mailed to the entire population (n = 349). To gain a deeper understanding of barriers to surveyed farmers of utilizing manure nutrients, an open-ended question was included in the survey instrument.

## Section II

## Population

The target population for this study was all Calhoun County farmers within the Kalamazoo River watershed.

The distribution list for the survey was compiled using the list of farmers at the Calhoun County MSU Extension office. It was determined whether an entry on the mailing list was within the Kalamazoo River watershed by cross-referencing each address with a map of the watershed.

A weakness of this method was that any farmer who resides outside of, but farms land within the Kalamazoo River watershed was excluded.

## Section III

## Instrumentation

A written questionnaire administered to all Calhoun County farmers within the Kalamazoo River watershed was selected as the measuring instrument (Appendix B). The survey instrument was developed by studying two similar instruments developed by

MSU Extension agents for manure management programs. The questionnaire consisted of three parts. The individual parts were as follows: Part I – filtering questions; Part II – Likert-type statements, and an open-ended question; and Part III – personal data.

Ms. Natalie Rector, MSU Extension Statewide Manure Management Agent, established face validity of the survey instrument by reading it, and suggesting improvements. The survey instrument was edited and changed to reflect suggested improvements.

## Section IV

## Data Collection

To assess the barriers to surveyed farmers of receiving manure, this study utilized a mailed census survey of farmers in Calhoun County within the Kalamazoo River watershed (n = 349).

Cover letters (Appendix C) and surveys (Appendix B) were mailed on July 29, 2003. A pre-addressed, stamped envelope accompanied the cover letters and surveys.

On August 8, 2003, a reminder postcard (Appendix D) was mailed to nonrespondents, encouraging them to respond to the original mailing.

On August 29, 2003, a second cover letter (Appendix E) and survey (Appendix B) with a pre-addressed, stamped envelope was sent to each nonrespondent.

Respondents returned 244 surveys (69.9%). Six surveys were returned because they were not deliverable as addressed. Two surveys were returned indicating the farmer was deceased. Two surveys were returned indicating the farmer had retired. One survey was returned indicating that farm received two surveys and one was submitted. One survey was returned indicating that farm had a minimal number of goats, and should not

be included. One survey was returned indicating the operation was a golf course. Fifty-eight surveys were returned with the "I do not actively farm" response marked.

Respondents returned 173 completed and usable surveys. The final, completed, and usable return rate was 49.6%.

## Section V

## Data Analysis

Data were analyzed using frequencies and independent samples *t* tests. The Statistical Package for Social Sciences, version 12.0, was used to analyze the data. Any incomplete questions or confusing marks were treated as missing values; they were not included in the analysis.

## Section VI

## Nonresponse Error

Nonresponse error was controlled for by comparing the mean responses of early respondents to late respondents, using an independent samples *t* test. Any survey returned on or before August 8, 2003, was considered returned by an early respondent. There were 126 early respondents and 47 late respondents. There was no significant difference in the mean response to any question when early and late respondents were compared (Appendix G), therefore results of this survey can be generalized to the entire population.

# CHAPTER IV

# FINDINGS

## Research Question 1

Research Question 1 asked how all surveyed farmers perceive issues related to manure exchange.

When asked if they thought farmers believed manure was too variable to be a reliable fertilizer source, 56.5% of respondents disagreed or strongly disagreed (Table 1). The mean response to that question was 2.48 (Table 1).

The next two questions concerned neighbor relations and odor from manure applications. The responses to these two questions were similar, as 64.5% of respondents agreed or strongly agreed (Table 1) that neighbors may complain about manure applications on fields not usually receiving manure, and 66.3% of respondents agreed or strongly agreed (Table 1) that odor concerns cause farmers not to apply manure on certain fields. The mean response to these two questions were 3.60 and 3.68, respectively (Table 1).

Among all respondents, 64.2% agreed or strongly agreed (Table 1) that farmers are concerned that manure may contain weed seeds. The mean response to that questions was 3.57 (Table 1).

Three questions concerned manure cost, and 57.2% of respondents indicated that they agreed or strongly agreed (Table 1) that farmers would be willing to accept manure from a neighboring farm only if it were available at no cost. When asked if farmers would be willing to accept manure from a neighboring farm at a cost, as long as the cost was less than commercial fertilizer, 32.6% of respondents agreed or strongly agreed.

Nearly 13% of respondents agreed or strongly agreed (Table 1) that farmers would be willing to accept manure from a neighboring farm at a cost, even if the cost was about the same as commercial fertilizer. The mean response to those questions were 3.47, 2.88, and 2.38, respectively (Table 1).

The responses among all respondents to other survey questions are listed in Table 1.

Table 1. Survey Responses of All Respondents

| | | Percent Responding | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Survey Question | (N) | Strongly Disagree | Disagree | Neutral | Agree | Strongly Agree | Mean | S.D. |
| Farmers feel manure is too variable (not consistent enough) to be a reliable fertilizer source | 173 | 14.1 | 42.4 | 28.2 | 12.4 | 2.9 | 2.48 | 0.980 |
| Farmers are concerned that neighbors may complain about manure applications on fields not | 173 | 2.9 | 14.0 | 18.6 | 49.4 | 15.1 | 3.60 | 0.994 |
| Odor concerns cause farmers to not apply manure on certain fields | 172 | 3.5 | 14.5 | 15.7 | 43.0 | 23.3 | 3.68 | 1.091 |
| Farmers are concerned that manure may contain weed seeds | 173 | 3.5 | 13.9 | 18.5 | 50.3 | 13.9 | 3.57 | 1.007 |
| Farmers would be willing to accept manure from a neighboring farm only if it were available at no cost | 173 | 3.5 | 15.6 | 23.7 | 44.5 | 12.7 | 3.47 | 1.015 |
| Farmers would be willing to accept manure from a neighboring farm at a cost, as long as the cost was less than commercial fertilizer | 172 | 9.8 | 27.7 | 29.5 | 28.9 | 3.5 | 2.88 | 1.048 |
| Farmers would be willing to accept manure from a neighboring farm at a cost, even if the cost was about the same as commercial fertilizer | 172 | 18.0 | 41.9 | 27.3 | 9.9 | 2.9 | 2.38 | 0.987 |

Table 1 (cont'd).

| | | Percent Responding | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Survey Question | (N) | Strongly Disagree | Disagree | Neutral | Agree | Strongly Agree | Mean | S.D. |
| Farmers are concerned with the potential compaction caused by manure application equipment | 173 | 1.7 | 18.5 | 31.2 | 38.7 | 9.8 | 3.36 | 0.953 |
| Farmers are concerned that manure applications could interfere with the timeliness of spring planting or other aspects of their cropping operations | 173 | 4.0 | 24.3 | 25.4 | 42.8 | 3.5 | 3.17 | 0.973 |
| Farmers would be willing to accept manure from a neighboring farm only if none of their time or labor were required to get it applied | 173 | 4.0 | 19.7 | 33.5 | 32.4 | 10.4 | 3.25 | 1.020 |
| Farmers would be willing to accept manure from a neighboring farm even if they had to supply some of their time and labor to get it applied | 172 | 7.6 | 26.2 | 37.2 | 27.9 | 1.2 | 2.89 | 0.939 |

## Research Question 2

Research Question 2 asked if there are differences between how surveyed livestock farmers and surveyed nonlivestock farmers perceive issues related to manure exchange.

Only one question differentiated between the two groups. When asked if farmers believe manure is too variable to be a reliable fertilizer source, 62.2% of livestock farmers either disagreed or strongly disagreed (Table 2), as compared to 50.5% of nonlivestock farmers (Table 2). The mean response by livestock farmers to this question was 2.30, as compared to 2.64 for nonlivestock farmers (Table 2). There was a significant difference in how these two groups responded to that question at the 95% confidence level (Table 2).

Table 2. Survey Responses by Farm Type

| | | | Percent responding | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Survey Question | Respondent Type | (N) | Strongly Disagree | Disagree | Neutral | Agree | Strongly Agree | Mean | Sig (*p*) |
| Farmers feel manure is too variable (not consistent enough) to be a reliable fertilizer source | Livestock Farmers | 82 | 18.3 | 43.9 | 29.3 | 6.1 | 2.4 | 2.30 | 0.025 * |
| | Nonlivestock Farmers | 87 | 10.3 | 40.2 | 27.6 | 18.4 | 3.4 | 2.64 | |
| Farmers are concerned with the potential compaction caused by manure application equipment | Livestock Farmers | 83 | 2.4 | 18.1 | 36.1 | 39.8 | 3.6 | 3.24 | 0.097 |
| | Nonlivestock Farmers | 89 | 1.1 | 19.1 | 25.8 | 38.2 | 15.8 | 3.48 | |
| Farmers would be willing to accept manure from a neighboring farm at a cost, even if the cost was about the same as commercial fertilizer | Livestock Farmers | 82 | 6.1 | 26.8 | 35.4 | 29.3 | 2.4 | 2.95 | 0.167 |
| | Nonlivestock Farmers | 89 | 13.5 | 29.2 | 24.7 | 28.1 | 4.5 | 2.81 | |
| Farmers are concerned that manure applications could interfere with the timeliness of spring planting or other aspects of their cropping operations | Livestock Farmers | 82 | 18.3 | 43.9 | 29.3 | 6.1 | 2.4 | 2.30 | 0.211 |
| | Nonlivestock Farmers | 87 | 10.3 | 40.2 | 27.6 | 18.4 | 3.4 | 2.64 | |
| Farmers would be willing to accept manure from a neighboring farm at a cost, as long as the cost was less than commercial fertilizer | Livestock Farmers | 82 | 4.9 | 14.6 | 14.6 | 39.0 | 26.8 | 3.68 | 0.376 |
| | Nonlivestock Farmers | 89 | 2.2 | 16.9 | 22.5 | 43.8 | 14.6 | 3.52 | |

Table 2 (cont'd).

| | | | Percent responding | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Survey Question | Respondent Type | (N) | Strongly Disagree | Disagree | Neutral | Agree | Strongly Agree | Mean | Sig (*p*) |
| Farmers are concerned that neighbors may complain about manure applications on fields not usually receiving manure | Livestock Farmers | 83 | 6.0 | 12.0 | 19.3 | 47.0 | 15.7 | 3.54 | 0.445 |
| | Nonlivestock Farmers | 88 | 0.0 | 15.9 | 18.2 | 51.1 | 14.8 | 3.66 | |
| Farmers are concerned that manure may contain weed seeds | Livestock Farmers | 83 | 3.6 | 13.3 | 21.7 | 50.6 | 10.8 | 3.52 | 0.472 |
| | Nonlivestock Farmers | 89 | 3.4 | 14.6 | 14.6 | 50.6 | 16.9 | 3.63 | |
| Farmers would be willing to accept manure from a neighboring farm only if it were available at no cost | Livestock Farmers | 83 | 6.0 | 12.0 | 19.3 | 47.0 | 15.7 | 3.54 | 0.541 |
| | Nonlivestock Farmers | 88 | 0.0 | 15.9 | 18.2 | 51.1 | 14.8 | 3.66 | |
| Farmers would be willing to accept manure from a neighboring farm even if they had to supply some of their time and labor to get it applied | Livestock Farmers | 82 | 4.9 | 25.6 | 42.7 | 26.8 | 0.0 | 2.91 | 0.733 |
| | Nonlivestock Farmers | 89 | 10.1 | 27.0 | 31.5 | 29.2 | 2.2 | 2.87 | |
| Farmers would be willing to accept manure from a neighboring farm only if none of their time or labor were required to get it applied | Livestock Farmers | 83 | 2.4 | 20.5 | 37.3 | 30.1 | 9.6 | 3.24 | 0.855 |
| | Nonlivestock Farmers | 89 | 5.6 | 19.1 | 29.2 | 34.8 | 11.2 | 3.27 | |

Table 2 (cont'd).

| | | | Percent responding | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Survey Question | Respondent Type | (N) | Strongly Disagree | Disagree | Neutral | Agree | Strongly Agree | Mean | Sig ($p$) |
| Odor concerns cause farmers to not apply manure on certain fields | Livestock Farmers | 82 | 4.9 | 14.6 | 14.6 | 39.0 | 26.8 | 3.68 | 0.958 |
| | Nonlivestock Farmers | 89 | 2.2 | 14.6 | 16.9 | 46.1 | 20.2 | 3.67 | |

* Significant Difference ($p < 0.05$)

## Research Question 3

Research Question 3 asked if there are differences between how surveyed farmers, age 50 years and younger, and how surveyed farmers age 51 years and older, perceive issues related to manure exchange.

Two questions differentiated between farmers opinions based on age. When asked if farmers are concerned that manure may contain weed seeds, 72.7% of farmers 50 years of age and younger agreed or strongly agreed (Table 3), as compared to 58.2% of farmers 51 years of age and older (Table 3). The mean response to that question was 3.85 (Table 3) for farmers 50 years of age and younger, as compared to 3.37 (Table 3) for farmers 51 years of age or older. There was a significant difference in how these two groups responded to this question at the 95% confidence level (Table 3).

When asked if farmers would be willing to accept manure from a neighboring farm only if it were available at no cost, 48.4% of farmers 50 years of age and younger agreed or strongly agreed (Table 3), as compared to 64.0% of farmers 51 years of age and older (Table 3). The mean response to that question was 3.26 (Table 3) for farmers 50 years of age and younger, as compared to 3.63 (Table 3) for farmers 51 years of age or older. There was a significant difference in how these two groups responded to that question at the 95% confidence level (Table 3).

Table 3. Survey Responses by Age

| | | | Percent responding | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Survey Question | Respondent Type | (N) | Strongly Disagree | Disagree | Neutral | Agree | Strongly Agree | Mean | Sig($p$) |
| Farmers are concerned that manure may contain weed seeds | Farmers 50 and Younger | 66 | 0.0 | 6.1 | 21.2 | 54.5 | 18.2 | 3.85 | 0.002 * |
| | Farmers 51 and Older | 103 | 5.8 | 19.4 | 16.5 | 48.5 | 9.7 | 3.37 | |
| Farmers would be willing to accept manure from a neighboring farm only if it were available at no cost | Farmers 50 and Younger | 66 | 3.0 | 21.2 | 27.3 | 43.9 | 4.5 | 3.26 | 0.020 * |
| | Farmers 51 and Older | 103 | 3.9 | 11.7 | 20.4 | 45.6 | 18.4 | 3.63 | |
| Farmers are concerned with the potential compaction caused by manure application equipment | Farmers 50 and Younger | 66 | 1.5 | 10.6 | 36.4 | 40.9 | 10.6 | 3.48 | 0.139 |
| | Farmers 51 and Older | 103 | 1.9 | 24.3 | 28.2 | 36.9 | 8.7 | 3.26 | |
| Farmers are concerned that manure applications could interfere with the timeliness of spring planting or other aspects of their cropping operations | Farmers 50 and Younger | 66 | 3.0 | 19.7 | 24.2 | 51.5 | 1.5 | 3.29 | 0.168 |
| | Farmers 51 and Older | 103 | 4.9 | 27.2 | 27.2 | 36.9 | 3.9 | 3.08 | |
| Farmers would be willing to accept manure from a neighboring farm only if none of their time or labor were required to get it applied | Farmers 50 and Younger | 66 | 4.5 | 19.7 | 40.9 | 27.3 | 7.6 | 3.14 | 0.184 |
| | Farmers 51 and Older | 103 | 2.9 | 20.4 | 28.2 | 35.9 | 12.6 | 3.35 | |

Table 3 (cont'd).

| | | | Percent responding | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Survey Question | Respondent Type | (N) | Strongly Disagree | Disagree | Neutral | Agree | Strongly Agree | Mean | Sig (*p*) |
| Farmers are concerned that neighbors may complain about manure applications on fields not usually receiving manure | Farmers 50 and Younger | 66 | 3.0 | 6.1 | 22.7 | 53.0 | 15.2 | 3.71 | 0.203 |
| | Farmers 51 and Older | 102 | 2.9 | 19.6 | 15.7 | 47.1 | 14.7 | 3.51 | |
| Farmers would be willing to accept manure from a neighboring farm at a cost, even if the cost was about the same as commercial fertilizer | Farmers 50 and Younger | 66 | 22.7 | 36.4 | 31.8 | 9.1 | 0.0 | 2.27 | 0.279 |
| | Farmers 51 and Older | 102 | 14.7 | 46.1 | 24.5 | 9.8 | 4.9 | 2.44 | |
| Farmers would be willing to accept manure from a neighboring farm even if they had to supply some of their time and labor to get it applied | Farmers 50 and Younger | 66 | 4.5 | 22.7 | 45.5 | 25.8 | 1.5 | 2.97 | 0.430 |
| | Farmers 51 and Older | 102 | 8.8 | 28.4 | 32.4 | 29.4 | 1.0 | 2.85 | |
| Farmers feel manure is too variable (not consistent enough) to be a reliable fertilizer source | Farmers 50 and Younger | 66 | 13.6 | 37.9 | 33.3 | 13.6 | 1.5 | 2.52 | 0.725 |
| | Farmers 51 and Older | 100 | 14.0 | 46.0 | 24.0 | 12.0 | 4.0 | 2.46 | |
| Odor concerns cause farmers to not apply manure on certain fields | Farmers 50 and Younger | 66 | 4.5 | 13.6 | 13.6 | 42.4 | 25.8 | 3.71 | 0.793 |
| | Farmers 51 and Older | 102 | 2.9 | 14.7 | 16.7 | 44.1 | 21.6 | 3.67 | |

Table 3 (cont'd).

| | | | Percent responding | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Survey Question | Respondent Type | (N) | Strongly Disagree | Disagree | Neutral | Agree | Strongly Agree | Mean | Sig ($p$) |
| Farmers would be willing to accept manure from a neighboring farm at a cost, as long as the cost was less than commercial fertilizer | Farmers 50 and Younger | 65 | 7.7 | 30.8 | 24.6 | 36.9 | 0.0 | 2.91 | 0.885 |
| | Farmers 51 and Older | 103 | 11.7 | 25.2 | 32.0 | 25.2 | 5.8 | 2.88 | |

* Significant Difference ($p < 0.05$)

## Research Question 4

Research Question 4 asked if there are differences between how surveyed farmers who farm250 or fewer acres and how surveyed farmers who farm more than 250 acres perceive issues related to manure exchange.

Three questions differentiated based on farm size. All three showed stronger agreement for larger farms. When asked if farmers are concerned that manure may contain weed seeds, 54.3% of farmers who farm 250 or fewer acres agreed or strongly agreed (Table 4), as compared to 72.7% of farmers who farm more than 250 acres (Table 4). The mean response to that question was 3.28 for farmers who farm 250 or fewer acres, as compared to 3.73 for farmers who farm more than 250 acres (Table 4). There was a significant difference in how these two groups responded to that question at the 95% confidence level (Table 4).

When asked if farmers are concerned with the potential compaction caused by manure application equipment, 28.2 % of farmers who farm 250 or fewer acres agreed or strongly agreed (Table 4), as compared to 63.7% of farmers who farm more than 250 acres (Table 4). The mean response to that question was 2.96 for farmers who farm 250 or fewer acres, as compared to 3.62 for farmers who farm more than 250 acres (Table 4). There was a significant difference in how these two groups responded to that question (Table 4) at the 95% confidence level.

When asked if farmers are concerned that manure applications could interfere with the timeliness of spring planting or other aspects of their cropping operations, 28.3% of farmers who farm 250 or fewer acres agreed or strongly agreed (Table 4), as compared to 63.3% of farmers who farm more than 250 acres (Table 4). The mean response to that

question was 2.80 for farmers who farm 250 or fewer acres, as compared to 3.44 for farmers who farm more than 250 acres. (Table 4). There was a significant difference in how these two groups responded to that question at the 95% confidence level (Table 4).

Table 4. Survey Responses by Farm Size

| | | | Percent responding | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Survey Question | Respondent Type | (N) | Strongly Disagree | Disagree | Neutral | Agree | Strongly Agree | Mean | Sig (*p*) |
| Farmers are concerned with the potential compaction caused by manure application equipment | Farm < 250 Acres | 46 | 2.2 | 32.6 | 37.0 | 23.9 | 4.3 | 2.96 | 0.001 * |
| | Farm > 250 Acres | 55 | 3.6 | 12.7 | 20.0 | 45.5 | 18.2 | 3.62 | |
| Farmers are concerned that manure applications could interfere with the timeliness of spring planting or other aspects of their cropping operations | Farm < 250 Acres | 46 | 8.7 | 30.4 | 32.6 | 28.3 | 0.0 | 2.80 | 0.001 * |
| | Farm > 250 Acres | 55 | 1.8 | 20.0 | 14.5 | 60.0 | 3.6 | 3.44 | |
| Farmers would be willing to accept manure from a neighboring farm at a cost, even if the cost was about the same as commercial fertilizer | Farm < 250 Acres | 46 | 6.5 | 19.6 | 19.6 | 47.8 | 6.5 | 3.28 | 0.023 * |
| | Farm > 250 Acres | 55 | 1.8 | 9.1 | 16.4 | 60.0 | 12.7 | 3.73 | |
| Farmers would be willing to accept manure from a neighboring farm at a cost, even if the cost was about the same as commercial fertilizer | Farm < 250 Acres | 46 | 8.7 | 43.5 | 30.4 | 8.7 | 8.7 | 2.65 | 0.106 |
| | Farm > 250 Acres | 55 | 18.2 | 43.6 | 27.3 | 9.1 | 1.8 | 2.33 | |
| Odor concerns cause farmers to not apply manure on certain fields | Farm < 250 Acres | 45 | 4.4 | 17.8 | 17.8 | 44.4 | 15.6 | 3.49 | 0.133 |
| | Farm > 250 Acres | 55 | 1.8 | 10.9 | 12.7 | 54.5 | 20.0 | 3.80 | |

Table 4 (cont'd).

| | | | Percent responding | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Survey Question | Respondent Type | (N) | Strongly Disagree | Disagree | Neutral | Agree | Strongly Agree | Mean | Sig (*p*) |
| Farmers would be willing to accept manure from a neighboring farm at a cost, as long as the cost was less than commercial fertilizer | Farm < 250 Acres | 46 | 6.5 | 19.6 | 30.4 | 34.8 | 8.7 | 3.20 | 0.168 |
| | Farm > 250 Acres | 55 | 7.3 | 30.9 | 27.3 | 32.7 | 1.8 | 2.91 | |
| Farmers are concerned that neighbors may complain about manure applications on fields not usually receiving manure | Farm < 250 Acres | 46 | 4.3 | 19.6 | 17.4 | 39.1 | 19.6 | 3.50 | 0.215 |
| | Farm > 250 Acres | 55 | 0.0 | 9.1 | 21.8 | 54.5 | 14.5 | 3.75 | |
| Farmers would be willing to accept manure from a neighboring farm only if it were available at no cost | Farm < 250 Acres | 46 | 4.3 | 19.6 | 21.7 | 39.1 | 15.2 | 3.41 | 0.236 |
| | Farm > 250 Acres | 55 | 0.0 | 14.5 | 21.8 | 47.3 | 16.4 | 3.65 | |
| Farmers would be willing to accept manure from a neighboring farm even if they had to supply some of their time and labor to get it applied | Farm < 250 Acres | 46 | 6.5 | 32.6 | 34.8 | 23.9 | 2.2 | 2.83 | 0.252 |
| | Farm > 250 Acres | 55 | 5.5 | 20.0 | 40.0 | 34.5 | 0.0 | 3.04 | |
| Farmers would be willing to accept manure from a neighboring farm only if none of their time or labor were required to get it applied | Farm < 250 Acres | 46 | 0.0 | 17.4 | 39.1 | 30.4 | 13.0 | 3.39 | 0.487 |
| | Farm > 250 Acres | 55 | 1.8 | 23.6 | 34.5 | 27.3 | 12.7 | 3.25 | |

Table 4 (cont'd).

| | | | Percent responding | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Survey Question | Respondent Type | (N) | Strongly Disagree | Disagree | Neutral | Agree | Strongly Agree | Mean | Sig ($p$) |
| Farmers feel manure is too variable (not consistent enough) to be a reliable fertilizer source | Farm < 250 Acres | 45 | 17.8 | 42.2 | 22.2 | 11.1 | 6.7 | 2.47 | 0.776 |
| | Farm > 250 Acres | 54 | 13.0 | 50.0 | 22.2 | 13.0 | 1.9 | 2.41 | |

* Significant Difference ($p < 0.05$)

## Research Question 5

Research Question 5 asked if there are differences between how surveyed farmers who do not currently raise livestock, but have within the past 10 years, and how surveyed farmers who do not currently raise livestock, and have not for at least 10 years, perceive issues related to manure exchange.

Four questions differentiated based on length of time since owning livestock. When asked if farmers are concerned that neighbors may complain about manure applications on fields not usually receiving manure, 74.3% of farmers who do not raise livestock, but did within the previous 10 years, agreed or strongly agreed (Table 5). Compare that to 54.8% of farmers who do not raise livestock, and have not for at least 10 years (Table 5). The mean response to that question was 3.89 for farmers who do not raise livestock, but did within the previous 10 years, as compared to 3.35 for farmers who do not raise livestock and have not for at least 10 years (Table 5). There was a significant difference in how these two groups responded to that question at the 95% confidence level (Table 5).

When asked if farmers would be willing to accept manure from a neighboring farm at a cost, as long as the cost was less than commercial fertilizer, 54.2% of farmers who do not raise livestock, but did within the previous 10 years, disagreed or strongly disagreed (Table 5). Compare that to 28.1% of farmers who do not raise livestock and have not for at least 10 years (Table 5). The mean response to that question was 2.54 for farmers who do not raise livestock, but did within the previous 10 years, as compared to 3.25 for farmers who do not raise livestock and have not for at least 10 years (Table 5).

There was a significant difference in how these two groups responded to that question at the 95% confidence level (Table 5).

When asked if farmers would be willing to accept manure from a neighboring farm at a cost, even if the cost was about the same as commercial fertilizer, 77.1% of farmers who do not raise livestock, but did within the previous 10 years, disagreed or strongly disagreed (Table 5). Compare that to about 54.9% of farmers who do not raise livestock and have not for at least 10 years (Table 5). The mean response to that question was 2.00, as compared to 2.58 for farmers who do not raise livestock and have not for at least 10 years (Table 5). There was a significant difference in how these two groups responded to that question (Table 5) at the 95% confidence level.

When asked if farmers would be willing to accept manure from a neighboring farm only if none of their time or labor were required to get it applied, 60.0% of farmers who do not raise livestock, but did within the previous 10 years, disagreed or strongly disagreed (Table 5). Compare that to 34.4% of farmers who do not raise livestock and have not for at least 10 years (Table 5). The mean response to that question was 3.66 as compared to 3.03 for farmers who do not raise livestock and have not for at least 10 years (Table 5). There was a significant difference in how these two groups responded to that question at the 95% confidence level (Table 5).

Table 5. Survey Responses By Duration Not Raising Livestock

| | | | Percent responding | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Survey Question | Respondent Type | (N) | Strongly Disagree | Disagree | Neutral | Agree | Strongly Agree | Mean | Sig (*p*) |
| Farmers would be willing to accept manure from a neighboring farm at a cost, as long as the cost was less than commercial fertilizer | Livestock in 10 Years | 35 | 17.1 | 37.1 | 20.0 | 25.7 | 0.0 | 2.54 | 0.007 * |
| | No Livestock in 10 Years | 32 | 3.1 | 25.0 | 21.9 | 43.8 | 6.3 | 3.25 | |
| Farmers would be willing to accept manure from a neighboring farm only if none of their time or labor were required to get it applied | Livestock in 10 Years | 35 | 0.0 | 14.3 | 25.7 | 40.0 | 20.0 | 3.66 | 0.015 * |
| | No Livestock in 10 Years | 32 | 6.3 | 28.1 | 31.3 | 25.0 | 9.4 | 3.03 | |
| Farmers would be willing to accept manure from a neighboring farm at a cost, even if the cost was about the same as commercial fertilizer | Livestock in 10 Years | 35 | 31.4 | 45.7 | 14.3 | 8.6 | 0.0 | 2.00 | 0.017 * |
| | No Livestock in 10 Years | 31 | 9.7 | 45.2 | 29.0 | 9.7 | 6.5 | 2.58 | |
| Farmers are concerned that neighbors may complain about manure applications on fields not usually receiving manure | Livestock in 10 Years | 35 | 0.0 | 11.4 | 14.3 | 48.6 | 25.7 | 3.89 | 0.023 * |
| | No Livestock in 10 Years | 31 | 3.2 | 16.1 | 25.8 | 51.6 | 3.2 | 3.35 | |
| Farmers would be willing to accept manure from a neighboring farm even if they had to supply some of their time and labor to get it applied | Livestock in 10 Years | 35 | 14.3 | 37.1 | 22.9 | 25.7 | 0.0 | 2.60 | 0.126 |
| | No Livestock in 10 Years | 32 | 3.1 | 28.1 | 40.6 | 25.0 | 3.1 | 2.97 | |

Table 5 (cont'd).

| | | | Percent responding | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Survey Question | Respondent Type | (N) | Strongly Disagree | Disagree | Neutral | Agree | Strongly Agree | Mean | Sig (*p*) |
| Farmers are concerned that manure may contain weed seeds | Livestock in 10 Years | 35 | 8.6 | 20.0 | 11.4 | 34.3 | 25.7 | 3.49 | 0.220 |
| | No Livestock in 10 Years | 32 | 0.0 | 9.4 | 9.4 | 71.9 | 9.4 | 3.81 | |
| Farmers are concerned with the potential compaction caused by manure application equipment | Livestock in 10 Years | 35 | 2.9 | 17.1 | 28.6 | 31.4 | 20.0 | 3.49 | 0.490 |
| | No Livestock in 10 Years | 32 | 0.0 | 21.9 | 34.4 | 34.4 | 9.4 | 3.31 | |
| Farmers would be willing to accept manure from a neighboring farm only if it were available at no cost | Livestock in 10 Years | 35 | 0.0 | 17.1 | 25.7 | 45.7 | 11.4 | 3.51 | 0.750 |
| | No Livestock in 10 Years | 32 | 0.0 | 25.0 | 21.9 | 37.5 | 15.6 | 3.44 | |
| Farmers feel manure is too variable (not consistent enough) to be a reliable fertilizer source | Livestock in 10 Years | 34 | 8.8 | 35.3 | 35.3 | 14.7 | 5.9 | 2.74 | 0.753 |
| | No Livestock in 10 Years | 32 | 9.4 | 43.8 | 18.8 | 28.1 | 0.0 | 2.66 | |
| Odor concerns cause farmers to not apply manure on certain fields | Livestock in 10 Years | 35 | 0.0 | 20.0 | 17.1 | 40.0 | 22.9 | 3.66 | 0.806 |
| | No Livestock in 10 Years | 32 | 6.3 | 9.4 | 15.6 | 56.3 | 12.5 | 3.59 | |

Table 5 (cont'd).

| | | | Percent responding | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Survey Question | Respondent Type | (N) | Strongly Disagree | Disagree | Neutral | Agree | Strongly Agree | Mean | Sig ($p$) |
| Farmers are concerned that manure applications could interfere with the timeliness of spring planting or other aspects of their cropping operations | Livestock in 10 Years | 35 | 5.7 | 22.9 | 22.9 | 45.7 | 2.9 | 3.17 | 0.844 |
| | No Livestock in 10 Years | 32 | 3.1 | 25.0 | 18.8 | 53.1 | 0.0 | 3.22 | |

* Significant Difference ($p < 0.05$)

## Research Question 6

Research Question 6 asked how prevalent manure exchange is among surveyed farmers.

Six respondents, or 3.5% of respondents, indicated that they have a manure exchange agreement.

## Responses to the Open-Ended Question

The open-ended question was, "Provide any comments concerning the exchange of manure from one farmer to another." Sixty-one respondents, or 35.2% of all respondents, provided comments.

Open-ended question were analyzed in three phases. First, the responses were coded according to their survey number to protect confidentiality. Second, each response was read to identify possible themes for discussion. Once a theme was identified, it was coded with a color. Each respondent comment relating to an identified theme was highlighted with a different color. Eight themes were identified. Third, all comments pertaining to each theme were compiled separately. Comments for each theme were examined for similarities, differences, and possible groupings. Eight responses (13.1 %) were found not to fit in with any of the identified themes, and they were not included in the analysis. Find these eight responses, and all other open-ended responses in Appendix F.

## Discussion of Themes

### Agronomic Concerns

Fourteen respondents (22.9 %) cited agronomic concerns within their written responses. Response categories within agronomic concerns included concern about weed

seed introduction, concerns about spreading manure at correct agronomic rates, concerns about compaction, and concerns of interfering with a no-tillage system.

Respondents who cited concern about weed seed introduction noted such issues as, "Would be concerned of the spread of a noxious weed . . ." (Respondent 317); "The spread of forien *[sic]* weed seeds increasing your chemical use, and cutting yield," (Respondent 181); "I wouldn't let just any farm do it because of the weed seed in the manure & the other debris some farmers have," (Respondent 312); and, "Bring weed seeds from one farm to another" (Respondent 125).

Concerns about spreading manure at correct agronomic rates included, "The idea is fine providing, the manure would be spread properly, an *[sic]* calibrated correctly," (Respondent 70); "On most livestock farms, the individual hauling manure has not been well trained or monitored to do an even spread, with no gaps . . . ." (Respondent 301); and ". . . correct application rates" (Respondent 136).

Concerns about compaction included, ". . . or pay attention to undesirable field contions [conditions], causing compaction," (Respondent 301); "Soil conditions when applied — wet — etc . . . ." (Respondent 337); "Soil Compaction" (Respondent 125); and "In the pass [past] I have seen manure spread on another's land containing cement blocks, cement, boards, plastic-bags-bucket-etc., pipe, you name it. They also spread when fields were to *[sic]* wet . . . ." (Respondent 308).

The final agronomic concern cited was a concern that the application of manure would interfere with a farmer's no-tillage system. Responses included, "I am NoTilling & Realy *[sic]* Don't want to Disturb The Ground Couther [coulter] Injection Would Be Fine" (Respondent 146); "no-till & manure application don't go together very well

spreading manure & tillage could be worse than comm. Fert & no-till eviromentaly *[sic]*" (Respondent 176); ". . . I no till farm & I think it would be hard to apply manure on fields," (Respondent 109); and, "I no till and this will not work in my plan," (Respondent 206).

**Odor Concerns**

Nine respondents (14.7 %) raised concern about manure causing odors, or other concerns about neighbor relations.

Four respondents (6.5%) stated that applicators should inject manure into the soil. Manure injection reduces odors, as compared to incorporating after application or not incorporating at all. Comments included, "I believe liquid manure should be Knife *[sic]* in ONLY!" (Respondent 16); "It should be required that liquid manure be injected," (Respondent 191); "Any liquid manure should be knifed into soil," (Respondent 348); and, "only if it is knifed in. I think all manure should be knifed in," (Respondent 203).

Three respondents cited odor control in their response, including, ". . . Odor control . . ." (Respondent 136); "Odor . . . The houses are closer all the time," (Respondent 33); and, "Odors to neighbors," (Respondent 125).

Respondent 173 noted, "In some cases it would work and anothers *[sic]* cases it wouldn't. It really depend *[sic]* on the neighbors." Finally, a livestock farmer wrote, "I don't like to move manure using the roads," (Respondent 341). Presumably, that respondent is concerned that when farmers use roads to transport manure, some manure would spill on the road, stressing relationships with neighbors.

## Timing Concerns

Eight respondents (13.1 %) noted timing concerns in their written responses. The concern about timing stems from the period in the spring after soils have dried to allow manure application equipment to travel on fields without causing excessive compaction, and the time when planting activities can begin, or the period in the fall after corn and soybean harvest and when rains begin, or fields freeze up. Comments included, "Most operations do not have adequate application equipment to apply manure in the time period between wet compactable soils and tillage and planting," (Respondent 204); "I am also apprehensive about . . . the very small window of opportunity to do this," (Respondent 149); "The Timeliness in which to apply during the growing season," (Respondent 136); ". . . Timing of application," (Respondent 125); "Application Timing . . ." (Respondent 146); ". . . Timing . . ." (Respondent 33); and, "Time," (Respondent 171).

Finally a dairy farmer provided the following comment: "I have farmers wanting the manure But when it works for them, not when I need to keep fly problem's from happening *[sic]*," (Respondent 331).

## Economic Concerns

Seven respondents (11.5%) noted economic concerns. These comments included, "Farmers are beginning to see some viable manure utilizing trading but money payment still seems rare," (Respondent 281); "I'd accept another farmer's manure, but only at no cost to myself," (Respondent 214); "Should the farmer with the manure have to pay the farmer with the land to spread manure?" (Respondent 102); "I would not be willing to purchase equipment to do this myself (spreader & loader)," (Respondent 149); "I find

that providing manure disposal is a service to livestock producers—it should be low cost—I also feel the farmer who plants and shares with me should have first disposal rights," (Respondent 143); and, ". . . Cost . . ." (Respondent 33).

A dairy producer provided the following comment: "Some farmers think we should Pay them for Putting manure on their Ground. Compaction, odor, and Reasonable commercial fertilizer costs suggest to them that they are better off without manure." (Respondent 12).

**Concerns about Spreading Disease**

Six respondents (9.8 %) commented about a concern of transmitting disease from manure to their own livestock. Their comments included, "It's not a good idea as it could spread disease from one farm to another," (Respondent 201); "I would not Except *[sic]* manure from other farm—Because of Disease!" (Respondent 344); "This is for cash crop farmer's I raise cattle and Do Not want neighbor's manure for Disease control," (Respondent 280); "The reason I don't want to receive manure from another farm is due to the spreading of disease," (Respondent 192); "even though I have very small numbers of livestock (pets) (home flock), I'm still very concerned about the spread of parasites and diseases . . ." (Respondent 149); and, " There would need to be a way to insure uniformity, lack of weeds, diseases etc." (Respondent 263).

**Concerns about the Size of Livestock Farms**

Five respondents (8.2 %) commented about the size of livestock farms. Their comments included, "If they have too much manure for their cropland, LIMIT THE NUMBER OF CATTLE ON their FARM! Make things as tough as possible for these mega-dairies!!!" (Respondent 299); "I think manure exchange does nothing but destroy

the family farms and promote corporate farms. To provide a better environment I think it would make more sense to promote smaller farms and you wouldn't have all the manure concentrated in one area. Probably not what you wanted to hear but overproduction by corporate farmers are also driving prices down and forcing small farmers out," (Respondent 319); "If you have to put manure on other land than your own you are to big untile *[sic]* you understand this we will continue to have all kinds of trouble," (Respondent 343); "Livestock Farms should not be allowed to have more animal units than they have cropland to utilise *[sic]* it. (Owned & rented combined) Adequate acreage for manure utilization should be a requirement for granting a construction permit for any livestock facility!!!" (Respondent 182); and, "I think Manure is better managed by 5-100 cow farmers than 1-500 cow farmer as I drive around and observe operations. The swine industry seems to a little better at applications technics *[sic]* in this area," (Respondent 294).

**Concerns about Government Regulations**

Four respondents (6.5 %) provided comment about concern over government regulations. Their comments included, "My concern about neighbor manure is 1: Regulations on my farm as though I had 100+ head 2: Inspection & controls I would have to obide *[sic]* by just as though I had 100+," (Respondent 245); "Receiving farmer should know what he receiving in value and that it is spread in accordance with right to farm act," (Respondent 267); ". . . If there is a nuisance complaint—who is responsible?" (Respondent 337); and, "Should be able to do what you want to do with your own land—GOV get out of tell you what you raise or do *[sic]*," (Respondent 255).

**Responses in Support of Manure Exchange**

The previous themes detailed concerns respondents had that impede their interest in exchanging manure. The final theme details responses by 11 respondents (18.0%) that support manure exchange. Their comments included:

"We have had some fields spread with manure from Neighboring Dairy farm and will have more in the Future. We have no cattle this year, but, had about one hundred and twenty head of Dairy Beef last year. Hope to have more in the Future," (Respondent 287); "Most Farmers that Don't Have Manure would like to Have it. To build ground up in spots. Any questions call [phone number omitted]," (Respondent 146); "With livestock facilities getting so large this may be the best way to keep your land investment down and still achieve economies of scale in livestock," (Respondent 223); "I would consider manure from another farmer," (Respondent 127);

"It can help benefit neighboring Farmers to utilize manure from livestock producers and help to spread the application to other areas of the community," (Respondent 159); "I think it is a great idea. It can [be] a benefit to both parties," (Respondent 218); "Manure is the best fertilizer," (Respondent 276); "In short, I Think it's mainly a matter of common sense regarding manure application. I've witnessed such overapplication that I thought the farmer should be reported. I worry more about ground water contamination. But on my own farm I would not have any problem with another farmer spreading manure there but I think I would want to supervise it somewhat. I think it's a good source of fertilizer," (Respondent 189).

"I would be more than willing to have manure on our land if it were available. We use sludge even so after don't like all the new rocks!" (Respondent 88); "I think it is a

good idea, what with all these dairy and hog factories around this part of the state," (Respondent 144); and, "It could be a very valuable program to have," (Respondent 84).

# CHAPTER V

# CONCLUSIONS, RECOMMENDATIONS, AND IMPLICATIONS

Based upon the findings presented in this study, the following conclusions, recommendations, and implications were formed.

## Conclusions

### Research Question 1

Research Question 1 asked how all surveyed farmers perceive issues related to manure exchange.

Conclusions

- Farmers rated manure variability as a low concern. This is supported by respondent 276: "Manure is the best fertilizer", and respondent 88: "I would be more than willing to have manure on our land if it were available. We use sludge even so after don't like all the new rocks!"
- Farmers rated neighbor complaints and odor concerns higher than any other concern surveyed. This supports findings by Kelsey and Vaserstein (2000) and Poe, et. al, (2001) that rural nonfarm neighbors of farmers complain about odors more often than they complain about water quality concerns. This is supported by respondent 16: "I believe liquid manure should be Knife in ONLY!", and respondent 173: "In some cases it would work and anothers cases it wouldn't. It really depend on the neighbors"
- Farmers rated concern about spreading weed seed highly. This is supported by respondent 317: "Would be concerned of the spread of a noxious weed..." and respondent 263: "There would need to be a way to insure uniformity, lack of

weeds, diseases etc." This perception does not, however, support data presented by Blackshaw and Rode (1991) that suggest that weed seed survival through rumen digestion and ensiling should be a minor concern.

- As farmers were presented with increased potential costs of receiving manure, farmer interest in receiving manure decreased. This is supported by respondent 281 "Farmers are beginning to see some viable manure utilizing trading but money payment still seems rare" and respondent 214 "I'd accept another farmer's manure, but only at no cost to myself". This supports the findings by Poe, et. al, (2001) of farmers' unwillingness to pay for practices associated with implementing a CNMP as costs for adopting those practices rose, despite having the capability of paying for those practices.

**Research Question 2**

Research Question 2 asked if there are differences between how surveyed livestock farmers, and surveyed nonlivestock farmers perceive issues related to manure exchange.

Conclusion

- Livestock farmers were more willing to trust manure as a consistent, reliable fertilizer source than nonlivestock farmers.

**Research Question 3**

Research Question 3 asked if there are differences between how surveyed farmers, age 50 years and younger, and how surveyed farmers, age 51 years and older, perceive issues related to manure exchange.

Conclusions

- Younger farmers were more concerned about manure containing weed seed than older farmers.
- Older farmers were more concerned than younger farmers that they not pay for exchanged manure.
- These findings initially appear to support the determination by Napier, et. al, (1986) that age has no effect on a farmers' likelihood of adopting conservation practices. However, an unwillingness to use manure because of a concern that it contains weed seed represents a situational barrier, while unwillingness to pay for exchanged manure represents a dispositional barrier (Cross, 1981). Likely, an educator would be more successful helping a farmer overcome a concern about manure containing weed seeds than helping a farmer overcome an unwillingness to pay for exchanged manure. Therefore, these findings support the determination by Featherstone and Goodwin (1993) that younger farmers are more likely to adopt conservation practices than older farmers.

**Research Question 4**

Research Question 4 asked if there are differences between how surveyed farmers who farm 250 or fewer acres, and how surveyed farmers who farm more than 250 acres perceive issues related to manure exchange.

Conclusions

- Farmers who farm more than 250 acres were more concerned about manure containing weed seed and the potential compaction caused by application equipment than farmers who farm 250 acres or fewer.

- Farmers who farm more than 250 acres were more concerned about manure exchange interfering with cropping operations than farmers who farm 250 acres or fewer. These conclusions support the Buttel, et. al, (1981) and Napier, et. al, (1984) findings that larger farms are less likely to adopt conservation practices than smaller farms. This is likely because larger acreage farmers may not feel they have the time to devote to spreading manure on their acreage. They already have a more difficult time executing field operations in a timely manner.

**Research Question 5**

Research Question 5 asked if there are there differences between how surveyed farmers who do not currently raise livestock, but have within the past 10 years, and how surveyed farmers who do not currently raise livestock, and have not for at least 10 years, perceive issues related to manure exchange.

Conclusions

- Farmers who do not currently raise livestock, but have within the past 10 years, are more concerned about neighbor complaints than farmers who do not currently raise livestock and have not for at least 10 years. This supports findings by Kelsey and Vaserstein (2000) and Poe, et. al, (2001) that neighbors are more likely to complain about farm odors than other concerns. Farmers who have raised livestock within the past 10 years would likely be more sensitive to potential neighbor complaints than farmers who have not raised livestock for at least 10 years.
- Farmers who do not currently raise livestock, but have within the past 10 years, are less willing to pay for exchanged manure than are farmers who do not

currently raise livestock and have not for at least 10 years. This is likely because farmers who have more recently raised livestock have more recently utilized manure at no economic cost.

- Farmers who do not currently raise livestock, but have within the past 10 years are more willing to supply time and labor to get exchanged manure applied than are farmers who do not currently raise livestock and have not for at least 10 years. This is likely because farmers who have more recently raised livestock have equipment available to spread manure.

**Research Question 6**

Research Question 6 asked how many surveyed farmers have manure exchange agreements.

Conclusion

- Few surveyed farmers have manure exchange agreements.
- The surveyed farmers who do have manure exchange agreements represent innovators (Rogers, 1995).

**Responses to the Open-Ended Question**

The remainder of this section is devoted to responses that were not included in the quantitative portion of the survey.

Conclusion

- No-till farmers are concerned about interference with their no-tillage systems. A no-till system is a conservation-friendly practice, as is manure exchange. A minority of Calhoun County farmers within the Kalamazoo River watershed employ no-till practices on their fields from year to year; these farmers never

plow a majority of their acreage. By using manure on their fields, the four respondents who raised this issue prefer not to compromise their no-till system by incorporating manure. This supports Nowak's (1987) contention that conservation tillage is a profitable conservation practice, and illustrates an unwillingness to compromise a profitable conservation practice in favor of a nonprofitable conservation practice.

- Note that Manure Management GAAMPs (MDA, 2003) do require that manure either be injected or incorporated within 48 hours of application. However, Manure Management GAAMPs allow exceptions for pasture land, land growing perennial forages, and land under continuous no-till. By not incorporating manure, however, odors would likely increase after manure application, thus potentially stressing neighbor relations.

Conclusion

- Six respondents noted a concern about infecting their animals with disease from another farm's transported manure. It is unknown how likely it is that manure could transmit disease from one farm to another farm's animals (Rozeboom, 2004). This is, however, a real concern (Rozeboom, 2004).

Conclusion

- Five respondents indicated they held a dispositional barrier to manure exchange. Four respondents indicated an unwillingness to help, or make things easier for larger livestock farms.
- One respondent indicated that the government should not be able to tell farmers what to do with their own land.

Conclusion

- Three respondents raised concern about right-to-farm guidelines. One specific concern was who would be responsible, the livestock farmer providing manure or the farmer receiving manure, if a nuisance complaint were filed after a manure application. This offers further support of Kelsey and Vaserstein, (2000) Poe, et. al, (2001) contentions about neighbor complaints.
- Note that Manure Management GAAMPs (MDA, 2003) offer no guide about whom a court would find liable, the farmer providing the manure or the farmer receiving manure, if a complainant filed a verified right-to-farm complaint after a manure application.

## Recommendations and Implications

Adult learners learn in different ways. As extension educators work with people, their challenge is to tailor programs that meet the needs of individuals. The purpose of this study as well as the following recommendations and implications is not to make broad generalizations about farmers, by trying to develop a recipe for educators to follow as they work with farmers to implement sustainable manure management practices. Rather, it is hoped that these suggestions will help educators understand challenges they may face as they help farmers adopt sustainable manure management practices.

The majority of surveyed farmers, both through the closed-ended questions and the open-ended question, indicated that they were generally supportive of the idea of manure exchange. Most farmers considered manure to be a consistent, reliable fertilizer source, although livestock farmers held that belief more strongly than nonlivestock farmers did. It appears that situational barriers primarily inhibit farmers' willingness to

enter into manure exchange agreements. Three important situational barriers were concern about spreading weed seed, the cost of transferring manure, and concerns about odors and neighbor complaints.

### Concerns about Spreading Weed Seeds

Blackshaw and Rode (1991) demonstrated that the seeds of many weed species do not survive both the ensiling and digestion processes, and the seeds of weed species that do survive these processes have a low viability. Therefore, extension educators should be able to help farmers successfully decrease their concern of developing weed problems by using another farmers' manure.

However, if a farmer neighbors a dairy farm that harvests forages from fields heavily infested with weed species known to survive rumen digestion and ensiling, a concern of spreading weed seed through transferred manure is real.

### Economic Concerns

Livestock farmers providing manure may feel they would be providing a valuable fertilizer for a receiving farm, and a receiving farm should compensate them. Farmers who may receive manure may feel they would be providing a service to a livestock farmer by providing a location for excess manure.

Perhaps time will help solve this problem. Commercial fertilizer prices may increase such that farmers will be more willing to pay for manure. Alternatively, livestock farmers may find themselves under enough pressure to conform to Manure Management GAAMPs that they would be more willing to provide manure free of charge, or even pay to have access to another's land.

**Concerns about Odors and Neighbor Complaints**

The most important situational barrier was the potential for manure odor to generate neighbor complaints; livestock farmers and nonlivestock were equally concerned about this matter. A livestock farmer may be more willing to risk violating water quality standards by spreading manure in a remote field with a high phosphorus soil test, close to the barnyard, and away from neighbors, than to open himself or herself up to a complaint by having manure spread on a neighbor's field. Likewise, a farmer who could accept manure from a neighboring farm may prefer to purchase commercial fertilizers, than risk potential neighbor complaints by accepting a neighbors' manure. Respondent 12, a dairy farmer, summed these final two concerns by stating: "Some farmers think we should Pay them for Putting manure on their Ground. Compaction, odor, and Reasonable commercial fertilizer costs suggest to them that they are better off without manure."

The decision to enter into a manure exchange agreement is complex. It requires an interaction between livestock and nonlivestock farmers. It can also not be assumed that a concern about weed seeds, or neighbor complaints, or even the cost of manure are the only factors inhibiting a farmer from entering into a manure exchange agreement. Highly productive farms must perform their operations in an efficient manner. The idea of complicating these operations by entering into a manure exchange agreement, especially when concerns about stressing relationships with neighbors, introducing weed seeds, and spending money on transferring manure may be less than appealing.

At the same time, the citizens of the United States have identified protection of water resources as an important goal. Extension educators have the task of helping

farmers not only manage their farms to maximize profits, but also to manage their farms as environmental stewards. Extension programming should take the direction of educating farmers less on the "rules" of manure management, contained in manure management GAAMPs, and more on the importance of protecting water quality, and a farmers' role in protecting water quality.

## Recommendations for Further Research

Listed below are three recommendations arising directly from the study that suggest further research in this area.

1. Conduct a survey of rural, nonfarm, Calhoun County residents within the Kalamazoo River watershed to determine their perceptions of manure management by farmers, and their willingness to live in an area where farmers responsibly spread manure in more locations.
2. Conduct a survey of the same population to determine better the extent to which dispositional barriers inhibit the exchange of manure in the portion of Calhoun County covered by the Kalamazoo River watershed.
3. Conduct a survey of the same population to determine the understanding of how manure management affects water quality.

# APPENDICES

# APPENDIX A

## UNIVERSITY COMMITTEE ON RESEARCH

## INVOLVING HUMAN SUBJECTS

MICHIGAN STATE
UNIVERSITY

July 24, 2003

TO: David KRUEGER
409 Agriculture Hall
MSU

RE: **IRB# 03-573** CATEGORY: EXPEDITED 2-6, 2-7

**APPROVAL DATE: July 23, 2003**
**EXPIRATION DATE:June 23, 2004**

TITLE: MANURE PHOSPHORUS UTILIZATION IN CALHOUN COUNTY, MICHIGAN WITHIN THE KALAMAZOO RIVER WATERSHED

The University Committee on Research Involving Human Subjects' (UCRIHS) review of this project is complete and I am pleased to advise that the rights and welfare of the human subjects appear to be adequately protected and methods to obtain informed consent are appropriate. Therefore, the UCRIHS approved this project.

**RENEWALS:** UCRIHS approval is valid until the expiration date listed above. Projects continuing beyond this date must be renewed with the renewal form. A maximum of four such expedited renewals are possible. Investigators wishing to continue a project beyond that time need to submit a 5-year application for a complete review.
**REVISIONS:** UCRIHS must review any changes in procedures involving human subjects, prior to initiation of the change. If this is done at the time of renewal, please include a revision form with the renewal. To revise an approved protocol at any other time during the year, send your written request with an attached revision cover sheet to the UCRIHS Chair, requesting revised approval and referencing the project's IRB# and title. Include in your request a description of the change and any revised instruments, consent forms or advertisements that are applicable.
**PROBLEMS/CHANGES:** Should either of the following arise during the course of the work, notify UCRIHS promptly: 1) problems (unexpected side effects, complaints, etc.) involving human subjects or 2) changes in the research environment or new information indicating greater risk to the human subjects than existed when the protocol was previously reviewed and approved.

If we can be of further assistance, please contact us at (517) 355-2180 or via email: UCRIHS@msu.edu. Please note that all UCRIHS forms are located on the web: http://www.msu.edu/user/ucrihs

Sincerely,

Ashir Kumar, M.D.
UCRIHS Chair

AK: kmb

cc: Robert Battel
21174 F Dr. S
Marshall, MI 49068

OFFICE OF
RESEARCH
ETHICS AND
STANDARDS
University Committee on
Research Involving
Human Subjects
Michigan State University
202 Olds Hall
East Lansing, MI
48824
517/355-2180
FAX: 517/432-4503
Web: www.msu.edu/user/ucrihs
E-Mail: ucrihs@msu.edu

MSU is an affirmative-action, equal-opportunity institution

# APPENDIX B

## SURVEY INSTRUMENT

# Manure Exchange Survey

This survey is an attempt to learn about the potential for manure to be exchanged from livestock farms where it is produced to fields operated by other farmers. This survey is intended for research purposes only. By filling out this survey, you in no way commit yourself to any manure exchange.

If you **do not actively farm**, please check the box below, and return the survey in the enclosed, pre-stamped envelope.

❑ I do not actively farm.

---

**GENERAL CLASSIFYING QUESTIONS**

**Do you raise livestock for sale, or sell livestock products (such as milk) as a significant portion of your farm income?**
❑ yes ❑ no

**Do you have an agreement with another farmer, in which you regularly use their manure on your fields?**
❑ yes ❑ no

---

**MANURE USE QUESTIONS**
*Following is a series of statements about manure and manure use. Please check the choice that corresponds to the degree that you agree or disagree with the statements.*

**1 = Strongly Disagree**
**2 = Disagree**
**3 = Neutral**
**4 = Agree**
**5 = Strongly Agree**

**Farmers feel manure is too variable (not consistent enough) to be a reliable fertilizer source.**

❑ 1 ❑ 2 ❑ 3 ❑ 4 ❑ 5

**Farmers are concerned that neighbors may complain about manure applications on fields not usually receiving manure.**

❑ 1 ❑ 2 ❑ 3 ❑ 4 ❑ 5

**Odor concerns cause farmers to not apply manure on certain fields.**

❑ 1 ❑ 2 ❑ 3 ❑ 4 ❑ 5

**1 = Strongly Disagree**
**2 = Disagree**
**3 = Neutral**
**4 = Agree**
**5 = Strongly Agree**

**Farmers are concerned that manure may contain weed seeds.**

❑ 1 ❑ 2 ❑ 3 ❑ 4 ❑ 5

**Farmers are concerned with the potential compaction caused by manure application equipment.**

❑ 1 ❑ 2 ❑ 3 ❑ 4 ❑ 5

**Farmers are concerned that manure applications could interfere with the timeliness of spring planting or other aspects of their cropping operations.**

❑ 1 ❑ 2 ❑ 3 ❑ 4 ❑ 5

**Farmers would be willing to accept manure from a neighboring farm only if was available at no cost.**

❑ 1 ❑ 2 ❑ 3 ❑ 4 ❑ 5

**Farmers would be willing to accept manure from a neighboring farm at a cost, as long as the cost was less than commercial fertilizer.**

❑ 1 ❑ 2 ❑ 3 ❑ 4 ❑ 5

**Farmers would be willing to accept manure from a neighboring farm at a cost, even if the cost was about the same as commercial fertilizer.**

❑ 1 ❑ 2 ❑ 3 ❑ 4 ❑ 5

**Farmers would be willing to accept manure from a neighboring farm only if none of their time or labor were required to get it applied.**

❑ 1 ❑ 2 ❑ 3 ❑ 4 ❑ 5

**Farmers would be willing to accept manure from a neighboring farm even if they had to supply some of their time and labor to get it applied.**

❑ 1 ❑ 2 ❑ 3 ❑ 4 ❑ 5

**Farmers are concerned about potential environmental impacts of manure over-application on cropland.**

❑ 1 ❑ 2 ❑ 3 ❑ 4 ❑ 5

*Rank the following items in order from 1 to 8, according to how you feel most farmers would rank the most important reasons to receive manure from another farm. Write a "1" in next to the most important reason, a "2" in the second most important reason and so on. An "8" should be written next to the least important reason. Please rank all eight reasons.*

**___ to build soil organic matter**

**___ as a cheaper fertilizer source**

**___ as an alternative nitrogen source**

**___ to help another farmer comply with environmental regulations**

**___ protection of water resources**

**___ to improve soil tilth**

**___ to build soil fertility levels**

**___ a feeling that it is important that nutrients be spread more evenly around the community**

**On a scale of 1 to 10, with 1 being most important, and 10 being least important, how important would *agronomic* reasons (improved crop yield, improved soil fertility, etc.) be in helping farmers decide to use manure on their fields?**

❑1 ❑2 ❑3 ❑4 ❑5 ❑6 ❑7 ❑8 ❑9 ❑10

**On a scale of 1 to 10, with 1 being most important, and 10 being least important, how important would *economic* reasons (a cheaper fertilizer source) be in helping farmers decide to use manure on their fields?**

❑1 ❑2 ❑3 ❑4 ❑5 ❑6 ❑7 ❑8 ❑9 ❑10

**On a scale of 1 to 10, with 1 being most important, and 10 being least important, how important would *environmental* reasons (protection of water resources) be in helping farmers decide to use manure on their fields?**

❑1 ❑2 ❑3 ❑4 ❑5 ❑6 ❑7 ❑8 ❑9 ❑10

**Provide any comments concerning the exchange of manure from one farmer to another.**

_____

_____

_____

_____

_____

**FINAL CLASSIFYING QUESTIONS**

*The final set of questions will help us learn more about you.*

**What is your age?**

- ❑ 18 – 30
- ❑ 31 – 40
- ❑ 41 – 50
- ❑ 51 – 60
- ❑ 61 – 70
- ❑ Older than 70

**If your farm is not currently a livestock farm, did you or a previous family member raise livestock on your home farm, within the past 30 or so years?**

❑ yes ❑ no

**If you answered "yes" to the previous question, for how many years has your home farm been out of livestock production?**

- ❑ Less than 10 years
- ❑ More than 10 years

_____ number of acres farmed

**Livestock Farmers Only:** Indicate the **typical** number of head on your farm at any one time.

**Dairy**

_____ number of milking cows
_____ number of dry cows
_____ number of heifers 0 to 2 yrs.
_____ number of others, list:

_____

**Beef (cow/calf herd)**

_____ number of brood cows
_____ number of all calves
_____ number of older calves being fed to market weight

**Beef (feeder herd)**

_____ number of head at any one time

**Swine**

_____ number of gestating sows/gilts
_____ number of sows and litters
_____ number of nursery pigs
_____ number of grower pigs
_____ number of finishing pigs

**Other livestock (list number and type)**

_____
_____
_____
_____

**Thank you for completing this survey. Your information will be kept strictly confidential. Please return this survey in the stamped, pre-addressed envelope provided or mail it to MSU Extension Manure Survey, 315 W. Green St., Marshall, MI 49068.**

# APPENDIX C

## FIRST COVER LETTER

MICHIGAN STATE
UNIVERSITY
EXTENSION

This is a survey that contains questions about the potential to exchange manure from farm to farm. Your participation in this survey is valuable for future Extension programming in the area of manure exchange in Calhoun County. The information you provide will help clarify and improve the direction of this effort. I appreciate your willingness to complete this survey. You may choose to not answer any given question for any reason.

The survey has been designed so that it is easy to follow, and should be quick to finish. I hope, however, that you take enough time to reflect a bit on your answers, and provide the best information possible. I expect it should take you between 8 and 12 minutes to complete.

Please return this survey by using the enclosed pre-addressed, stamped envelope. It would be helpful if you would return the survey before August 31, 2003.

Your responses will remain confidential. I will be the only person who enters your responses, analyzes the data collected, and writes the final report. The documents returned to me by you will be stored in my office in a secure area. Also, your privacy will be protected to the maximum extent allowable by law.

This is a research project. You indicate your voluntary agreement to participate by completing and returning this questionnaire.

Thank you again for taking time to complete this survey. If you have any questions about this study, please contact me by mail at 315 W. Green St., Marshall, MI 49068, by phone at (888) 212-9828 or e-mail at battelr@msue.msu.edu.

Sincerely,

Bob Battel
Extension Agent and Graduate Student
Michigan State University

# APPENDIX D

## REMINDER POSTCARD

Approximately two weeks ago, a survey was sent to you along with a letter requesting your assistance in completing the survey on behalf of MSU Extension, Calhoun County. As a Calhoun County farmer, your participation in is valuable to help clarify and improve the future direction of manure use programming. I am looking forward to receiving your completed responses. You may choose to not answer any given question for any reason.

You can return the survey in the pre-addressed, stamped envelope provided with the previous mailing. It would be helpful if you would return the survey before August 31, 2003. Your responses will remain confidential.

This is a research project. You indicate your voluntary agreement to participate by completing and returning this questionnaire.

If you have already returned this survey, I thank you, and you may disregard this mailing. If you have misplaced the survey, you can request another one by calling me at (888) 212-9828.

Sincerely,

Bob Battel
Extension Agent and Graduate Student
Michigan State University

# APPENDIX E

## SECOND COVER LETTER

MICHIGAN STATE
UNIVERSITY
EXTENSION

Approximately four weeks ago, a survey was sent to you along with a letter requesting your assistance in completing the survey on behalf of MSU Extension, Calhoun County. Your participation in this survey is valuable for future Extension programming in the area of manure exchange in Calhoun County. The information you provide will help clarify and improve the direction of this effort. I appreciate your willingness to complete this survey. You may choose to not answer any given question for any reason.

I have not heard from you yet, so I wanted to give you another chance to provide this information. The survey has been designed so that it is easy to follow, and should be quick to finish. I hope, however, that you take enough time to reflect a bit on your answers, and provide the best information possible. I expect it should take you between 8 and 12 minutes to complete.

Please return this survey by using the enclosed pre-addressed, stamped envelope. It would be helpful if you would return the survey as quickly as possible.

Your responses will remain confidential. I will be the only person who enters your responses, analyzes the data collected, and writes the final report. The documents returned to me by you will be stored in my office in a secure area. Also, your privacy will be protected to the maximum extent allowable by law.

This is a research project. You indicate your voluntary agreement to participate by completing and returning this questionnaire.

Thank you again for taking time to complete this survey. If you have any questions about this study, please contact me by mail at 315 W. Green St., Marshall, MI 49068, by phone at (888) 212-9828 or e-mail at battelr@msue.msu.edu.

Sincerely,

Bob Battel
Extension Agent and Graduate Student
Michigan State University

# APPENDIX F

# OPEN-ENDED RESPONSES

1. I believe liquid manure should be Knife in ONLY! (16)

2. I have had very little experience with manure in my farming. I would say I cant help much. [signature omitted]. (81)

3. I would consider manure from another farmer (127)

4. It can help benefit neighboring Farmers to utilize manure from livestock producers and help to spread the application to other areas of the community. (159)

5. Manure is also an excellent source in alfalfa to eridicate Potato leaf hopper a little is enough to keep the leafhopper out till next cutting Down side is that Potassium levels get too high to use alfalfa for dry cow feeding. (165)

6. In some cases it would work and anothers cases it wouldn't. It really depend on the neighbors (173)

7. Farmers are beginning to see some viable manure utilizing trading but money payment still seems rare. (281)

8. The Timeliness in which to apply during the growing season. Odor control and correct application rates. (136)

9. I think it is a good idea, what with all these dairy and hog factories around this part of the state. (144)

10. Application Timing—The way it was put on. I am NoTilling & Realy Don't want to Disturb The Ground Couther Injection Would Be Fine Most Farmers that Don't Have Manure would like to Have it. To build ground up in spots. Any questions call [phone number omitted] (146)

11. Have farmed Dairy and livestock (sheep and Beef cows for 60 years. Never had any experience exchanging manure with anyone. All cattle and sheep were on pasture or crop residue fields for 6 or 7 months of the year. We had no intensive livestock set ups. (166)

12. no-till & manure application don't go together very well spreading manure & tillage could be worse than comm. Fert & no-till eviromentaly (176)

13. It should be required that liquid manure be injected. (191)

14. It's not a good idea as it could spread disease from one farm to another. (201)

15. I think it is a great idea. It can a benefit to both parties. (218)

16. There is not manure moved from one farm to another in our community. (247)

17. Should be able to do what you want to do with your own land—GOV get out of tell you what you raise or do. (255)

18. Manure is the best fertilizer. (276)

19. I think Manure is better managed by 5-100 cow farmers than 1-500 cow farmer as I drive around and observe operations. The swine industry seems to a little better at applications technics in this area. (294)

20. If they have too much manure for their cropland, LIMIT THE NUMBER OF CATTLE ON their FARM! Make things as tough as possible for these mega-dairies!!! (299)

21. Would be concerned of the spread of a noxious weed. Only 1 field would be a environmental problem next to the river. (317)

22. Some farmers think we should Pay them for Putting manure on their Ground. Compaction, odor, and Reasonable commercial fertilizer costs suggest to them that they are better off without manure. (12)

23. There would need to be a high level of trust between livestock & grain farmer in respect for each persons concerns & values. (13)

24. The idea is fine providing, the manure would be spread properly, an calibrated correctly. (70)

25. My concern about neighbor manure is 1: Regulations on my farm as though I had 100+ head 2: Inspection & controls I would have to obide by just as though I had 100+ (245)

26. On most livestock farms, the individual hauling manure has not been well trained or monitored to do an even spread, with no gaps, or pay attention to undesirable field contions, causing compaction. (301)

27. I think manure exchange does nothing but destroy the family farms and promote corporate farms. To provide a better environment I think it would make more sense to promote smaller farms and you wouldn't have all the manure concentrated in one area. Probably not what you wanted to hear but overproduction by corporate farmers are also driving prices down and forcing small farmers out. (319)

28. Receiving farmer should know what he receiving in value and that it is spread in accordance with right to farm act. (267)

29. Manure was never a problem when livestock were spread evenly around the community. Manure is not a problem now except for the amount, in to small of an area or near a stream. [signature omitted] (268)

30. We have had some fields spread with manure from Neighboring Dairy farm and will have more in the Future. We have no cattle this year, but, had about one hundred and twenty head of Dairy Beef last year. Hope to have more in the Future. (287)

31. Any liquid manure should be knifed into soil. (348)

32. In my operation, I would not want manure from an anaerobic source. I think that this is a key problem in how most manure is handled It may be a cheaper, easier way to dispose of manure, but I believe it is a poorer choice. (23)

33. I would not Except manure from other farm—Because of Disease! (344)

34. In short, I Think it's mainly a matter of common sense regarding manure application. I've witnessed such over-application that I thought the farmer should be reported. I worry more about ground water contamination. But on my own farm I would not have any problem with another farmer spreading manure there but I think I would want to supervise it somewhat. I think it's a good source of fertilizer. (189)

35. With livestock facilities getting so large this may be the best way to keep your land investment down and still achieve economies of scale in livestock. (223)

36. There would need to be a way to insure uniformity, lack of weeds, diseases etc. (263)

37. I would like to see the ones coming from other countries have to comply with the same rules as our farmers have to (29)

38. I would be more than willing to have manure on our land if it were available. We use sludge even so after don't like all the new rocks! (88)

39. This is for cash crop farmer's I raise cattle and Do Not want neighbor's manure for Disease control (280)

40. Manure has to be free of chemical contamination (55)

41. Odor-Timing-Cost The houses are closer all the time (33)

42. I have farmers wanting the manure But when it works for them, not when I need to keep fly problem's from happening. (331)

43. Soil conditions when applied—wet—etc Soil Testing Contents of manure—chemicals weed seed etc If there is a nuisance complaint—who is responsible? (337)

44. I'd accept another farmer's manure, but only at no cost to myself. (214)

45. In the pass I have seen manure spread on another's land containing cement blocks, cement, boards, plastic-bags-bucket-etc., pipe, you name it. They also spread when fields were to wet. I have also seen manure from a local mega dairy piled 8 ft high over a couple of acres by their neighbor house during the winter because the snow was to depth to spread, I don't want that in my back yard. What about their water & run off?? (308)

46. The reason I don't want to receive manure from another farm is due to the spreading of disease. (192)

47. If you have to put manure on other land than your own you are to big untile you understand this we will continue to have all kinds of trouble (343)

48. The spread of forien weed seeds increasing your chemical use, and cutting yield. (181)

49. Timing, compaction, consistency of manure, not just water, solids would be better for my operation, I no till farm & I think it would be hard to apply manure on fields. (109)

50. I find that providing manure disposal is a service to livestock producers—it should be low cost—I also feel the farmer who plants and shares with me should have first disposal rights. (143)

51. even though I have very small numbers of livestock (pets) (home flock), I'm still very concerned about the spread of parasites and diseases. I am also apprehensive about the lack of standards (not knowing what you're getting) and the very small window of opportunity to do this. I would not be willing to purchase equipment to do this myself (spreader & loader) (149)

52. Livestock Farms should not be allowed to have more animal units than they have cropland to utilise it. (Owned & rented combined) Adequate acreage for manure utilization should be a requirement for granting a construction permit for any livestock facility!!! (182)

53. only if it is knifed in. I think all manure should be knifed in (203)

54. It could be a very valuable program to have. (84)

55. Time (171)

56. I don't like to move manure using the roads. (341)

57. I no till and this will not work in my plan (260)

58. I wouldn't let just any farm do it because of the weed seed in the manure & the other debris some farmers have. (312)

59. Most operations do not have adequate application equipment to apply manure in the time period between wet compactable soils and tillage and planting (204)

60. Should the farmer with the manure have to pay the farmer with the land to spread manure? (102)

61.
1) Bring weed seeds from one farm to another
2) Soil Compaction
3) Odors to neighbors
4) Timing of application (125)

# APPENDIX G

## MEAN RESULTS COMPARISON OF EARLY AND LATE RESPONDENTS

Table 6. Mean Results Comparison of Early and Late Respondents

| Survey Question | Early Respondent Mean | Late Respondent Mean | Sig (*p*) |
|---|---|---|---|
| Farmers feel manure is too variable (not consistent enough) to be a reliable fertilizer source | 2.41 | 2.66 | 0.133 |
| Farmers are concerned that neighbors may complain about manure applications on fields not usually receiving manure | 3.57 | 3.68 | 0.512 |
| Odor concerns cause farmers to not apply manure on certain fields | 3.68 | 3.68 | 0.996 |
| Farmers are concerned that manure may contain weed seeds | 3.63 | 3.40 | 0.181 |
| Farmers are concerned with the potential compaction caused by manure application equipment | 3.35 | 3.40 | 0.736 |
| Farmers are concerned that manure applications could interfere with the timeliness of spring planting or other aspects of their cropping operations | 3.11 | 3.34 | 0.169 |
| Farmers would be willing to accept manure from a neighboring farm only if it were available at no cost | 3.48 | 3.47 | 0.963 |
| Farmers would be willing to accept manure from a neighboring farm at a cost, as long as the cost was less than commercial fertilizer | 2.93 | 2.77 | 0.368 |
| Farmers would be willing to accept manure from a neighboring farm at a cost, even if the cost was about the same as commercial fertilizer | 2.45 | 2.19 | 0.129 |
| Farmers would be willing to accept manure from a neighboring farm only if none of their time or labor were required to get it applied | 3.23 | 3.32 | 0.611 |
| Farmers would be willing to accept manure from a neighboring farm even if they had to supply some of their time and labor to get it applied | 2.90 | 2.85 | 0.328 |

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