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Environmental Attitude and its Effect on Growers' Nitrogen
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ENVIRONMENTAL ATTITUDE AND ITS EFFECT ON
GROWERS' NITROGEN MANAGEMENT PRACTICES:
A Case Study of St. Joseph County Corn Growers

By

Maria Emily Ouano Arnaiz

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ABSTRACT

ENVIRONMENTAL ATTITUDE AND ITS EFFECT ON
GROWERS' NITROGEN MANAGEMENT PRACTICES:
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By

Maria Emily Ouano Arnaiz

Federal groundwater policy relies heavily upon
educational programs on water quality to effectuate reform
of nitrogen management practices among growers. The
presumed efficacy of this approach is based upon the tacit
assumption that attitudinal change will lead to behavioral
change. However, other studies have indicated that other
factors can strongly influence this relationship.

This study examines the strength of the attitude
behavior relationship for nitrogen use within the context of
a narrowly defined economic risk space. Results indicate
that attitude and application rate are negatively related
among growers with a wide financial risk space. Although
this relationship was found to be weak, it is significant
that no such relationship was observed among growers with a
narrow financial risk space.   The results suggest that a
grower's economic situation can negate the influence of
attitude on behavior.

This is dedicated to my mother,
Leticia Ouano Arnaiz

ACKNOWLEDGEMENTS

The road leading to the completion of this thesis has been a long and tortuous one. I could not have made it without the help and encouragement of professors, friends and family. The person most responsible for the content and format of this thesis, other than myself, is Dr. Tom Edens. His constructive criticism, willingness to discuss, and patience with my progress were instrumental in getting me to organize my ideas and to put them down on paper. I would also like to thank the other members of my committee, Drs. Frank Fear and Phil Robertson, for their timely advice and editorial comments. To Joel Lichty, who gave me the opportunity to work on the St. Joseph County Survey, and to my friends in the Department: Brent Simpson, Ignacio Villa, Susan Corcoran, and Bob Pigg, who were willing to help me overcome the technical and logical barriers I encountered in this study, my appreciation.

Finally, none of this would have been possible if not for the unconditional support I received from my family, both in my decision to return to school and during the thesis process. I love you all and sincerely, salaamat kaayo.

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CHAPTER 1

INTRODUCTION

Background. Groundwater contamination is predicted to become the environmental issue for U.S. agriculture in the 1990's (Kenski, 1990; Conservation Foundation [CF], 1985). Approximately half of the urban population and 95% of the rural population rely upon groundwater as their primary source of drinking water (Danielson and Abdalla, 1990). It has been estimated by the USDA (United States Department of Agriculture) that 46% of all counties in the U.S. depend upon groundwater sources susceptible to contamination from pesticides and nitrogen fertilizers (National Research Council [NRC], 1989). The EPA (Environmental Protection Agency) has detected nitrate concentrations exceeding the national standard of 10 ppm nitrate-nitrogen in over 800 rural drinking water sources (Environmental Reporter [ERC]: Current, February 6, 1989). Because private wells are not required to be tested by law, current estimates of contaminated water sources are considered conservative.

Of the sources of contamination, agriculture has been cited as contributing at least half of all the contaminants, pesticides and nitrates, found in groundwater (NRC, 1989).

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Other sources contributing nitrates to groundwater include animal manures, human wastes (faulty sewage systems), nitrogen-fixing bacteria and plants, other natural sources in geologic formations, and precipitation (Hallberg, 1987; Robertson, 1986). Nitrates are a by-product of natural processes. Nitrate concentrations of 3 mg/l or less are attributable to these processes (NRC, 1989).

Concern over the continuing degradation of the nation's groundwater resources has been the source of a growing conflict between growers and non-agriculturists. Although restrictions and bans have been placed on the use of certain pesticides, no such action, at the national level, has been taken with regard to inorganic nitrogen use. However, increasingly strident demands for federal restrictions of these agricultural practices that can lead to contamination of surface and groundwater sources is being made by those outside of agriculture (Batie, 1988).

To date, the federal government's response has been limited to the provision of financial assistance to state governments for the development and implementation of water quality plans as promulgated in the Clean Water Act of 1972, 1977 and 1987. Unlike previous actions taken against polluting industries involving direct regulation of activities, policy-makers at the federal level rely upon a voluntary approach to control nitrogen use among growers. In light of the costs attendant with monitoring grower

activities, this is considered the most cost-effective means of control (Goldfarb, 1988)[1].

The approach adopted by U.S. groundwater policy to control nitrogen use among growers is grounded in the belief that **attitudinal change will lead to behavioral change.** State water quality efforts stress the use of educational programs as the primary means of inducing the voluntary adoption of "Best Management Practices" (BMPs) among growers. BMPs are alternative management practices which have the potential to reduce the use of inorganic nitrogen fertilizers in agricultural production. They are developed at the state-level by a consortium of specialists from public and private institutions (Logan, 1990).

Educational programs are intended to increase grower awareness of the health and environmental risks stemming from nitrate contamination of groundwater. In the process of educating growers to the hazards and costs of groundwater contamination, the value held by growers' toward water quality can be enhanced. This favorable attitude toward water quality is presupposed to act as a stimulus for the adoption of the appropriate BMPs (Goldfarb, 1988).

Results from grower surveys have indicated that growers are aware of the problems and of the concomitant risks

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[1]
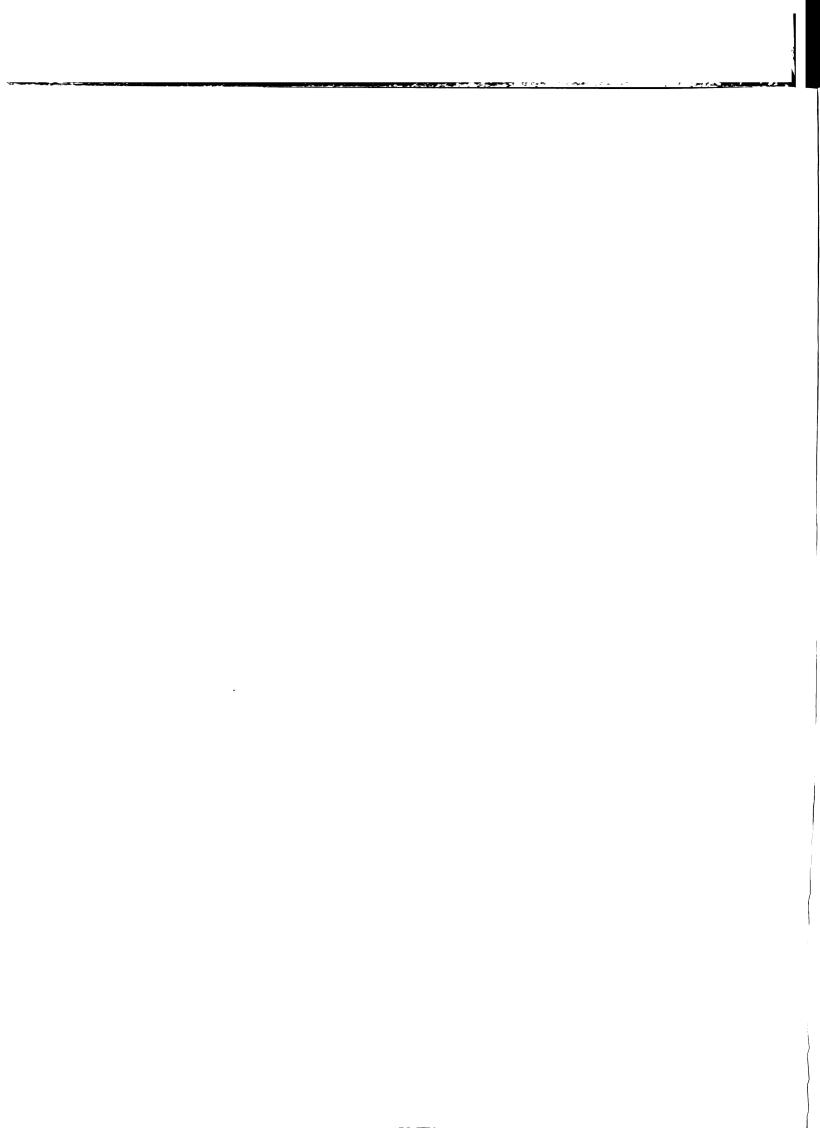
Some states, such as Iowa which has acute problems with groundwater contamination, have taken action to regulate nitrogen use via the imposition of a tax on the sale of nitrogen ("Iowa," 1987).

associated with groundwater contamination (Halstead, Padgitt and Batie, 1990; Martin, Guither, Jones and Spitze, 1989; Lasley and Bultena, 1988). Increasing concern among growers is testament to the efficacy of the educational component of U.S. groundwater policy. Yet, figures relating total use of fertilizers and pesticides suggest that growers have not changed their nitrogen management practices significantly (Economic Research Service [ERS], 1991; NRC, 1989; ERS, 1987).
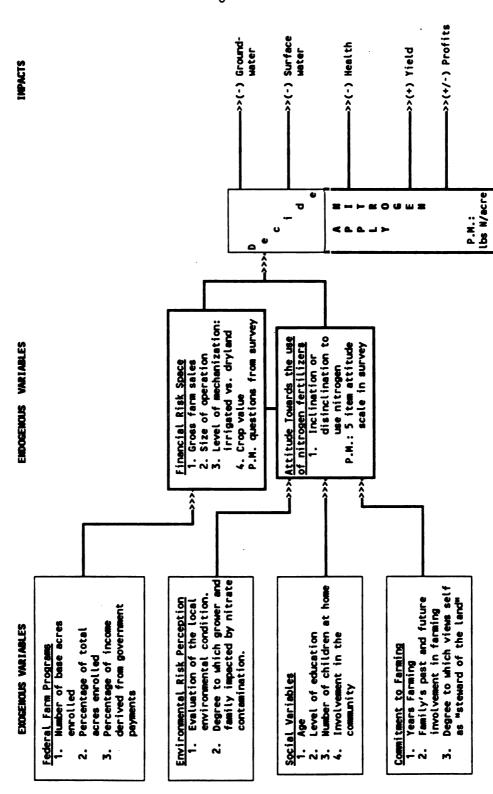
This inconsistency between growers' expressed concern over water quality and their behavior, i.e., use of inorganic nitrogen, would suggest that there is a limitation to the "bottom-up" strategy currently espoused by groundwater policy-makers. Apparently, more than attitudinal change is required to effectuate the adoption of more conservative nitrogen management practices. Because groundwater policy is based on voluntary compliance, understanding the role played by values and attitudes held by growers toward water quality and nitrogen use is important. These values and attitudes, along with economic and other considerations, enter into a grower's decision-making. In order to better understand why a grower chooses one nitrogen management strategy over another, it is necessary to estimate the importance given each of these variables by the grower in decision-making.

The Research Problem. Figure 1.1 is a conceptual model depicting several variables which are proposed to be present in a grower's decision-making calculus. While the model is not all-inclusive, it does include variables which have been suggested by previous research as being influential in the farm management decisions that a grower makes (Halstead et al., 1990; Gillepsie and Buttel, 1989; Lockeretz and Madden, 1988; Love, 1982; Gasson, 1974). In the model, attitudinal variables and financial risk space are considered to be the primary determinants of nitrogen use behavior. Past attitudinal-behavioral studies have noted that <u>attitude alone</u> is insufficient for predicting behavior. <u>Situational variables</u>, which can facilitate the expression of attitude into overt behavior, are required (van Liere and Dunlap, 1978; Azjen and Fishbein, 1977; Liska, 1975). These facilitating variables are identified in the model as those variables defining a grower's financial risk space. **This thesis will investigate the influence exerted by a grower's financial situation on the attitude-behavior relationship in terms of that grower's use of nitrogen.**

Financial risk space defines the flexibility a grower has to experiment with new technologies and management practices. For example, BMPs can reduce growers' use of nitrogen fertilizers, but at the risk of short-term yield and/or income loss. It is a reflection of the amount of financial loss a grower is able absorb and still remain

Figure 1.1   Grower's Decision-Making Model: Economic and attitudinal (social) variables interact and define behavior.

EXOGENOUS VARIABLES

ENDOGENOUS VARIABLES

IMPACTS

EXOGENOUS VARIABLES

Federal Farm Programs
1. Number of base acres enrolled
2. Percentage of total acres enrolled
3. Percentage of income derived from government payments

Environmental Risk Perception
1. Evaluation of the local environmental condition.
2. Degree to which grower and family impacted by nitrate contamination.

Social Variables
1. Age
2. Level of education
3. Number of children at home
4. Involvement in the community

Commitment to Farming
1. Years Farming
2. Family's past and future involvement in farming
3. Degree to which views self as "steward of the land"

Financial Risk Space
1. Gross farm sales
2. Size of operation
3. Level of mechanization: irrigated vs. dryland
4. Crop value
P.M. questions from survey

Attitude Towards the use of nitrogen fertilizers
1. Inclination or disinclination to use nitrogen
P.M.: 5 item attitude scale in survey

Decide

APPLY NITROGEN

P.M.: lbs N/acre

>>(-) Ground-water
>>(-) Surface water
>>(-) Health
>>(+) Yield
>>(+/-) Profits

**Note: ——— are variables considered in this study.
P.M. are performance measures used in the study

financially viable. Secondary variables, which broadly define financial risk space, are federal farm program structure and rules, credit and tax policies, and long-term market trends. On a micro-level, size and structure of the operation, farm sales and debt burden (return to labor and capital investments) directly constrain the choice set afforded a grower (Batie and Taylor, 1989). The other set of variables, a grower's attitude toward the use of nitrogen fertilizers, is shaped by social, environmental and other intangible factors, such as commitment to farming and ascription to the "stewardship of the land" ethic (Love, 1982; Gasson, 1974). It is these variables (attitude precursors) that current groundwater policy focuses upon as the precedents of behavioral change.

Research Locale. The data used in this thesis were obtained from a survey of corn growers in St. Joseph County, Michigan conducted in the spring of 1989. A self-administered questionnaire was the survey tool. Selected questions were intended to elicit a grower's attitude toward the use of nitrogen fertilizers in the farming operation. Also included were questions relating to scale and structure of production operations and types of management practices employed.

Organization of the Study. The use and importance of nitrogen fertilizers in U.S. agriculture is documented in the following chapter. It will be shown that the current structure of federal farm programs, specifically federal price and income support programs, constrain a grower's choice set. Past attitudinal-behavioral studies are also reviewed to better understand the relationship between attitude and behavior and the facilitating and neutralizing influence of situational variables.

The latter chapters include a discussion of the study's hypothesis, research methods and design, results of the statistical tests of the hypothesis and analysis of those results. In the final chapter, conclusions based on the empirical results of this study are made. The question posed in the introduction. "How effective can educational programs be in inducing the widespread adoption of nitrogen use-reducing BMPs?", will be re-examined in light of the results of this study. Based upon this analysis, recommendations for substantive changes in U.S. groundwater and agricultural policies are advanced. The intent of these recommendations is to aid policy-makers in devising an effective and equitable policy solution to the nation's nitrate problem.

CHAPTER 2

PROBLEM ANALYSIS

U.S. agricultural policy, especially in the economic arena, has had a profound effect on growers' crop management decisions. By setting prices and dictating land-use mandates to those wishing to participate in farm programs, federal policy has curtailed the number of choices available to the grower (General Accounting Office [GAO], 1990; Young and Painter, 1990; NRC, 1989; Buttel and Gertler, 1982). Price support and income support programs are among the most influential of federal farm programs in terms of affecting growers' management decisions. Between 85% and 95% of all eligible farmland was enrolled in farm programs in 1987 (GAO, 1990).

Price support programs provide nonrecourse loans to growers who pledge their commodity crops as collateral. In the event that the grower in unable to repay the loan, that grower's crops are forfeited to the government as repayment[2]. These programs allow the grower to sell when commodity prices are higher than the loan rate.

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[2]
If the target price for the commodity for which the loan is made falls below the market price at the end of the loan period, the government is required to accept that grower's crop as payment for the loan.

Income support programs pay deficiency payments to participating growers if commodity prices fall below the target prices set by law (GAO, 1990; NRC, 1989). Deficiency payments are based on a grower's acreage base and demonstrated program yield. The acreage base is the number of acres enrolled under a specific commodity program. The program yield is the average yield for the past five years excluding the highest and lowest yields (GAO, 1990). Approximately two-thirds of all U.S. cropland, and 95% of all land in corn, wheat, sorghum, cotton and rice are enrolled in commodity programs (NRC, 1989).

Disincentives Toward the Adoption of BMPs. "Best Management Practices" are mandated by the Clean Water Act of 1972, 1978 and 1987, to be included in states' water management plans. Funding of these plans by the federal government are contingent upon approval by the EPA (Environmental Protection Agency). BMPs are developed by agricultural specialists at the state level and are intended to deal specifically with non-point sources of pollution (Goldfarb, 1988). Adoption of BMPs is voluntary and is facilitated by the provision of technical assistance and cost-share programs for their implementation (Logan, 1990). BMPs intended to reduce grower use of nitrogen include:

- rotations,
- use of leguminous cover crops,;
- soil testing,
- plant analysis,
- proper nutrient credits,
- selecting realistic yield goals,
- timely fertilizer applications, and
- following university [soil testing lab] recommendations (Vitosh and Pruden, 1990).

The scarcity of cost-share and technical assistance programs has been cited as being one of the primary impediments to the widespread adoption of the practices listed above. Not all growers wishing to adopt these practices have access to technical and financial assistance (Logan, 1990). The lack of a reliable and inexpensive soil nitrogen test has been a disincentive toward greater grower use of soil tests and plant analysis in the determination of soil nitrogen content (Papendick, Eliot and Power, 1988; Cooperative Extension Service [CES], 1985).

Despite these technical drawbacks, probably the greatest impediment to the widespread adoption of nitrogen use-reducing BMPs are the rules and regulations determining eligibility for federal farm programs. Growers' desire to continue to participate in federal farm programs was identified as a barrier toward the adoption of low-input practices in a survey conducted by the Government Accounting Office (GAO). Other disincentives identified in that survey included growers' perceptions of increased management and labor needs associated with low-input practices (GAO, 1990).

The incentives built into federal commodity programs encourage growers to:

- grow only commodity program crops;
- grow the same crops year after year;
- maximize per acre yields of these crops; and
- plant program crops on land best left fallow.

These incentives are embodied in the eligibility rules governing participation in commodity programs and in the differential support given to targeted program commodities such as wheat and corn (GAO, 1990).

Only 16 commodities are supported by federal programs. Of these, corn, cotton, wheat and soybeans are the largest program supported crops (NRC, 1989). It has been noted that program crops (except for soybeans) receiving the largest financial support are particularly dependent on agrichemicals. Crops which are less agrichemical dependent, i.e., oats, receive comparatively less support or none at all (GAO, 1990). Legume cover crops, such as alfalfa and clover, are not program crops. Lack of price supports for these crops act as a disincentive for their incorporation into the farming operation. Although growers can plant some of their base acreage in non-program crops, at least 67.5% of their program acres must be kept in program crops in order to receive full payments. This proviso penalizes growers using crop rotations that span three years or more (Fleming, 1987).

Program Payments to Growers. Participation in commodity programs is a means of minimizing risks. The uncertainty surrounding crop prices on the national and world markets is effectively nullified for program crops via the provision of a guaranteed/target price (Pfeffer and Gilbert, 1990; Buttel and Gertler, 1982). For most of the 1980's, the government price for commodities, such as corn and wheat, has been substantially greater than the market price. In 1987-88, the target price for corn was 37% greater than the season-average price. For wheat, it was even greater at 41% (Table 2.1). This discrepancy between the target and market price encourages growers to make decisions in response to government prices in lieu of market prices.
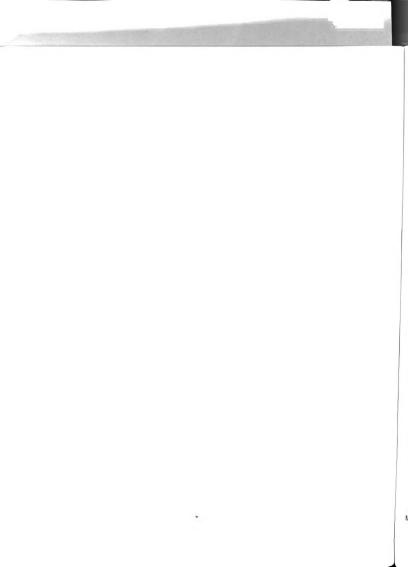
Table 2.1   Target price and season average-price for feed grain and wheat (Dollars per bushel)***

1987 Season	Corn	Wheat	Cotton*	Rice**
Target price	$3.03	$4.38	$0.79	$11.66
Season-average price	$1.63	$2.57	$0.64	$6.95
% Difference	37%	41%	19%	40%
Participation rate (% base acres)	88%	87%	92%	97%

*   cents per pound
**   dollars per cwt (crude weight)
***   Data adapted from Economic Indicators of the Farm Sector: Production Costs (1989).

The total dollars paid directly to growers via government programs has increased steadily throughout the 1980's reflecting the increasing reliance of commodity growers on government payments. Between 1985 and 1987, total federal payments increased from 7.7 billion dollars to 16.75 billion dollars. The commodity receiving the greatest percentage of government payments was feed grain (corn, oats, barley). By 1987, approximately 50% of all government payments were made to feed grain growers (Figure 2.1).

Figure 2.1   Total government payments made to program growers: 1985-1987. Information adapted from data in Economic Farm Indicators: Production Costs (1989).

Economic Farm Indicators (1989)
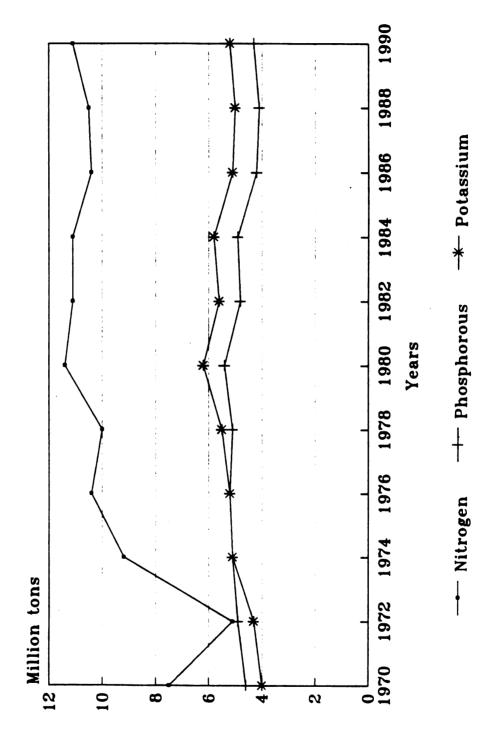
Use of Nitrogen Fertilizers. The structure of government agricultural policy - commodity policies, credit and research policies, special agricultural taxation policies and export policies - has influenced and determined the types of agronomic practices used today in U.S. agriculture. The preponderance of large, specialized operations, which are heavily dependent on external inputs, are largely the result of past and current U.S. agricultural policy (Buttel and Gertler, 1982). The two crops receiving most of the directly applied nitrogen annually, and whose growers are the primary beneficiaries of government payments, are corn and wheat.

Figure 2.2 is a graph of total nitrogen, potassium and phosphorous used in the U.S. between the years 1970 to 1990. During that period, total U.S. consumption of inorganic nitrogen nearly doubled from 7.1 million tons to 11.4 million tons (ERS, 1982; Tennessee Valley Authority [TVA], December 1990). There has been a slight decrease in total nitrogen use during the past decade. This was due, in part, to the idling of farm land in the Conservation Reserve (CRP) and Acreage Reserve (ARP) programs created by the 1985 Farm Act. Consumption of both potassium and phosphorous has remained relatively constant since 1970 (ERS, 1991 February; NRC, 1989).

Figure 2.2   Total nutrient use among U.S. growers: 1970-1990.

Million tons

Years

— Nitrogen   —+— Phosphorous   —*— Potassium

ERS, December 1982 and TVA, 1990

Table 2.2 contrasts the mean rate of nitrogen application per acre for corn, wheat, cotton and soybean during the past 20 years. The average rate of application per acre for corn doubled between 1964 and 1987, as did that for wheat. The application rates for both soybean and cotton remained relatively stable. The steep increase in the quantity of nitrogen applied to both corn and wheat can be attributed, in part, to the breeding of more nitrogen-responsive corn and wheat hybrids (NRC, 1989).

Table 2.2 Approximate application rates (lbs. nitrogen/acre) for corn, cotton, wheat and soybeans for 1964, 1970, 1976, 1982 and 1987 (NRC, 1989).

	1964	1970	1976	1982	1987
Corn	58	115	127	134	130
Cotton . . .	68	79	80	82	82
Wheat	28	38	49	58	61
Soybeans . .	13	13	13	15	17

The primary corn-producing regions recognized by the USDA are the Corn Belt states (Ohio, Indiana, Illinois, Iowa and Missouri), the Lake States (Michigan, Wisconsin and Minnesota) and the Northern Plains (North Dakota, South Dakota, Nebraska and Kansas). From 1977 to 1982, these 11 states accounted for more than 50% of the total nitrogen used in the United States (ERS, 1982).
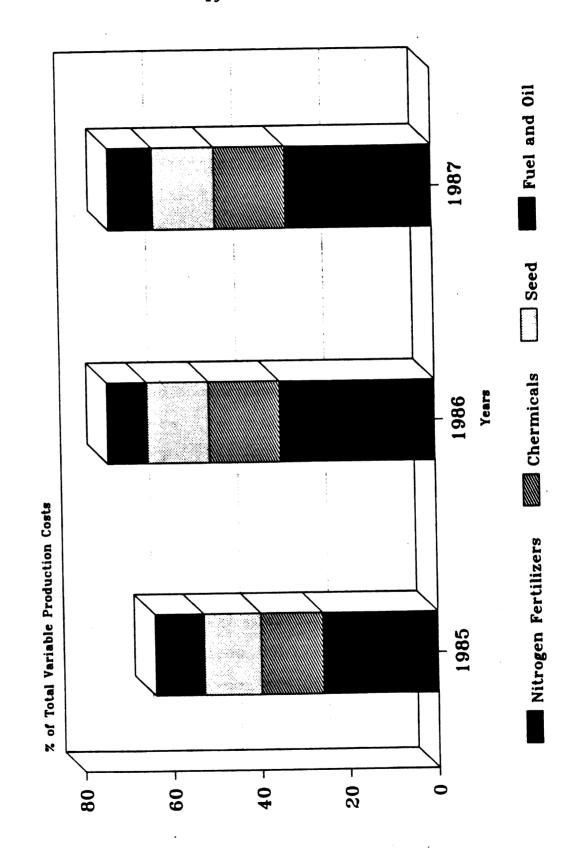
Growers' Fertilizer Expenditures. The increasing dependence of U.S. growers on inorganic nitrogen fertilizers is reflected in the amount of nitrogen used in the production system and the proportion of a grower's total production variable costs accounted for by fertilizer expenditures. It should be noted that increases in prices for nitrogen fertilizers during the 1980's accounted for a portion of the total increase in the fertilizer expenses documented in Figure 2.3 (ERS, 1991, February).

The Annual Farm Costs and Returns Survey (AFCRS) jointly conducted by the Economic Research Service (ERS) and the National Agricultural Statistics Service (NASS) revealed that growers spent more on fertilizers than they did on seed, pesticides, fuel or labor. In fact, from 1985 to 1987, the proportion of the total production variable costs accounted for by fertilizers increased from 25% to 33% (ERS, 1987)[3]. Figure 2.3 contrasts the proportion of an average corn grower's production variable costs used to purchase fertilizers to that accounted for by seed, chemicals and fuel and oil outlays. During the three year period covered by the graph, fertilizers accounted for up to 35% of total variable costs, with chemicals accounting for 16% of total variable costs in corn production (ERS, 1987).

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[3] Non-variable or fixed costs are expenditures on land, buildings and machinery. These are long-term costs which do not vary from year to year.

Figure 2.3   Percentage of total production variable costs accounted for by
fertilizers, chemicals, fuel and oil and seed. Adapted from data
contained in Economic Farm Indicators: Production Costs (1989)

The Policy Context. Failure of past U.S. agricultural

policies to effectively address issues of environmental

degradation can be attributed to the assumptions or criteria

used as a basis for developing them. These assumptions

limit the amount of flexibility for program implementation:

> The assumptions relate to (1) the economic rationality
> of man, (2) the homogeneous distribution of knowledge
> and information across a population of farmers, and (3)
> the individualism of the farmer in his decision-making
> and action (Korsching and Nowak, 1982, p. 1).

To elaborate further, agronomic systems are nested within

larger political and socioeconomic systems, which impose

constraints upon them. In order to remain financially

viable, growers make decisions within the parameters

established by these larger systems. Thus, a grower's

economic situation and dependency on federal farm programs

influence on-farm decisions to differing degrees (Figure

1.1).

In an effort to buffer grower income from the

instability of market prices and unpredictable weather, and

to maintain the supply of certain commodity crops, federal

farm policy instituted commodity programs, which offered

growers the choice of selling their products to the

government in lieu of the marketplace. Because market

prices for these commodity crops are generally below those

set by USDA, in recent years, growers have preferred to sell

their crops to the government. By breaking the linkage
between a grower's projected production expenses (supply)
and market price (demand), federal policy has created an
economically artificial situation within which growers
operate. Growers are rewarded for maximizing per acre
yields irrespective of demand for that product. Their
operations are tailored to be profitable based on the price
set by law as opposed to a market price for their products.
In a sense, by achieving one objective -- assuring growers
of a stable and adequate income -- federal policy has
sacrificed another of its objectives -- supply control.

The implications for groundwater policy is that
commodity programs make it profitable for growers to over-
apply agricultural chemicals. In the 1960's, the average
rate of application for corn was approximately 65 pounds of
nitrogen per acre. At this rate, practically all of the
nitrogen applied was removed with the harvest. At a rate of
140 pounds nitrogen per acre, the average during the 1980's,
approximately 50% of the nitrogen applied was removed with
the harvest (CAST, 1987). This figure includes the stover
and grain. If only the grain is harvested, the percentage
of applied nitrogen removed is approximately 35% or less
(Hallberg, 1987)[4].

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[4]
Of the nitrogen left in the field, a certain percentage is
locked in the soil as organic material, and some is lost via
volatilization. Depending upon the hydrogeology of the area,
the remaining nitrogen is lost to groundwater at differing

Past policy has encouraged the growth of specialized operations, which are largely dependent on chemical inputs to maintain soil fertility and yields. Because the structure of these operations are profitable within the context of federally supported prices, owners of these operations are compelled to continue to participate in federal commodity programs. To summarize, federal income support programs have altered the rules of the game for participating growers such that, in terms of the decisions made on-farm, these growers respond not so much to market prices (demand) for their products but to the prices set by the government.

It should be noted that growers do not make decisions based solely on expected short-term economic returns (Gasson, 1974). This chapter has merely outlined one set of factors, economic, which enter into a grower's decision-making calculus. Attitudinal variables, which are a reflection of the values ascribed by growers to the environment, community, and farming, are equally important, and have had an uncertain influence on growers' on-farm decisions.

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rates (Council for Agricultural Science and Technology [CAST], 1985). Studies measuring the quantity of nitrates lost to groundwater as a function of nitrogen application rate have shown a positive relationship between application rates and quantity of leachates (Hallberg, 1987).

Problem Statement. The House Committee on Agriculture

(1988) has suggested that the USDA conduct:

> Sociological research on chemical management by type of
> farmer-innovator vs. non-innovator, level of education,
> farm size, farm capital base, percent of land owned vs.
> leased etc...

Information from this type of research should be useful in

targeting education efforts towards "those who have the

greatest potential for chemical misuse" and in aiding USDA

to "develop appropriate responses in operating its programs:

cost-share, commodity support, etc..." (House Committee on

Agriculture, 1988). Although studies have been undertaken

documenting growers' attitudes toward groundwater quality

and the relationship between attitudinal and socioeconomic

variables, few have examined the interaction of

socioeconomic and attitudinal variables in terms of their

influence on a grower's chosen nitrogen management strategy

(Halstead et al., 1990; ALPI, 1989; Lasley and Bultena,

1988; Love, 1982; Pratt, 1964).

This thesis will investigate the interplay between a

grower's attitude toward the use of inorganic nitrogen and

his/her financial situation in determining the actual rate

at which nitrogen is applied. Formally stated, the

hypothesis to be tested in this thesis:

> **The primary determinant of the actual amount of nitrogen used is a grower's financial risk space. Only growers who are financially stable will have the luxury of acting consistently with a conservative attitude toward the use of nitrogen fertilizers.**

The role played by financial considerations in a grower's decision-making process has been established in the preceding discussion. However, in the conceptual model presented in the introduction (Figure 1.1), attitudinal variables are also proposed to have a significant influence on the rate at which growers apply nitrogen. The following chapter will explore the theoretical basis for the attitudinal-behavioral relationship and discuss its implications for this study.

CHAPTER 3

LITERATURE REVIEW

It has been documented in the previous chapter that:
(1) the problem of nitrate contamination of groundwater is a
growing problem in the United States, particularly in rural
communities; and (2) the incentives built into federal farm
programs, such as income and price support commodity
programs, reward participating growers for maximizing per
acre yields instead of maximizing net returns per acre.
According to economic theory, growers make decisions based
solely on the expected economic benefits to be derived from
each outcome (Gasson, 1974). The primary motivating force
is the maximization of individual utilities. However,
examination of only the economic parameters in decision-
making leads to an over-simplification of the process.
Values, beliefs and attitudes, which cannot be described by
economic theory, may exert great influence on the agronomic
choices a grower makes (Gasson, 1974).

Agricultural systems are embedded in the society within
which they are found. The choices made by individuals are
influenced, to differing degrees, by their perceptions of
what is appropriate behavior as dictated by societal norms
(Hodgson, 1988). Not all growers participate in federal

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farm programs, and among those who do participate in federal programs, fertilizer practices vary considerably. What motivates some growers to minimize their use of fertilizers? Results from previous grower surveys suggest that growers' concern for water quality and the negative health effects of their agricultural practices on themselves and their families is positively related with adoption of nitrogen use- reducing practices (Halstead et al., 1990; Lockeretz and Madden, 1988).

For the past sixty years, the issue of whether or not an individual's attitude determines subsequent behavior has been dealt with extensively in attitudinal-behavioral literature (Azjen and Fishbein, 1977; Liska, 1975). However, few of these studies have dealt expressly with growers' attitudes and behavior in terms of their agronomic practices. Despite the scarcity of studies explicitly investigating the attitudinal-behavioral relationship among growers, recent studies that focus on the effects of pro-environmental attitudes on behavior have relevance for this study (See, for example: Van Liere and Dunlap, 1978; Dunlap, Grieneeks and Rokeach, 1983, chp. 8). Nitrate contamination is a non-point source of pollution. Often times, the negative impacts of nitrate contamination are not experienced by the offending grower. This is attributable to the manner in which nitrates enter an aquifer and contaminate a groundwater flow system (Moody, 1990). The

motivation to reduce use of nitrogen is similar to motivations for recycling and conserving. In each case, the benefits accruing to the individual are minimal, and the action can be perceived as being motivated more by altruistic rather than self-serving reasons.

Definition of Attitude. Attitude can be described as the manner in which an individual evaluates an entity (Azjen and Fishbein, 1977). It is a normative concept in the sense that it cannot be empirically proved or disproved because it is ultimately based on an individual's values. Belief, on the other hand, has been defined as an assessment of what an individual thinks to be true (Dillman, 1978). Because, in theory, it can be determined to be true or not via empirical study, it is considered a positive concept.

There is dissension among researchers as to whether it is appropriate to consider the two concepts as different. McGuire (1975) argues that attitudes and beliefs are just two among several closely related constructs that fall in the category, "acquired behavioral dispositions". Attitudes and beliefs, along with opinions, values and cognitions, are so closely related that it would just be academic "hair-splitting" to consider them as distinctly separate constructs. Rokeach (1973) makes no distinction between the normative/positive difference between attitudes and beliefs

when he defines attitudes as:

> ...a relatively enduring organization of inter-related beliefs that describe, evaluate and advocate action with respect to an object or situation.

For the purposes of this study, no distinction will be made between a grower's attitude and/or belief toward the use of nitrogen fertilizers. In this thesis, both attitudes and beliefs will be defined as:

> ...a form of experience that (a) refers to specific objects, events, people or issues, and (b) is primarily **evaluative** (Eiser and van der Pligt, 1988, p.1).

The Theoretical Basis for Consistency Theory. Primarily motivated by the need to explain variation in individual behaviors, early definitions postulated a causal relationship between attitude and behavior (Liska, 1975). It was assumed logical to suppose that, for any given situation, individuals will behave in a manner consistent with their own personal attitudes. Traditional psychologists used the attitude concept to explain differences in individual behavior in the course of experiments, psychoanalysts used it to explain variations in individuals' emotional behavior, and sociologists used it to explain differences in individuals' reaction to the social structure (Liska, 1975). An early definition provided by

Allport (1935) illustrates the deterministic influence
attitude was believed to have on behavior. He defined
attitude as:

> ...a mental and neural state of readiness, organized
> throughout experience, exercising a directive or
> dynamic influence upon the individual's response to all
> objects and situations with which it is related
> (Allport, p. 810).

However, results from attitudinal-behavioral studies
conducted in the 1930's, 1940's and 1950's suggested that
this causal relationship was not valid. The study often
used as an example of the inconsistent attitude-behavior
relationship was one investigating the effect of prejudicial
attitude on behavior conducted by LaPierre (1934).

In LaPierre's study, it was shown that although hotel
managers (based on their willingness to provide
accommodations for a Chinese couple) did not exhibit
prejudicial behavior toward Chinese, their responses to a
questionnaire sent to them six months later suggested that
they were highly prejudicial toward Chinese. This and other
studies in problem areas, such as prejudice and cheating,
prompted a re-evaluation of the then existing consistency
theory (Azjen and Fishbein, 1977; Liska, 1975).

In the revised theory, the attitudinal-behavioral
relationship is posited to be a correlational as opposed to
a causal one. In most cases, attitude is not a good

predictor of behavior due to the presence and influence
exerted by contextual variables. These situational
variables, can act to impede or even neutralize the
attitude-behavior relationship (DeFleur and Westie, 1963).

Situational Variables. In order to observe a consistent
attitude-behavior relationship, two conditions need to be
met: (1) situational variables need to be such that there
exists an opportunity to display that behavior, and (2) the
individual must be competent enough to carry out the
behavior (Liska, 1975). The variables defining opportunity
and competence can be both facilitating and neutralizing.
In this society, different situations impose different
constraints, both social and economic in nature, on
behavior, i.e., normative conflict (Westie and DeFleur,
1963). It is the relative weights assigned by individuals
on: (1) acting consistently with their attitudes, and (2)
the incentives or disincentives as presented by situation-
specific variables for acting accordingly, which define the
relationship between personal attitudes and relevant
behavior in any given situation. To summarize:

> Behavior is the outcome of personal proclivities and
> situational stresses. The past behavior flowed from
> personal attitudes and the situational forces operating
> on that past occasion. Future behavior ...will derive
> from personal attitudes and the forces operating in
> each subsequent, unforeseeable situation. It may well

be that behavior on any given occasion is more
determined by <u>situational</u> rather than personal
attitudinal factors, but it is the attitudes which
provide the continuity from situation to situation
(McGuire, 1975, p. 18).

Stated another way:

Behavior is the interaction of two variables, the
person with goals and aspirations which direct his
behavior towards a desired end and his environment, as
he perceives it, of resources and material constraints
or means to attain a desired end.
(Gasson, 1974, p. 522).

Attitudinal and Behavioral Change. In cases where

behavioral change is voluntary, a necessary prerequisite is

recognition for a need to change. It is the acknowledgement

of a gap between "what is" and what the individual perceives

as "what should be". Needs can be defined as a situation in

which one's "desires" outweigh the "actualities" (Rodgers,

1983). It is important to note that the extent to which an

individual can act on fulfilling those needs are dependent

on the resources at hand and the strength of the stimulus

for change. Once more, the presence of facilitating or

neutralizing variables influence behavior to address those

needs.

Increasing the degree of perceived risks associated

with inaction such that it becomes greater than the

perceived risks of action can lead to both attitudinal and

behavioral change. Stated as an equation, risk can be conceived as:

$$Risk = Probability \times Severity$$

In this equation, probability is how much or how often, and severity is the risk assigned per unit of action or event. In the decision-making process, the perceived amount or severity of risk acts as an approximation of the risk itself. Re-stating the foregoing equation in terms of perceived risk:

> Our perception of the magnitude of risk from some event depends on some form of product of how often we think the event will occur and how serious we consider each occurrence to be in its effect (Wilson and Crouch, 1982, pp. 9-10).

In a study investigating the effects of fear on attitude and behavior (Leventhal, Singer and Jones, 1965) in regard to tetanus shots among college students, the researchers found that among the experimental group subjected to high fear-arousing information, there was a higher rate of subjects actually seeking to get a tetanus shot than in the control group, which was subjected to low fear-arousing information. In a study investigating the effects of fear-arousal among smokers, those smokers subjected to high fear-arousal communications expressed

greater intent to stop smoking than those subjected to low
fear-arousal communications (Leventhal, Watts and Pagano,
1967). In both studies, those subjected to high fear-
arousal communications and provided with a specific plan of
action were more likely to either get tetanus shots or to
agree to stop smoking.

Stimuli for change are not restricted to factors which
directly affect the individual. In a study conducted among
recyclers, researchers found that concern for the quality of
the environment was adequate stimulus for recycling (Dunlap,
Grieneeks and Rokeach, 1983). Unlike the studies on tetanus
shots and smoking, neither the benefits derived from
recycling nor the costs from not recycling accrue solely to
the acting individual. Another important finding in this
study was that individuals whose economic needs were met,
i.e., safety and security, were more likely to engage in
this behavior than those who were more economically
disadvantaged. Thus, the ability to engage in "altruistic"
behavior would appear to be an option available only for the
better off.

The interaction of situational variables and attitudes
and behavior can be summarized in Schwartz's norm-activation
model (1972). In his model, Schwartz postulates that
individuals will act consistently with their attitudes if
they are aware of the consequences of their actions, and if
they accept responsibility for them. Neutralizing factors

are those which lead individuals to re-define the decision-
making situation. These factors can be inherent in the
situation, i.e., time considerations, cost, etc..., or they
can stem from the individual in terms of denial of any
harmful consequences or denial of responsibility for those
consequences resulting from the action.

In both of the studies linking fear-arousal with
attitudinal and behavioral change, the catalyst for
behavioral change was a modification of the individual's
risk perception in terms of contracting tetanus or lung
cancer as a result of either inaction (not getting
inoculated) or continuing the action (smoking). In these
cases, fear for one's own personal safety compensated for
the extra time, effort and money needed to either get the
tetanus shots or stop smoking. Although attitudinal change
is not necessarily causally related with behavioral change,
it is directly related when the causes of both are directly
related, i.e., the probability of lung cancer linked to
smoking a pack of cigarettes a day (Azjen and Fishbein,
1977). As the two studies illustrate, in order to induce
behavioral change, realization that there exists a need for
behavioral change is required. In the study of recyclers,
economic security was a significant consideration.

In cases where the benefits of an action do not directly accrue to the individual, something more than need recognition is needed.

Selective Exposure. Two assumptions are made in the three studies reviewed: (1) All individuals have access to information that could potentially influence them to re-define their risk equations, with respect to a specific action, and (2) the information is given serious consideration. In the real world, however, individuals are not required to be attentive to all the information they receive. Generally, if the individual is not receptive to information that might affect the perceived risks associated with a certain action, then there would exist no conduit by which that information could impact risk perception and, consequently, behavior.

> Individuals generally tend to expose themselves to
> ideas that are in accordance with their interests,
> needs or existing attitudes. We consciously or
> unconsciously avoid messages that are in conflict with
> our predispositions. This tendency is called <u>selective
> exposure</u> (Rodgers, 1983, p. 166).

Past attitudinal-behavioral studies have shown that attitude and behavior, in the absence of neutralizing situational variables, are closely related (Ehrlich, 1969). However, in reality for any given situation, there exist

both neutralizing and facilitating situational variables.
It is the relative weights assigned to these variables by
the individual in the decision-making situation that
determines the strength of the correlation between attitude
and relevant behavior.

Because attitudes are normative constructs, they can be
defined as an individual's assessment or evaluation of a
situation or object (Azjen and Fishbein, 1978; McGuire,
1975). Attitudes are closely related to other constructs
categorized as "acquired behavioral dispositions." The
importance of such constructs in inducing behavioral change
lies in the concept of risk. Risk has been defined as an
individual's perception of the probability of an event
occurring as a result of some action (Wilson and Crouch,
1982). Risk perceptions are not static. New information
gathered by the individual can lead to a redefinition of the
risk equation. When the risks associated with continuing an
action outweigh the risks associated with discontinuing that
action, then a stimulus sufficient to induce behavioral
change is said to exist. Change can occur either in an
individual's awareness of the consequences of an action
and/or in the acceptance of responsibility for the negative
effects of that action (Schwartz, 1978). However, because
individuals are free to ignore information which might not
conform to their own personal attitudes or beliefs
(selective exposure), the mere existence of information with

the potential to motivate a redefinition of one's risk equation is not enough (Rodgers, 1983).

Implications for this Study. Two sets of variables have been introduced in this, and previous, chapters which enter into a grower's decision-making calculus. One set, economic concerns, focuses on a grower's need to maximize short-term economic benefits. The other set, attitudinal variables, link a grower's behavior with held values and beliefs. Economic variables can act either in concert with or in opposition to attitudinal variables in determining behavior. The degree to which each influences the amount of nitrogen fertilizers used by the grower will be the subject of the remaining chapters in this thesis.

CHAPTER 4

CONCEPTUAL FRAMEWORK AND RESEARCH DESIGN
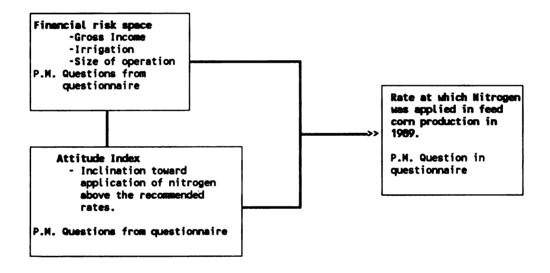
Conceptual Framework: Volatile input prices, an unstable market, and unreliable weather --- all contribute to making farming a risky business venture. In such an atmosphere of uncertainty, a rational individual would be reluctant to change established and proven practices. Federal programs, such as commodity income and price support programs, have offered some sense of financial security to growers by assuring them of a fixed price for their products. In exchange, growers who participate in these programs accept a more limited choice set in terms of the agronomic decisions they can make.

Not all growers participate in government programs nor do they all use the same management strategies. There exist a considerable number of persons who practice low-input agriculture or organic agriculture. It would appear that growers' decisions are not based solely on an economic calculus. The values a grower holds in terms of environmental quality and community can influence the final outcome. Generally, individuals will behave in accordance with their held values if the situation, as they perceive

it, permits them. It is the relative weights assigned to each of these sets of variables which will determine subsequent behavior.

This study is limited to the examination of the influence exerted by a grower's financial situation on the attitude- behavior relationship with respect to the application of nitrogen fertilizers (Figure 4.1).

Figure 4.1   Variables considered in the study.

Hypothesis. The classical paradigm for the diffusion of innovations states that early adopters of an agricultural innovation possess the following characteristics:

- own large farms,
- are more likely to have a commercial rather than a subsistence orientation,
- have a more favorable attitude toward credit,
- have specialized operations, and
- have a greater degree of social mobility than later adopters (Rodgers, 1988).

It is assumed, in this model of diffusion, that the innovation being promoted holds a clear economic advantage over the existing technologies. Thus, individuals adopting these technologies do so for economic reasons (instrumental rationality) (McIntosh, Thomas and Albrecht, 1990). However, studies in the diffusion of conservation technologies have noted that the Rodgerian paradigm of diffusion cannot be applied to all technologies. Rather, it is the **nature of the technology** which defines the characteristics of the early adopters (McIntosh et al., 1990; Carlson and Dillman, 1988; van Es, 1982). Some conservation technologies do not offer an economic advantage to the adopter. Their adoption is grounded in the value orientation of the adopter toward soil conservation rather than the adopter's desire to increase economic efficiency (non-instrumental rationality) (McIntosh et al., 1990). In cases where adoption is the result of non-instrumental rationality, the characteristics identifying early adopters can be expected to differ from those identifying early adopters of economically advantageous technologies.

The diffusion of conservation technologies is analogous to the diffusion of nitrogen use-reducing technologies. In both cases, there is a mix of technologies which can be adopted on the grounds of either instrumental or non-instrumental rationality. Nitrogen use-reducing BMPs, in the context of relatively inexpensive nitrogen fertilizers,

can be assumed to pose no clear-cut economic advantage to existing practices. In the case of cover crops and rotations, because of the eligibility rules governing farm program participation, their adoption can reduce a grower's income in the short-term. These innovations have a higher risk premium than previous agricultural innovations, such as hybrid corn and the all-purpose tractor. Thus, two characteristics that early adopters of these innovations need to have are: (1) a positive value orientation toward water quality and preservation, and (2) the financial flexibility to absorb financial loss.

In this thesis, it is proposed that a grower's financial risk space will determine the strength of the attitude-behavior relationship in terms of nitrogen fertilizer management. Contrary to the Rodgerian model, it is postulated that smaller growers will be more likely to adopt nitrogen use-reducing BMPs than larger growers. The rationale is that smaller growers enjoy a greater degree of financial flexibility than larger growers. Formally stated, the hypothesis to be tested is:

H1: **Among growers operating within a wide financial risk space, there exists an inverse association between a grower's attitude toward the use of nitrogen fertilizers and actual use of nitrogen in corn production.**

This tests the null hypothesis:

HO: **Among all growers, there is no association between a grower's attitude toward the use of nitrogen fertilizers and actual use of nitrogen in corn production.**

The hypotheses are represented by the equations:

$$HO: \quad dt \; \frac{attitude}{N \; rate} \leq 1 \quad and \quad H1: \; dt \; \frac{attitude}{N \; rate} > 1$$

In the analysis, an index score will be used as the attitude indicator; the greater the score, the less inclined that grower is toward over-applying nitrogen. <u>High scores are presumed to correspond to lower rates of application</u>. Financial risk space is accounted for by dividing the sample into two subsamples representing wide and narrow financial risk spaces.

The hypothesis poses two questions. One question is: Are the attitude and application rate variables interrelated? The second question is: How are these two variables related?. The following test of the hypothesis will be carried out in two steps reflecting these two questions. A chi-square test of independence will establish the interrelatedness between the attitude and application rate variables. The degree of interrelatedness between the variables will be measured using Somers' d, a measure of

association. This measure is suited for testing presumed causal relationships between ordinal level variables (Loether and McTavish, 1974).

Because the direction of the relationship is explicitly stated in the hypothesis, a one-tailed test was considered appropriate. The critical area is defined at a significance level of .05. By convention, an outcome occurring only 5 out of 100 times by chance is considered sufficiently rare to satisfy confidence in the relationship in sociological research. Because of the "relatively unsophisticated measurement levels of sociological data", this level of significance is commonly used in sociological research (Loether and McTavish, 1974: 144).

Research Methods. A cross-sectional design is employed in this study. Few attitudinal-behavioral studies have addressed the question of nitrogen use among U.S. growers. Due to the scarcity of empirical data, the research undertaken in this thesis is primarily exploratory, even though the hypothesis itself poses a question which is explanatory in nature. Explanatory research attempts to study causal processes that occur over time. Use of a cross-sectional study design for this type of research, although common, has an inherent weakness in that it is capable of documenting the process only during a single

period of time. Thus, inferences (internal validity) are limited by the use of this design. However, because this research is primarily exploratory, this design is reasonable (Babbie, 1989).

Choice of this design was dictated by both financial and time considerations. The survey was sponsored by a private seed corn company desiring an inventory of agronomic practices employed by both commercial and seed corn growers in St. Joseph County, Michigan. A time frame and budget was set by the company for the development and conduct of the survey and preparation of the summary report.

At the time of the survey, no definitive list of corn growers in the County existed. A list of growers with corn and sorghum acreage enrolled with the St. Joseph County Soil Conservation Service was used to identify potential survey respondents. Because the survey was concerned only with corn growers, questions in the first section of the questionnaire were used to filter out those who did not grow either commercial or seed corn in St. Joseph County during the 1989 season.

A nonprobability sampling approach (total enumeration) was used to draw the sample for the survey. This was done because of the lack of a definitive list of corn growers for the County. In order to ensure maximum coverage of County corn growers, it was decided that all of the growers on the list were to be sent a questionnaire. A weakness of the

list was that growers, who did not have enrolled acreage
with the County SCS office (such as Amish growers in the
County), were precluded from the potential pool of
respondents. The resultant sample is believed to be biased
toward high appliers of nitrogen because growers not
participating in the institutional system directly affected
by federal farm policies were excluded from sample
population.

Use of nonprobability sampling limits the
generalizability of the study results to other areas
(external validity). However, because of the prohibitive
costs and time demands attendant with developing a
comprehensive list of corn growers for St. Joseph County, it
was an acceptable choice of sampling method (Babbie, 1989).

A self-administered mailed questionnaire was used to
collect the data for this study. This method was chosen
over face-to-face and telephone interviews for several
reasons. First of all, the costs of training interviewers
and conducting the interviews would have exceeded the budget
for the survey. Secondly, the amount of time needed to
contact all of the potential respondents (N=897) would have
been greater than the time allotted for the conduct of the
survey. Finally, the questionnaire itself was lengthy and
contained potentially sensitive questions. In these cases,
a self-administered mailed questionnaire is superior to
either face-to-face or personal interviews (Dillman, 1978).

Questionnaires were mailed to all 897 addresses present on the SCS list.
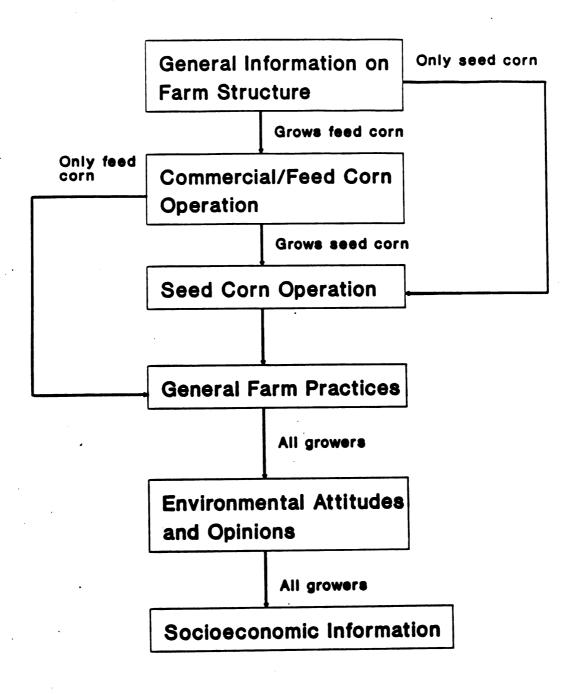
Development of the Questionnaire. In developing the questionnaire, interviews were conducted with specialists in Michigan corn production, agricultural economics, extension and water quality in the departments of Crops and Soil Science, Agricultural Economics and Resource Development at Michigan State University. Interviews with personnel from the Cooperative Extension Service in St. Joseph County and a seed corn company which contracts growers in the County were also conducted. The questionnaire was a collaborative effort between the Department of Resource Development at Michigan State University, the Cooperative Extension Service of St. Joseph County, and the private seed corn company sponsoring the survey.

The final questionnaire is divided into six sections: General Information, Commercial/Feed Corn Production, Seed Corn Production, General Farm Practices, Environmental Attitudes and Opinions and Background Information. In the commercial/feed corn, seed corn and general farm practices sections, respondents were asked about the type of irrigation equipment and farming practices, including nitrogen fertilizer management, used in the production of commercial/feed corn, seed corn, and other crops in 1989.

Respondents were instructed to skip a section if that section was not relevant to their farming operation (Figure 4.2).

Figure 4.2   Organization of the Questionnaire

```
                    ┌──────────────────────────┐  Only seed corn
                    │ General Information on    │
                    │ Farm Structure           │
                    └──────────────────────────┘
                              │ Grows feed corn
       Only feed   ┌──────────────────────────┐
       corn        │ Commercial/Feed Corn     │
                   │ Operation                │
                   └──────────────────────────┘
                              │ Grows seed corn
                   ┌──────────────────────────┐
                   │ Seed Corn Operation      │
                   └──────────────────────────┘
                              │
                   ┌──────────────────────────┐
                   │ General Farm Practices   │
                   └──────────────────────────┘
                              │ All growers
                   ┌──────────────────────────┐
                   │ Environmental Attitudes  │
                   │ and Opinions             │
                   └──────────────────────────┘
                              │ All growers
                   ┌──────────────────────────┐
                   │ Socioeconomic Information │
                   └──────────────────────────┘
```

The questionnaire itself is a booklet measuring 5 3/8"
by 8 1/2". Following the recipe provided by Dillman (1978)
in his definition of the appropriate design of a
questionnaire, efforts were made to make the questionnaire
attractive. A soft blue cover was used. On the front, the
survey logo (a cornstalk) was included along with the name
of the survey unit, the Corn Growers Survey Team,
responsible for its contents and conduct. It was 16 pages
in length, not including the front and back covers.
Instructions were located on the inside of the front cover,
and space was provided on page 16 and on the inside of the
back cover for respondents' comments. A replica of the
questionnaire is contained in Appendix A.

The questionnaire was pre-tested among a group of ten
growers, and subsequently, further modifications were made
in the questionnaire before the actual mailing in March,
1990. A major change arising from the pre-test was the
exclusion of sensitive questions concerning growers opinions
towards agriculture's role in the nitrate problems currently
affecting certain areas of the County. Growers in the pre-
test group felt that leaving the questions in the
questionnaire would negatively impact the response rate. A
copy of the questions excluded are contained located in
Appendix A.

Conduct of the Survey. The methods used in the conduct of the survey are outlined by Dillman (1978) in his <u>Total Design Method</u> framework. This framework was chosen because of its well-established use among social science researchers. Continuity and personalization in all correspondence sent to growers was achieved via the inclusion of a logo (a cornstalk) on all the correspondence (including the questionnaire) sent to the potential respondents and identification of the survey unit responsible for the survey as the Corn Growers Survey Team. All correspondence was acknowledged as coming from this unit.

An advance letter was sent to all the prospective respondents (Appendix B). Respondents were warned that the they would be receiving a questionnaire sponsored by the Department of Resource Development at Michigan State University two weeks after receiving the letter. In order to encourage response to the survey, potential respondents were informed that: (1) the survey was a collaborative effort between MSU and the St. Joseph Cooperative Extension Service, (2) results would be used to design future programs and research for the benefit of St. Joseph County corn growers, and (3) all individual responses were strictly confidential. It was stated in the advance letter that the survey results would be made available to the respondents.

The questionnaire packet consisted of the
questionnaire, a stamped and pre-addressed return envelope,
a cover letter and instructions. In the cover letter,
sponsorship for the survey was acknowledged as coming from a
private seed corn company. Returned questionnaires were
tracked using a customized D-base III program. Two weeks
after the initial mailing, a reminder postcard was sent to
all of the growers in the sample encouraging them to fill-
out the questionnaire and return it. Growers were also
encouraged to return the questionnaire blank if they did not
wish to complete it. Two weeks after the reminder postcards
were mailed out, a second mailing of the questionnaire was
undertaken. Growers who at that point, a month after the
initial mailing, had not yet returned the questionnaire were
sent a second questionnaire packet. Two months after the
initial mailing of the questionnaire, the collection of
questionnaires was considered closed.

Response Rate. Of the potential pool of 897 respondents,
322 returned completed questionnaires, and 62 returned the
questionnaire blank. Of the 897 names which were on the
list, 103 were disqualified because the grower either no
longer lived at the address or was no longer growing corn.
Disqualification was based on returned advance letters or
notes from growers indicating that they no longer grew corn.

These growers were removed from the potential pool of respondents yielding a response rate of 41% (Table 4.1).

Table 4.1 Summary of survey responses

Growers whose names were on the list 897
Disqualified questionnaires 103
Growers who returned the questionnaire blank 62
Growers who returned a completed questionnaire . . . <u>322</u>

Response Rate   41%

Generally, a level of at least 50% is considered the minimum standard for an acceptable response rate. However, there is no statistical basis for this standard. For the purposes of external validity, a lack of non-response bias is considered more important than a high response rate. Non-response bias is introduced into the survey data when the composition of the respondents returning the questionnaire does not adequately reflect the variability existing in the survey population. This is particularly troublesome for mailed questionnaires because of the prominent role played by self-selection in the process (Babbie, 1988; Dillman, 1978). Because a non-probability sampling method was used in this study, a demonstrated lack of non-response bias would be a sounder basis upon which to gauge the reliability of the data than the response rate.

In terms of coverage, the survey represents over two-thirds of the cropland and commercial (feed) corn acreage in the County (Table 4.2).

Table 4.2 Comparison of acreage represented by the survey and total acreage recorded in the 1987 census*.

	Acres represented by the survey **	1987 Census acreage totals	Percentage of total
Total Cropland	116,089	179,703	65%
Total acreage in feed corn	42,227	67,500	63%

*Census was conducted by the Michigan Department of Agriculture in 1987
**Survey figures are for 1989

When broken down into farm size classes, the distribution of respondents according to the scale of their operations closely parallels the distribution figures contained in the 1987 census (Table 4.3.). There is a slight over-representation of larger growers, i.e., operations greater than 500 acres, in the sample population. However, the differences between the proportion of growers in the different size classes in the sample and in the actual population does not exceed 5%.

Table 4.3 Comparison of sizes (acres) of farming operations
         between survey respondents and the general
         population as measured in the 1987 census.

	Survey results	1987 census	Difference
Percent of farms in:			
1 to 99 acres	38%	42%	5%
99 to 179 acres	16%	21%	5%
180 to 259 acres	10%	10%	0%
260 to 499 acres	13%	14%	1%
500 to 999 acres	13%	10%	-3%
1,000 to 1,999 acres . .	8%	3%	-5%
2,000 or more acres . .	2%	.7%	-1.3%

In terms of the total acreage represented by the survey and
the representativeness of the sample with respect to scale
of operation, the response to the survey was better than the
actual response rate would suggest.

Measurement of the Variables. Data used to measure the
variables considered in the hypothesis were obtained either
from the survey or derived ex-post. In cases where the data
needed were not available in the survey results (par ex.,
recommended rates and yield goals) interviews were conducted
with specialists in the St. Joseph County Cooperative
Extension Service and in the Department of Crops and Soils
Science at Michigan State University in order to derive an
estimate of these figures.

The following sections outline the methods used to construct an index intended to measure a grower's attitude toward the use of nitrogen fertilizers, to divide the sample into subsamples reflective of wide and narrow financial risk spaces, and to develop recommended application rates for irrigated and dryland corn production.

Attitude Index. An index is a cumulative score derived from several questions used to measure a complex phenomena (Babbie, 1990). A five-item index was developed to measure a grower's inclination to apply more than the recommended rate of nitrogen. The soundness of the Attitude Toward the Use of Nitrogen (ATUN) index was gauged using two criteria: face validity and internal validity.

Face validity is "that quality of an indicator that makes it seem a reasonable measure of some variable" (Babbie, 1989, p. G3). Each of the questions comprising the attitude index asks respondents to agree or disagree with statements concerning the use (i.e., an action) of nitrogen fertilizers (Table 4.1). In past studies, it has been noted that:

> High attitude behavior correlations cannot be expected in the absence of correspondence between attitudinal and behavioral entities... the most appropriate predictor of a single act criterion is the attitude toward the action rather than the attitude toward the target (Azjen and Fishbein, 1977, p. 891).

Table 4.4 Questions used to construct the Attitude Towards Nitrogen Use (ATUN) index and response frequencies.

Points earned——>	Strongly disagree (1)	Disagree (2)	Neutral (3)	Agree (4)	Strongly agree (5)
(n=266) 1. In general, applying extra fertilizer is [not] good insurance*	2%	10%	21%	48%	19%
(n=267) 2. Minimizing use of fertilizer increases farm profits	9%	41%	20%	26%	3%
(n=268) 3. Usually, fertilizer application recommendations call for more than is really needed	6%	41%	28%	22%	3%
(n=265) 4. The cost of a little extra fertilizer is a [large] price to pay for the security it gives*	3%	18%	25%	47%	7%
(n=269) 5. It is too expensive to use all the fertilizer that is usually recommended	6%	42%	20%	26%	7%

*These items were reverse scored

A single act criterion is defined as the combination of both target and action elements observed in a single behavior. In this study, nitrogen fertilizers constitute the target element, and the rate at which it is applied constitutes the action element. Both are the focus of the attitudinal questions used to construct the index (Table 4.4).

Internal validation or item analysis is the process by which the ability of the composite index to predict the responses of the items included in the index is evaluated (Babbie, 1990). A reliability test using SPSS-X (the mainframe version of Statistical Package for the Social Sciences) was run on the items comprising the index in order to assure an adequate level of internal validity. Items one and four were reverse scored so that they would be consistent with the other three index items. A five part Likert-scale was used to rank responses. For each question, the range was from 1 (strongly disagree) to 5 (strongly agree). For the purposes of simplifying the subsequent analysis, the five response categories were collapsed into three (Table 4.5).

Table 4.5 Scoring categories for the ATUN index.

Categories	Scoring as presented in the questionnaire	Corresponding categories in the questionnaire
0	1 to 2	Strongly disagree or disagree
1	3	Neutral
2	4 to 5	Agree or strongly agree

The range of index scores was 0 to 10. The reliability coefficient calculated for the five items was **0.528** (Table 4.6).

Table 4.6 Internal validity check of the ATUN index

```
                 SCALE        SCALE     CORRECTED
                 MEAN       VARIANCE      ITEM-        ALPHA
                IF ITEM      IF ITEM      TOTAL       IF ITEM
                DELETED      DELETED   CORRELATION    DELETED

Q2101           3.7692       4.3635       .3156        .4644
Q2102           4.5192       3.8568       .3413        .4420
Q2103           4.5154       3.9882       .3432        .4422
Q2104           3.9577       4.2492       .2781        .4829
Q2105           4.4692       4.2500       .2097        .5291

RELIABILITY COEFFICIENTS
N OF CASES =    260.0                  N OF ITEMS =  5
ALPHA =    0.5288
```

Although it would appear that a reliability coefficient
of 0.5288 is low, it should be noted that the questions
contained in the index measure two different dimensions or
motivations (i.e., target and action variables) which can
shape a grower's attitude towards the use of nitrogen
fertilizers. The relationships between the items used in
the index are illustrated in the correlation matrix below
(Table 4.7)

Table 4.7 Correlation matrix for items in the Attitude
          Towards Nitrogen Use (ATUN) index.

	Item 1	Item 2	Item 3	Item 4	Item 5
Item 1	1.0000*	.2492*	.0784	.5744*	-.1106*
Item 2		1.0000*	.2261*	.2009*	.1798*
Item 3			1.0000*	.0177	.4628*
Item 4				1.0000*	-.0278
Item 5					1.0000*

* Level of Significance < .05

The two dimensions measured by the index are use of nitrogen
fertilizers as security or yield insurance (items 1 and 4),
and reduced use of fertilizers as a means of increasing
economic profits (items 2, 3 and 5). There is a significant
correlation between items 1 and 4, and between items 2, 3
and 5. Given that the index measures two dimensions of the

attitude construct, a reliability coefficient of .5288 is
not unreasonable[5].

Financial Risk Space: The sample was divided into four
subsamples based on reported total farm sales for 1989 and
irrigation of corn crop (Figure 4.3). This division was
undertaken for the purpose of developing economically
homogenous groups representing growers with wide versus
narrow financial risk spaces. A wide financial risk space
reflects the economic flexibility a grower has with which to
experiment with nitrogen use reducing practices which could
also reduce yield and/or income. Indicators considered in
this study are _gross farm sales_ and _level of investment_ as
represented in the use and/or possession of irrigation
equipment.

   Two of the four subsamples, large growers/irrigated and
small growers/dryland, were chosen for the subsequent
analysis to test the hypothesis because: (1) they represent
the extremes in terms of economic circumstances among the
four subsamples derived, and (2) the sample sizes for the
other two groups are too small for the statistical tests
which will be used.

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[5]
Harry Schwarzweller, personal communication, April 27, 1991.
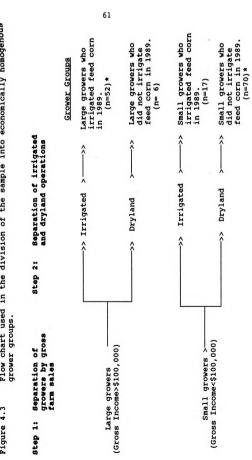
The intent in dividing the sample into subsamples was
to derive groups that are relatively homogenous economically
in order to control for as many economic variables as
possible. The effectiveness of the two indicators chosen to
divide the groups is justified by the significant
differences in the average total acreage and average total
commercial corn acreage between the two subsamples chosen
for subsequent analysis (Table 4.8). A one-tailed ANOVA
test was used to determine level of significance.

Table 4.8 Summary table of average total acreage and average
total commercial corn acreage for the subsamples
used to test the hypothesis.

	Large growers/ irrigators	Small growers/ dryland
	(n=52)	(n=70)
Total tillable acres	1118	254*
Total commercial corn acres .	481	65*

*Significance level < .05

Figure 4.3   Flow chart used in the division of the sample into economically homogenous grower groups.

Step 1: Separation of growers by gross farm sales

Step 2: Separation of irrigated and dryland operations

Grower Groups

Large growers
(Gross Income>$100,000)

>> Irrigated >————>>   Large growers who irrigated feed corn in 1989.
(n=52) *

>> Dryland   >————>>   Large growers who did not irrigate feed corn in 1989.
(n= 6)

Small growers >
(Gross Income<$100,000)

>> Irrigated >————>>   Small growers who irrigated feed corn in 1989.
(n=17)

>> Dryland   >————>>   Small growers who did not irrigate feed corn in 1989.
(n=70) *

* Subsamples used in testing the hypothesis

Correlations between profitability and farm size has
been noted in a 1988 survey conducted among Michigan cash
crop growers (Hepp, 1989). It was found that major
differences between high profit and low profit operations
were the number of tillable acres, yields and financial
returns per acre. Low profit farms had fewer tillable acres
and less investment (Hepp, 1989). In another survey
conducted by the Michigan Agricultural Experimental Station
(AES), it was shown that although small growers had less
profitable operations, i.e., lower returns per acre, a
greater proportion of them were debt-free after sale of
their crop. This is due, in part, to the fact that a
greater proportion of the family income was derived from
off-farm sources. Furthermore, small growers had invested
less in terms of capital improvements and machinery than
larger growers (AES, 1990). Based on the results of these
two surveys, it can be inferred that small growers (gross
farm sales less than $100,000) who do not irrigate have a
wider financial risk space than large growers (gross farm
sales equal to or greater than $100,000) who do irrigate.
Larger growers enjoy greater financial returns per acre than
smaller growers, but a greater proportion of their family
income is derived from their agricultural activities. This
restricts their flexibility in terms of experimenting with
potentially income-reducing management practices and/or
technologies.

Application Rate: In order to test the study's hypothesis, it was necessary to categorize the nitrogen application rates reported by the survey respondents into low applier, recommended rate applier, and high applier groups. The recommended nitrogen fertilizer application rates were derived using the following equation (CES E-550, 1985):

$$XN = [-27 + (1.36 * YG)] - [40 + (60 * PS)] - (4 * TM)$$

where:

XN = recommended rate
YG = Yield goal specified by grower
PS = Percent stand of alfalfa from previous season
TM = Tons of manure applied

In deriving the recommended application rates, two assumptions were made: (1) livestock manure was not used by the respondents (TM=0); and (2) an alfalfa crop did not precede the 1989 corn crop (PS=0). The first assumption, TM=0, is validated by the fact that only one respondent in the large growers/irrigated group and only two respondents in the small growers/dryland group indicated that they had applied livestock manure to their commercial corn in 1989. Given that only one respondent admitted to having an alfalfa field in 1989, the second assumption, PS=0, is also justified.

Respondents' yield goals for the 1989 season were not solicited in the questionnaire. Yield goal is the projected yield in terms of number of bushels per acre calculated by

the grower at the beginning of the season. A range of yield goals was approximated for irrigated and dryland corn based on information provided by the St. Joseph County Cooperative Extension Service[6] and twenty year irrigated and dryland corn yields generated with the CERES-MAIZE simulation model (Vieux, Ervin, Schwab and Needham, 1988). The yield goals and corresponding recommended rates for irrigated and dryland corn are presented in Table 4.9.

Table 4.9 Yield and applier categories for irrigated and dryland corn

	Yield Goal*	Recommended Rate**
Irrigated corn . .	150 to 190	180 to 230
Dryland corn . . .	70 to 120	70 to 140

* Bushels per acre
** Pounds Actual Nitrogen per acre rounded off to the nearest ten

A missing factor in the above calculations is soil type. It is acknowledged that soil type is a consideration when gauging the appropriate amount of nitrogen to be applied. In the survey area, four types of soils: sandy, sandy-loam, loamy-sand and loam, are present. However, soil type was not considered in the derivation of the recommended rate categories for two reasons. First, a field can be

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Rod King, personal communication February 10, 1991.

composed of several soil types. It is unlikely that a
grower will modify application rate for each different soil
type present in a field. Generally, the actual application
rate is modified according to the topography and soil
composition of the field. To accurately calculate the
appropriate recommended rate for each of the respondents'
fields, would have required time and expense beyond the
scope of this thesis. Second, examination of actual soil
test results for St. Joseph County growers (dated June 1989)
from the MSU soil testing lab revealed that recommended
rates were influenced to a greater degree by the use of
alfalfa as a previous crop and yield goal than by soil
type[7].

Conclusion. It is proposed in this study that an inverse
relationship between a grower's inclination to apply
nitrogen fertilizers at recommended rates and his/her actual
use of nitrogen fertilizers will be observed only if the
grower's financial risk space is wide. The independent
variables (attitude score and financial risk space) and the

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[7]

At the time of the survey, no reliable soil test for nitrogen
had been developed for wide-scale use in the Great Lakes area.
Due to the volatility of nitrogen in the soil and the
contribution made by organic nitrogen via mineralization
(positively related to soil temperature), nitrogen content in
the soil was not tested for unless specifically demanded by
the grower (CES Bulletin E-550).

dependent variable (actual pounds of nitrogen applied per acre) have been defined. In the following chapter, the hypothesis will be tested using Pearson's chi-square test of independence and Somers' d measure of association. Also included will be the results of these statistical tests.

CHAPTER 5

RESULTS AND ANALYSIS

It has been advanced that growers' opportunities are defined by public policies. Traditionally, federal farm policy has dictated the parameters of grower behavior via price and income support programs. Groundwater policy proposes to work within the economic parameters defined by federal farm policy to change growers' nitrogen management practices. The objective is to bring about reform in nitrogen practices by changing grower's attitudes towards the use of nitrogen. The assumption underlying this strategy is that grower's have enough latitude within their opportunity sets to act in accordance with their attitudes and beliefs.

In the following analysis, the interrelationship between three variables: financial risk space, attitude towards the use of nitrogen, and application rate will be investigated. Controlling for financial risk space, 3 x 3 bivariate contingency tables were constructed for the two subsamples identified as representing growers with a wide financial risk space (small growers/dryland) and growers with a narrow financial risk space (large growers/irrigated). The independent variable is identified as a grower's score on the Attitude Towards the Use of Nitrogen (ATUN) index. The

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dependent variable is the reported rate at which nitrogen fertilizers were applied by the respondents in their commercial corn operation in 1989.

Socioeconomic Differences between the Subsamples. In most sociological studies employing survey methods, it is impossible to account for all the variables other than the designated independent variables which can act upon the dependent variable. Ideally, all variables other than those under study are controlled in order not to confound the results. In studies employing survey methods to obtain the data, the confounding effects of these variables must be identified before the hypothesis can be tested (Selvin, 1970).

In this study, two subsamples were derived on the basis of irrigation practices and gross farm sales. Admittedly, the two groups differed in other respects. Table 5.1 contrasts the differences between the groups in terms of selected socioeconomic variables which have been identified as directly affecting a grower's attitude toward the use of nitrogen fertilizers and indirectly affecting nitrogen management practices (Figure 1.1). A one-tailed means test was employed to determine if there were significant differences between the groups.

Table 5.1 Summary table of selected socioeconomic variables.

	Large growers/ irrigators (n=52)	Small growers/ dryland (n=75)
Age	46 years	51 years
Years Farming	26 years	28 years
Education:		
Completed High School	50%	53%
Post-H.S. education .	50%	47%
Organization of Farm:		
Family farm	75%	87%
Other*	25%	13%

* Partnership, Family-held corporation, Non-family
  corporation

In terms of age, farming experience, level of education and farm organization, there were no significant differences between the two grower groups. These results lend support to the assumption made in this study that intra-group differences are minimal with respect to these key socioeconomic variables.

Attitude Scores. The original scoring for each of the five items in the **ATUN index** ranged from 1 (strongly disagree) to 5 (strongly agree). The scores for items 1 and 4 were reverse scored in order to assure a consistent direction in scoring between all of the items. The five scoring categories were further collapsed into three categories representing growers

who disagreed (0 points), were neutral (1 point) and agreed (2 points) with the statements in the index. The total ATUN score per respondent ranged from 0 to 10. The average scores for each group are presented in Table 5.2.

Table 5.2 Average scores per item contained in the ATUN index.

	Large growers/ irrigator (n=52)	Small growers/ dryland (n=70)
Item 1	. . . . . . .1.725	1.449
Item 2	824	.676
Item 3	577	.899
Item 4	. . . . . . .1.510	1.309
Item 5	353	.913
Total	.4.904	5.217

On the average, growers in both the large growers/irrigated and small growers/dryland, were moderately inclined to use nitrogen fertilizers conservatively. A one-tailed means test was performed to determine if there was a significant difference between the average ATUN scores between the two grower groups. It was important to see if ATUN scores were affected by the financial variables used to derive the subsamples. An f-value of .4351 was calculated which correlates with an alpha (level of significance) of .5107. The result of this test indicates that the two variables used to define financial risk space did not significantly affect the mean scores on the ATUN index.

In order to facilitate the next step of the analysis, the ATUN scores were grouped into three categories: **inclined** to apply more than recommended rates, **neutral** and **disinclined** to apply more than recommended rates. All growers with scores less than 4 were placed in the inclined group, growers with scores falling in the 5 to 6 range were considered neutral, and growers with scores greater than 7 were placed in the disinclined group. The percentage of growers falling into each of the attitude categories are presented in Table 5.3.

Table 5.3 The three ATUN categories and the percentage of growers from each subsample in each category.

Applier Categories:	Large growers/ irrigator (n=52)	Small growers/ dryland (n=70)
(1) Inclined	46%	42%
(2) Neutral	29%	30%
(3) Disinclined . . .	25%	28%
Total	100%	100%

Application Rates. The average rate at which nitrogen was applied to commercial corn in 1989 by the large grower/irrigator group was **175.5 lbs. Nitrogen per acre.** For the small grower/dryland group, the average rate was **117.6 lbs. Nitrogen per acre.** A one-tailed ANOVA test was used to determine if there was a significant difference in means between the two subsamples. A f-value of **21.3309** was obtained; this corresponds to an alpha of **.0000** suggesting that there is a significant difference in the average rate at which nitrogen was applied between the two groups.

Based upon their reported application rate of nitrogen, growers in each group were placed into one of three categories corresponding with;

- Applying nitrogen at a rate below the recommended rate;

- Applying nitrogen at the recommended rate; and

- Applying nitrogen at a rate above the recommended rate.

The percentage of growers from each group falling into the different categories are presented in Table 5.4.

Table 5.4 Application rate categories and the percentage of growers from each subsample contained in each category.

	Large growers/ irrigator (n=52)	Small growers/ dryland (n=70)
Applying at:		
(1) Below recommended rates	61%	13%
(2) Recommended rate*	29%	66%
(3) Above recommended rates	10%	21%
Total	100%	100%

* Recommended rates for:

        dryland   =   70 lbs. N/acre to 140 lbs. N/acre
        irrigated = 180 lbs. N/acre to 230 lbs. N/acre

Nitrogen contributed by livestock manure applications was not included in the application rates derived for this analysis. Only three growers in both groups (i.e., irrigators and dryland) responded that they applied livestock manure as fertilizer during the 1989 corn season.

The findings contained in Table 5.4 are consistent with the Rodgerian paradigm of the diffusion of innovations. In his paradigm, Rodgers states that early adopters can be characterized as having large and specialized farms (Rodgers, 1988). Over half of the large growers/irrigated, compared to less than a fifth of the smaller growers/dryland, applied nitrogen at below recommended rates. This result can be interpreted to imply that larger growers/irrigated have have been more prone to adopt

nitrogen use-reducing practices and technologies than smaller growers/dryland. It would appear that in terms of nitrogen-use reducing technologies, as a group, the Rodgerian model is applicable.

A weakness in this study has been the need to infer growers' yield goals ex-post facto. Admittedly, yield goals vary according to soil type, management and a particular fields proven yield capacity. In Table 5.4, the category containing the greatest number of growers for the large growers/irrigated group is the "below recommended rates" category. Assuming a normal distribution of yield goals among these growers, one would expect a distribution similar to the one for small growers/dryland group. The outcome for the large growers/irrigated group raises the question: Do large growers/irrigated as a group apply nitrogen at below recommended rates or is this just an artifact of the methods used to define the application rate categories? Because data pertaining to previous nitrogen use by these growers are not available, this question cannot be answered. However, this result does suggest that caution should be taken in the interpretation of the results of the subsequent analyses.

Cover crops and rotations are promoted as BMPs in Michigan. The percentage of growers from each grower group utilizing cover crops and rotations in their farming operations are summarized in Table 5.5.

Table 5.5 Percentage of large growers/irrigated and small growers/dryland reporting to have used cover crops and rotations in their operations in 1989.

	Large growers/ irrigator (n=52)	Small growers/ dryland (n=70)
Used cover crops . . .	35%	28%
Used rotations	50%	60%

There is no significant difference in the percentage of growers employing either cover crops or rotations between the two groups. This finding brings into question the validity of the assumption that smaller growers would be more likely to adopt technologies, such as cover crops and rotations, which are not perceived to have a clear economic advantage over existing technologies (McIntosh et al., 1990).

Test of Independence. A chi-square test of independence was undertaken for both the large growers/irrigated and small growers/dryland groups. A 3 x 3 contingency table containing the ATUN and application rate variables was constructed (Tables 5.6 and 5.7).

**Table 5.6 Contingency table: Application rate by ATUN score
for large growers/irrigated group.**

Application rate:	ATUN scores			
	Inclined	Neutral	Disinclined	Total
Below	6	8	8	32
Recommended	5	6	4	15
Above	3	1	1	5
Totals (n)	24	15	13	52

**Table 5.7 Contingency table: Application rate by ATUN score
for small growers/dryland group.**

Application rate:	ATUN score			
	Inclined	Neutral	Disinclined	Totals
Below	1	1	6	8
Recommended	23	14	9	46
Above	5	6	4	15
Totals (n)	29	21	19	69*

*Missing case = 1

In the contingency tables for both groups, five of the nine
cells contained an expected frequency of less than five.
Although it has been recommended that the expected frequency

for any one cell in a contingency table be at least 5, some studies suggest that this rule is too stringent and can be relaxed (Everitt, 1977).

A Pearson chi-square test of independence was performed for each subsample in order to ascertain if the ATUN and application rate variables were independent. In this test, the two variables are considered independent if "the probability that a case falls into a given cell is simply the product of the marginal probabilities of the two categories defining the cell" (Norusis, 1988, p. B-97). The critical area correlating with a .05 level of significance corresponds with a value equal to, or greater than, 9.49 (degrees of freedom = 4). The null and alternative hypotheses can be stated as follows:

HO: Chi-square value < 9.49

and

H1: Chi-square value $\geq$ 9.49

The results of the chi-square test are contained in Table 5.8.

Table 5.8 Results of the Pearson chi-square test for
        independence

	Value	Significance
Large growers/irrigated	1.85778	.76190
Small growers/dryland .	11.53196	.02119

For the small growers/dryland group, the null hypothesis was
rejected. For the large growers/irrigated group, we fail to
reject the null hypothesis because the chi-square value is
less than the value defining the critical area.

Measure of Association. The next step in the analysis was
to determine the strength and direction of the relationship
between the ATUN score and application rate for the small
growers/dryland group. The results of the chi-square test
indicate that there is a significant degree of
interrelatedness between the ATUN score and application rate
for the small growers/dryland group but not for the large
growers/irrigated group.

A Somers' d test was used to measure the degree of
interrelatedness between the ATUN and application rate
variables. The resultant values when using Somers' d range
from +1 to -1. A positive value is indicative of a direct
relationship between the variables being tested, and a
negative value is indicative of an inverse or indirect
relationship. Thus, it is a measure which can indicate both

the strength and direction of the relationship between two variables.

This measure of association was chosen because of the level of measurement of the variables in the hypothesis, the hypothesized relationship between the variables, and the structure of the contingency table. Somers' d is a correct measure for variables measured at the ordinal level. Furthermore, it is an asymmetric measure which is appropriate when testing the causal or predictive relationship between an independent variable and dependent variable. Other measures, such as gamma, tau-b and tau-c, assume a symmetrical relationship between the variables being tested and are used in cases where no distinction between independent and dependent variables are made (Loether and McTavish, 1974). In terms of the number of allowable categories per variable, i.e., the number of rows and columns, it is not restrictive unlike other measures such as phi that require a 2 x 2 table. Finally, Somers' d is a PRE (Predicted Reduction in Error) measure. The calculated value represents the reduction in the probability of error when predicting the rank of the dependent variable when the rank of the independent variable is known (Norusis, 1988). The results of the test for measure of association are presented in Table 5.9.

Table 5.9 Results of the Somers' d measure of association
between the ATUN and application rate variables
for the small growers/dryland group.

                                                        Value

With application rate
        dependent* . . . .   -.09814

With ATUN score
        dependent . . . .   -.12988

* Causal relationship advanced in the hypothesis

The results of the test support the hypothesis which

postulates a negative association between a grower's ATUN

score and application rate. However, the causal

relationship posited in the hypothesis is not strongly

supported. Given a grower's ATUN score, the error in

predicting the application rate is reduced by approximately

10%. A slightly stronger association between the variables

is presumed when a grower's application rate category is

considered the independent variable. In this case, the

predictive ability of application rate is superior to that

of ATUN score by approximately 3%. However, this difference

is not great.

Summary of results. The empirical results of the
statistical tests concur with the predicted relationship
between the ATUN and application rate variables advanced in
the hypothesis. It would appear that financial variables
can affect the attitude-behavior relationship to the point
of neutralizing it. For growers with a wide financial risk
space, attitude was found to be negatively associated with
application rate. However, the calculated measure of
association indicates that this relationship is a weak one.
The data suggests that a relationship exists between
attitude and application rate, but it is not conclusive.

An interesting finding was that a considerable number
of growers from both groups already utilize cover crops and
rotations in their farming operations (Table 5.5).
Furthermore, more than half of the large growers/irrigated
applied nitrogen in their commercial corn enterprise at
rates below the recommended rate (Table 5.4). Because of
the need to infer growers' yield goals ex-post, the validity
of this result is questioned.

The results of the statistical test are in accord with
the growing body of empirical and qualitative evidence
contending that educational efforts intended to reform
targeted agricultural practices will be limited in their
effectiveness without complementary changes in agricultural
policy. Implications for current groundwater policy will
be discussed in the proceeding chapter.

CHAPTER 6

CONCLUSION AND RECOMMENDATIONS

The central question posed in this thesis is: Given
the economic structure under which growers operate today,
how effective can educational programs be in bringing about
the adoption of nitrogen use-reducing practices? The
efficacy of educational programs in raising grower awareness
of water quality issues and concern for the health and
environmental costs arising from nitrate contamination has
been documented in the literature (Halstead et al., 1990;
Martin et al., 1990; ALPI, 1989; Lasley and Bultena, 1988).
Yet, in terms of average rate at which nitrogen is applied
per acre, there has not been a significant reduction (TVA,
1990, December; NRC, 1989).

Findings. The question posed in this thesis can be answered
by studying the differential influences exerted by
attitudinal and financial variables on the nitrogen
management decisions made by a grower. In the conceptual
model of a grower's decision-making process presented in the
introduction (Figure 1.1), attitudinal and financial
variables were identified as the primary determinants of the

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amount of nitrogen applied during production. Of the two
primary variables, financial variables were postulated to
have a dominating effect on the expression of the attitude-
behavior relationship. These variables are a subset of a
larger class of situational variables which, for any given
situation, define the opportunity individuals have to
articulate their attitudes via consistent behavior.

It was postulated in the hypothesis that an inverse
relationship between ATUN (Attitude Toward the Use of
Nitrogen) score and application rate would be observed only
among small growers who practiced dryland corn culture, the
rationale being that small growers have greater financial
latitude to experiment with potentially income-reducing
practices than do larger growers. Their economic situation
would permit them, to a greater degree than larger growers,
to adopt innovations on the basis of philosophical rather
than economic reasons.

Two previous studies have indicated that small growers
derive a greater proportion of their income from off-farm
sources, and make fewer investments in their production
operations than large growers (Hepp, 1990; Michigan AES,
1990). Because their subsistence relies less upon the
profitability of their operations, small growers/dryland may
have a wide financial risk space, thus allowing them to act
in accordance with their attitudes. Large growers/irrigated
were considered to have a narrow financial risk space

because a significant proportion of their livelihood was based upon the profitability of their operations, thereby limiting the types of decisions they could make.

The empirical results partially support the hypothesis. A weak inverse relationship was observed among the small growers/dryland group, but not among the large growers/irrigated group. Apart from the differences in average application rates, there were no significant differences in terms of average ATUN scores, age, farming experience and education between the two grower groups. In the conceptual model, age, farming experience and education were indicated as being influential in shaping the attitude a grower holds toward the use of nitrogen. The observed similarity in these socioeconomic variables and ATUN scores between the two grower groups is consistent with the model. Given the similarities between the two groups, it is evident that a grower's financial situation greatly influences the types of management changes which a grower does make.

Two unexpected and interesting findings are: (1) a considerable number of growers in both groups already use cover crops (31%) and rotations (56%) in their farming operations; and (2) more than half of the large growers/irrigated applied nitrogen at below recommended rates in their commercial corn enterprise in 1989 (Table 5.4). In discussing the rationale for the hypothesis, it was proposed that smaller growers would be

more likely to adopt nitrogen-use reducing BMPs, such as cover crops and rotations, than larger growers, the rationale being that larger growers were influenced, to a greater degree, by economic considerations than smaller growers, and cover crops and rotations do not pose a large economic advantage over conventional methods. The results do not support this assumption (Table 5.5).

In terms of the objectives contained in U.S. groundwater policy, the second finding is the most interesting. Assuming a normal distribution of yield goals, one would expect the largest category to be "applied at recommended rates". Because this was not the case, two conclusions can be drawn: either large growers/irrigated use less nitrogen than recommended to achieve their yield goals, or this result is an artifact of the methods used to derive the application rate categories.

It would not be altogether surprising to find that most of the large growers/irrigated apply nitrogen at below recommended rates. After all, farming is a business, and using less nitrogen while achieving yield goals is cost-effective. Certain nitrogen-use reducing BMPs, which emphasize better timing and placement of nitrogen applications, allow growers to use nitrogen more efficiently. Unlike cover crops and rotations, they do not require a reorientation of the system, but better management of it (Kirschenmann, 1989). An advantage to irrigated corn

production is that the variability in yields is considerably
less than it is in dryland corn production which relies upon
rainfall. This reduction in variability gives growers who
irrigate greater predictive abilities in terms of the amount
of nitrogen needed to achieve yield goals. Currently, some
of these large growers/irrigated are participants in a soil
fertility research project being conducted by researchers at
Michigan State University, the Cooperative Extension Service
in St. Joseph County, and the Michigan Energy Conservation
Program (MECP). The objective of this research is to
demonstrate improved fertilizer management practices to
growers and to evaluate the efficacy of fertilizer products
to improve fertilizer use efficiency (Vitosh and Pruden,
1990).

The findings are summarized below:

1. A weak negative inverse relationship between ATUN
    score and application rate was observed among
    growers with small growers/dryland.

2. No relationship between ATUN score and application
    rate was observed among large growers/irrigated.

3. More than half of the large growers/irrigated
    applied nitrogen at rate below the recommended
    rates.

4. Approximately a third of all growers used cover
    crops in their farming operation.

5. More than half of all growers used rotations in
    their farming operation.

Conclusions. The empirical results of this study suggest that the influence attitudes have on grower behavior is minimized if the grower's financial situation is constrained. Although the negative relationship between attitude and application rate for small growers/dryland was found to be weak, it is significant that no such relationship was observed among large growers/irrigated.

Full-time growers have made considerable investments into their farming operations and derive a substantial proportion of their total income from agriculture. This limits the types of decisions that they can make which could negatively impact the profitability of their operations. Small growers and/or part-time growers have more flexibility in their choice set. Because a greater proportion of their income is derived from off-farm sources, the question of profitability is not as critical as it is for larger growers.

To conclude from the results of this study that small growers have more opportunity to act consistently with their attitudes would only be partially correct. Two important findings indicate a weakness in the underlying assumption used to formulate the hypothesis in this thesis; larger growers would be less likely to adopt innovations which do not impart an economic advantage over existing innovations because of concern for the profitability of their operations. A limitation posed by the use of a cross-

sectional design is that data are gathered for only one point in time. It is not possible to determine trends or changes which may have occurred. The fact that a similar proportion of growers from both groups already uses cover crops and rotations in their farming operation, coupled with the finding that more than half of the large growers/irrigated applied nitrogen at rates below the recommended rate for their yield goals suggests that: (1) large growers/irrigated have already reduced their application rate; and (2) small growers/dryland are in the midst of reducing their application rates.

Other studies in this topical area are needed to determine: (1) the trends in nitrogen use among small growers and large growers, and (2) if the <u>rate of adoption</u> of technologies, such as rotations and cover crops, whose adoption is supposed to be based more on philosophical rather than economic considerations, differs between small and large growers. A longitudinal study of growers of different commodities would be instrumental in identifying differences in the influence exerted by both financial and attitudinal variables on a grower's nitrogen management decisions and adoption of relevant BMPs. These studies would provide a more comprehensive and accurate interpretation of the interplay between attitudinal and financial variables in a grower's decision-making process.

Implications. Current groundwater policy relies upon the use of educational programs to facilitate the adoption of nitrogen use-reducing BMPs among growers. The underlying assumption is that U.S. groundwater policy suffers from a rationalistic bias. That is, it presumes that individuals will make the logical decision when presented with the appropriate information (Zaltman and Duncan, 1977). This assumption does not hold for all cases, and the findings of this study illustrate the limitation of the "bottom-up" approach in terms of its capacity to control and reduce the amount of nitrogen currently being used by growers. The conclusions drawn from this research stress two important points which policy-makers in the environmental field need to be aware of: (1) economic variables limit the degree to which growers can express their concern for water quality into reduced use of nitrogen fertilizers; and (2) there is a limit, given the degree of investments made and the technologies available, to the amount by which nitrogen use can be feasibly reduced. Admittedly, changing a grower's attitude toward the use of nitrogen fertilizers is a necessary first step in the eventual adoption of conservative practices. However, **although attitudinal change is a prerequisite for long-term behavioral change, it is not in itself sufficient to bring about that change.** Thus, in addition to educational programs and the provision of alternative practices, groundwater policy needs to assure

growers that adoption of nitrogen use-reducing BMPs will give them some clear cut advantage or at the very least, not penalize them financially.

Federal agricultural policy is instrumental in the types of technologies and practices growers adopt and use. This influence is exerted through its economic programs; by setting prices and supporting income, U.S. agricultural policy defines the level of profitability associated with different technologies and management practices (Buttel and Gertler, 1982). To remain economically competitive, agricultural producers have invested substantially in machinery and goods with a high degree of asset specificity[8]. Implicit in income and price support commodity programs is the promised maintenance of an economic structure which ensures the profitability of those investments (Bonnen and Browne, 1989). Conceptually, the relationship between policy-makers in the agricultural policy arena and U.S. growers can be conceived as being a contractual one. Growers will continue to invest in goods with a high degree of asset specificity and adopt the concomitant practices so long as policy-makers make it profitable to do so.

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[8]

Asset specificity refers to the salvage value of a good or investment. The salvage value of an investment is inversely related to its degree of specialization. Thus, highly specialized equipment represents investments with a high degree of asset specificity whereas multi-purpose equipment exhibit a low degree of asset specificity (Williamson, 1985).

It is obvious that, within this economic structure
conditioned by U.S. agricultural policies, growers are prone
to react first to benefit/price ratios and, later, to non-
pecuniary concerns (Batie and Taylor, 1989). The incentives
for change offered by groundwater programs are weak when
compared to the high-powered market incentives contained in
U.S. agricultural policy. When one considers the amount of
capital already invested by growers in their operations, it
becomes apparent that, given the technologies available
today, there is a limit to the amount by which a grower can
reduce his/her use of nitrogen fertilizers. This limit is
defined by the production (bushels/acre) needed to keep the
farming operation solvent. Few growers will risk losing
their farms for the sake of acting on their concern for
water quality.

More effective policy will require a coordinated effort
between agricultural and environmental policy-makers at the
national level. To date, the responsibility for formulating
and implementing policies intended to control agricultural
non-point source pollution has been relegated to state
officials (Kenski, 1990; Goldfarb, 1988). This situation
has given rise to an uneven policy landscape at the national
level. Since growers are linked to national and
international markets, an effort to balance the options
available to growers from all states needs to be made at the
national level.

Growers make choices within their opportunity sets. These opportunity sets are largely defined by U.S. agricultural policy and, to a smaller degree, by U.S. groundwater policy. Policy-induced changes in growers' opportunity sets that increase the attractiveness of reduced nitrogen use are needed if a truly effective effort to combat nitrate contamination is to be realized (Batie and Taylor, 1989). In the absence of complementary changes in agricultural policy, the types of incentives made available to growers by water quality programs will not be sufficient to induce the magnitude of change in nitrogen use required to mitigate the nitrate problem.

Policy Recommendations. The results of this preliminary study support a growing body of evidence indicating the need for a coordinated effort between policy-makers in the environmental and agricultural policy arenas (GAO, 1991; Abdalla, Gaynell and Meij, 1990; Kenski, 1990; ALPI, 1989; Reichelderfer, 1989). Whereas soil erosion and conservation technologies were the issues of the 80's, groundwater contamination will be the issue of the 90's for agriculture (Kenski, 1990). As concern for water quality increases within the non-farm sector, greater demands will be made on policy-makers to develop more environmentally friendly policies. There is already a growing conflict between

environmentalists who are predominantly urban-based and farmers. In a survey of growers in Cedar Rapids, IA, 86% of the growers interviewed felt that the townspeople saw them as polluters (Kilman, 1991). In order to effectively address the issue of nitrate contamination, both agricultural and groundwater policy will need to consider:

- the limitations of educational programs to effectuate changes in growers' management practices;

- the financial capability of growers to adopt nitrogen use-reducing practices;

- the financial resources required to facilitate the adoption of nitrogen use-reducing practices; and

- the economic viability of these practices given the current structure of federal farm programs.

The central issue is the determination of who will bear the costs of nitrate contamination: growers or the general public?

An acceptable solution will need to be an equitable one. Because of the costs and difficulty of regulating nitrogen use in agriculture, it is not currently feasible to directly regulate the use of nitrogen fertilizers. This constraint demands that growers be "willing" to change their practices. Continued use of educational programs will serve this purpose. In addition, educational and publicity programs directed at non-agriculturists are needed to establish realistic expectations, in terms of the magnitude

and pace at which growers can reduce their use of nitrogen
fertilizers. This is a necessary first step in resolving
the growing conflict between farmers and environmentalists.
To facilitate the transition, greater financial resources
will need to be committed toward aiding growers in defraying
the costs of implementation. Finally, complementary changes
will need to be made in the structure of federal farm
programs which will increase the financial attractiveness of
BMPs. This can be achieved by tying in program benefits to
the use of BMPs similar to the cross-compliance measures for
conservation technologies contained in the 1985 Farm Act, by
reducing the profitability of current levels of nitrogen use
via a reduction in target prices and loan rates, by
including leguminous cover crops in the commodity program
and by relaxing the rules governing the management of base
acreage. In terms of groundwater policy, a closer link
between national and state policies on nitrate contamination
needs to be achieved. This would maintain the
competitiveness of the agricultural sector and address the
issue of nitrate contamination. Specific recommendations
supported by this research include:

- The continued use of educational programs to
  increase grower awareness of the health and
  environmental costs arising from nitrate
  contamination,

- The use of educational programs to increase grower
  willingness to adopt nitrogen use-reducing
  practices,

- The provision of educational programs for non-agriculturists to establish realistic expectations of the rate at which growers can reduce their use of nitrogen fertilizers,

- The provision of cost-share programs to all growers willing to adopt nitrogen use-reducing BMPs,

- Changes in the structure of federal farm programs making nitrogen use-reducing BMPs an economically attractive alternative via:

    -Reduction in target prices and loan rates,
    -Inclusion of leguminous cover crops in the commodities program,
    -Increasing the flexibility of the rules governing base acreage eligibility, and

- Greater coordination between national and state policy-makers in the formulation and implementation of groundwater policies.

Recommendations for Further Research. Farm Bill 1990, recently passed by Congress, contains several of the recommendations proposed in this study. Most notably, growers willing to participate in the Integrated Farm Management Option (IFMPO) and Water Quality Protection (WQPP) programs will be allowed to plant up to 50% of their enrolled acres in non-program crops without penalties and will be eligible for up to $3,500 per year for periods of three to five years in financial assistance for the implementation of their management plans. Growers also have the option of growing resource-conserving crops on their program acres while still receiving deficiency payments on

those acres as if they were planted in program crops[9].
These newly instituted changes provide a unique opportunity
for a more rigorous test of the hypothesis advanced in this
study.

A weakness in this study has been the use of a cross-
sectional design which negates the measurement of
intertemporal changes in growers' attitudes and behavior.
Further studies in this topical area need to employ a
longitudinal design in order to document (1) changes in
growers' attitudes arising from educational programs in
water quality and (2) subsequent adoption of nitrogen use-
reducing practices. It would be helpful if these studies
were conducted among growers from different regions in the
country who specialize in different commodities in order to
ascertain if location and farm type variables affect rates
of adoption.

Farm policy is influential in determination of the
types of technologies adopted. It would be worthwhile to
record changes in the adoption rates of BMPs, such as
rotations and cover crops, which require a reorientation of

9

Resource-conserving crops considered by Farm Act 1990 are:

  -forage legumes (such as clover and alfalfa),
  -any legume grown for use as forage or green manure,
  -legume/small grain mixtures (such as oats/clover),
  -legume/grass mixtures, and
  -legume/grass/small grain mixtures.

(Sustainable Agriculture Working Group, January 1991)

the farming system, and which carry a higher risk premium
than other BMPs, such as better timing and placement of
applications, nitrogen soil tests, and plant analysis. In
terms of radically reducing the amount of nitrogen needed in
a system, rotations and cover crops can provide more
efficient use of nitrogen fertilizers and can add organic
nitrogen to the soil. Other BMPs which carry a lower risk
premium, such as better timing and placement of
applications, while promoting more efficient use of nitrogen
fertilizers, do not contribute supplemental nitrogen to the
system (Kirschenmann, 1989). Farm Act 1990 does change
growers' opportunity sets making adoption of nitrogen use-
reducing technologies and practices more attractive.
Studies employing a longitudinal design will yield
definitive conclusions on the effect of financial risk space
and attitude on a grower's use of nitrogen.

The issue of how much should growers reduce their use
of nitrogen fertilizers needs to be defined and included as
the primary objective for future groundwater policy. This
study has not addressed this question, yet, it is imperative
the technical, sociological and economic factors needed to
answer it be provided by future research in this topical
area. The absence of specific goals, par ex., reduction of
total inorganic nitrogen use by X amount, from current
groundwater policy can be attributable to insufficient
scientific understanding of nitrate movement in the soil and

groundwater flow dynamics. Work in this area needs to be
continued to provide an empirical base upon which to ground
more explicit use reduction goals for nitrogen use. In
addition to technical studies, sociological and economic
studies gauging the feasibility of different nitrogen-use
reducing levels is also needed.

Reducing the use of nitrogen in agriculture, although
necessary, is not sufficient to adequately address the
problem of nitrate contamination of groundwater sources
(Kenski, 1990; CF, 1985). Source reduction efforts can
reduce the magnitude of the problem, by diminishing the
quantity of contaminants entering the system. However, it
does not address the present problem. Remedial action to
redress existing cases of nitrate contamination is needed to
complement source reduction efforts (O'Neil and Raucher,
1990). An appropriate federal policy response to nitrate
contamination will need to contain both remedial and
preventative provisions. Reliance on source reduction
efforts will not be the solution.

Ultimately, a complete reform of agricultural policy
will be necessary if nitrate contamination is to be
contained. Although the changes instituted by Farm Act 1990
encourage the adoption of longer rotations and
diversification of the farming system, it does not radically
change the policy framework, within which growers operate.
The incentives built into government programs encourage the

excessive use of nitrogen fertilizers[10]. Establishment of
target prices at levels above market demand distorts the
cost-effectiveness of certain nitrogen management practices.
Thus, the benefits derived from the use of nitrogen at
levels currently defined as profitable by government
programs are not commensurate with their true costs (GAO,
1990; Fleming, 1987).

The bottom line facing policy-makers with regard to
nitrate contamination is that politically unpopular
decisions need to be made. Dependence on the voluntary
adoption of nitrogen use-reducing practices, albeit
politically acceptable to growers and their supporters, is
an inadequate response to the problem. Public concern over
water quality will demand that the economic benefits derived
from the use of nitrogen fertilizers more accurately reflect
both pecuniary and intangible costs, even though the latter
are difficult to measure.

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[10] Throughout the 1980s, the target prices set by the USDA have
usually exceeded the commodity price on the world market. In
terms of market demand (world price) for the product, corn
yields have exceeded demand. Excessive in this sense refers
to the use of nitrogen to produce corn in excess of market
demand.

APPENDIX

Appendix: Advance Letter used in the Survey.

**ST JOSEPH COUNTY
CORN GROWERS SURVEY**

March 19, 1990

Dear St. Joseph County corn grower,

You as well as all the other corn growers in St. Joseph County have been selected to participate in the St. Joseph County Corn Growers Survey.

You should be receiving a survey packet which will be mailed to you on Friday, March 23, 1990 or soon after. Directions will be enclosed with the questionnaire.

No name appears on this letter, and no names will ever be used in this survey. It should be completed by the primary grower of the farm unit. All opinions will be anonymous and confidential.

The information you can provide as well as your opinions are important, and we urge you to take this chance to help the St. Joseph County Cooperative Extension Service and Michigan State University researchers in planning future research and educational programs for your area.

If you have any questions about the survey, you can call the Department of Resource Development at Michigan State University at (517) 353-9501 and ask for either Joel Lichty or Emily Amaz during business hours Monday through Friday.

Thank you for your time and cooperation.

Sincerely,

The Corn Growers Survey Team
Department of Resource Development
Michigan State University

Appendix: Cover Letter used in the Survey.

March 23, 1990

Dear St. Joseph County corn grower,

Thank you for your participation in the St. Joseph County Corn Growers Survey.

The Department of Resource Development at Michigan State University in conjunction with the St. Joseph County Cooperative Extension Service, the Department of Crops and Soil Science and the Department of Agricultural Economics at MSU, have developed the enclosed questionnaire for the purpose of finding out the conditions under which corn is grown in St. Joseph County.

All opinions will be anonymous and confidential. No name appears on this letter, and no names will ever be used in this survey. All of the corn growers in St. Joseph County will receive a questionnaire.

The questionnaire includes all of the instructions you will need to fill it out; you can start on it any time. Attached to this letter, you will find some answers to questions commonly asked about the survey process; you may want to read these now, or refer back to them if you have questions later. If your questions are not answered on these pages, please feel free to call the Department of Resource Development at Michigan State University Monday to Friday during business hours at (517) 353-9501 and ask for either Joel Lichty or Emily Arnaiz.

Your cooperation in completing the questionnaire is appreciated. The results will be used to assist Michigan State researchers and your Cooperative Extension Service in planning future research and educational programs for your area. Information from this survey may be used by public and private companies in the area. We are grateful for your time and thoughtful opinions.

Sincerely,

The Corn Growers Survey Team
Department of Resource Development
Michigan State University

ANSWERS TO SOME QUESTIONS ABOUT THE
St. Joseph County CORN GROWERS SURVEY

Who should fill out the questionnaire?

For a good sample, only the primary grower of the farm unit should answer the questions on this questionnaire.

How do I fill out the questionnaire?

Directions for filling out the questionnaire are inside the front cover. Most questions should be easy to understand and answer. Either pen or pencil is fine.

It is best if you complete it all at one time. It should take between 30 minutes to an hour. You may want to do all of the easy questions first, and come back to questions that need more thinking or writing.

What do I do when I am done?

When you are finished, put the questionnaire in the envelope that came with it. Do not write on the envelope. To make sure that your answers are confidential, there are no identifying numbers or marks on the envelope.

A business reply (pre-stamped) envelope is included in the questionnaire packet. All you need do is put the completed questionnaire into the envelope and mail it directly to Michigan State University.

How do I know my answers are confidential?

No name appears on the questionnaire or on this letter, and no names will ever be used with this survey. All information and opinions will be kept anonymous and confidential.

Just in case someone might recognize your handwriting, the questionnaire itself will never come back to St. Joseph County. Only your answers, along with all the others, will come back to help the St. Joseph County Cooperative Extension Service with future programming.

The number on the front of the questionnaire has been assigned to your address to help in distributing the questionnaire, and to make sure that only official questionnaires are counted. It may also be used by MSU researchers in some statistical analyses, to find out how cultural practices between different growers in different areas of St. Joseph County differ. No one in St. Joseph County will have any way of knowing which answers came from your address.

What if I have a problem filling out the questionnaire?

If you need help in completing the questionnaire, if you have a problem with a question, or if you just want more information about the survey, you can call Joel Lichty or Emily Arnaiz at the Department of Resource Development at (517) 353-9501 during normal business hours, Monday through Friday.

What if I can't do it, or don't want to?

Filling out this questionnaire is entirely voluntary. If you decide you can't or don't want to fill it out, you can put the blank questionnaire in the envelope, seal it up, and mail it back to the Department of Resource Development using the business reply envelope in your questionnaire packet.

Please remember, though, that the survey only works if enough people fill out the questionnaire.

Who exactly is responsible for this survey?

This survey is conducted by the Department of Resource Development with funds provided by a private seed company. Help in the development of the questionnaire was provided by Rod King, director of the St. Joseph County Cooperative Extension Service and faculty from the Departments of Crops and Soil Science and Agricultural Economics at Michigan State University.

Appendix: Replica of Questionnaire with Response Frequencies
and Final Comments

St. Joseph County Corn Growers Survey

Reponse Frequencies and Open-ended Responses in Questionnaire Form

Developed by
Department of Resource Development
Michigan State University

Section I. GENERAL INFORMATION: This questionnaire is specifically for St. Joseph County corn growers. It should be filled out by by the primary grower of the farm operation. Information about your farm and your farm practices are needed by the designers of this questionnaire in order to have a better idea of the conditions under which corn is grown in St. Joseph County.

Q-1. Are you a resident of St. Joseph County?

n=317   (circle one number)

          93%   Yes

          7%   No

Q-2. Is your home located on your farm?

n=315   (circle one number)

          81%   Yes

          19%   No

Q-3. How many total acres did you farm in 1989?

n=288   mean = 403 acres, total acres = 116,089 acres

          33%   1 to 80 acres

          18%   81 to 160 acres

          26%   161 to 500 acres

          14%   501 to 1000 acres

          9%   more than 1000 acres

Q-4. Which of these types of corn did you grow in 1989?

	Yes	No
(circle one number)		
n=289 1. Commercial and feed corn	81%	19%
n=230 2. Seed corn	23%	77%
n=229 3. Both	21%	79%

Section II. COMMERCIAL AND FEED CORN: This section is to be filled out by growers who planted commercial corn in 1989.

IF YOU DID NOT PLANT COMMERCIAL OR FEED CORN IN 1989,
PLEASE SKIP THIS SECTION AND GO TO SECTION III, PAGE 4.

Q-1. How much land did you have in commercial or feed corn production in 1989?
n=234, mean = 180 acres, total acres = 42,227 acres

28%	1 to 80 acres
26%	81 to 160 acres
22%	161 to 500 acres
20%	501 to 1000 acres
4%	more than 1000 acres

Q-2. When did you begin and end planting your commercial and feed corn in 1990?
[Note: The following figures are cumulative percentages.]

by:	n=209 Began planting	n=199 Ended planting
the end of March	1%	<1%
third week of April	9%	2%
the end of April	35%	8%
the first week of May	70%	35%
the second week of May	90%	64%
the third week of May	99%	85%
the end of May	99%	93%
the first week of June	100%	99%
the first week of July	100%	100%

Q-3. Do you ever irrigate your commercial or feed corn?
n=236 (circle one number)

38%	Yes
62%	No

If you answered No above, skip the next 2 questions and go to Q-6.

Q-4. What kind of irrigation system do you have on your farm?
n= 87 (circle all that apply)

76%	Soft hose traveller
17%	Hard hose traveller
64%	Pivot

Q-5. In 1989, how many acre-inches of water on the average did you put on your commercial corn: (circle one number)
n=89

11%	Did not irrigate in 1989
4%	Less than 2 acre-inches
33%	2-4 acre-inches
36%	4-6 acre-inches
14%	6-8 acre-inches
2%	more than 8 acre-inches

The next three questions deal with the use of fertilizer on your commercial or feed corn.

Q-4. Considering all your commercial and feed corn fields, what was your most common practice when applying the nitrogen fertilizers below? Please enter the amount in actual pounds of nitrogen per acre for each type and method used. [The following are the mean rates of the responses.]

			Plow-down Spring / Fall		Preplant Starter	Weed/ Feed	Side-dress (knifing)	Dribble	Irrigation system
1.	Anhydrous ammonia	lbs N/acre=	130	119	120	75	119	107	0
		n=	13	2	10	1	65	6	0
2.	28% UAN	lbs N/acre=	250	0	35	80	85	68	59
		n=	1	0	31	50	17	26	17
3.	Ammonium nitrate	lbs N/acre=	39	0	33	0	93	0	0
		n=	6	0	21	0	3	0	0
4.	Urea	lbs N/acre=	100	0	55	78	62	0	0
		n=	13	0	14	2	4	0	0
5.	Livestock manure	lbs N/acre=	7	10	0	5	0	0	0
		n=	37	14	0	1	0	0	0

[Overall mean rate of application per acre excluding manure.]

n=172   144.42 lbs N/acre

Q-5. When did you apply nitrogen fertilizers after planting your commercial corn in 1989?

n=188   (circle all that apply)

48%	0-4 weeks
58%	5-7 weeks
8%	after 8 weeks

Q-6. What other fertilizers did you apply to your commercial corn in 1989? What was your application rate for each?

(circle one number for each)

			Did not apply	Did apply	Application rate (mean)		
n=204	1.	Potassium	16%	84%	106	pounds/acre	n=177
n=193	2.	Phosphorous	24%	76%	61	pounds/acre	n=151
n=168	3.	Marl	88%	12%	5	cubic yards	n= 16
n=171	4.	Dolomitic lime	75%	25%	2	tons/acre	n= 43
n=164	5.	Calcic lime	96%	4%	3	tons/acre	n= 3

Section III. SEED CORN: This section is only to be filled out by growers who planted seed corn in 1989.

IF YOU DID NOT PLANT SEED CORN IN 1989,
PLEASE GO TO SECTION IV ON PAGE 7.

Q-7. How much land did you have in seed corn production in 1989?

n=64, mean=395 acres, total acres = 25,289 acres

23%	1 to 80 acres
10%	81 to 160 acres
45%	161 to 500 acres
16%	501 to 1000 acres
6%	more than 1000 acres

Q-8. Which seed company are you currently growing seed corn for? How many years have you been growing seed corn for this company?

n= 74

	Years contracted by company			
	1 year	**2-5 years**	**6-10 years**	**more than 10 years**
		(circle all that apply)		
1. Cargill	5%	7%	0%	0%
2. Crow's	7%	1%	0%	0%
3. Dekalb	7%	1%	1%	3%
4. Great Lakes	3%	0%	1%	0%
5. Hoffman	3%	0%	1%	0%
6. Menden Seed Growers	3%	1%	3%	1%
7. Pioneer Hi-Bred	3%	8%	9%	12%
8. Select	3%	5%	0%	0%
9. Super Crost	0%	1%	4%	0%
10. *Other [Amcorn (1) . .	3%	0%	0%	0%
RK Hybrids (1)]				

Q-9. How many years have you been growing seed corn in total?

n=64

27%	1 to 2 years
16%	3 to 5 years
26%	6 to 9 years
14%	10 to 14 years
9%	more than ten years

The next two questions concern your seed corn irrigation practices.

Q-10. What kind of irrigation system do you use for your seed corn?
n= 65   (circle all that apply)

68%	Soft hose traveller
11% .	Hard hose traveller
89%	Pivot

Q-11. Last year, how many acre-inches of water on the average did you put on your seed corn:

n=63   (circle one number)

5%	Did not irrigate
0%	Less than 2 acre-inches
13%	2-4 acre-inches
48%	4-6 acre-inches
30%	6-8 acre-inches
5%	more than 8 acre-inches

The following 3 questions deal with your fertilizer application practices for your seed corn.

Q-12. Considering all your of your seed corn fields, what was your **most common practice** when applying the nitrogen fertilizers below? Please enter the amount in actual pounds of N per acre for each type and method use.
[The following are the means for each group of responses]

			Plow-down Spring	/ Fall	Preplant Starter	Weed/ Feed	Side-dress knifing	Dribble	Irrigation system
1.	Anhydrous ammonia	lbs N/acre=	141	0	33	0	136	117	0
		n=	6	0	3	0	20	3	0
2.	28% UAN	lbs N/acre=	100	0	17	52	88	71	40
		n=	1	0	20	21	10	15	15
3.	Ammonium nitrate	lbs N/acre=	100	0	19	· 90	0	0	50
		n=	1	0	3	1	0	0	1
4.	Urea	lbs N/acre=	90	0	24	0	0	0	0
		n=	1	0	3	0	0	0	0
5.	Livestock manure	lbs N/acre=	1	1	0	0	4	0	0
		n=	4	3	0	0	1	0	0

[Overall mean rate of application per acre excluding manure.]

n=55   160.63 lbs N/acre

Q-13. When did you apply nitrogen fertilizers after planting your seed corn in 1989?
n=61   (circle all that apply)
          36%   0-4 weeks
          82%   5-7 weeks
          18%   after 8 weeks

Q-14. What other fertilizers did you apply to your seed corn in 1989? What was your application rate for each?

(circle one number for each)

			Did not apply	Did apply	Application rate		
n=56	1.	Potassium	1%	99%	126	pounds/acre	n= 54
n=55	2.	Phosphorous	9%	91%	53	pounds/acre	n= 51
n=50	3.	Marl	96%	4%	4	cubic yards	n= 1
n=52	4.	Dolomitic lime	73%	27%	1.5	tons/acre	n= 12
n=51	5.	Calcic lime	94%	6%	3.5	tons/acre	n= 2

Section IV. GENERAL FARM PRACTICES: This section will help us understand the whole system within which your corn enterprise operates.

Q-15. Do you adjust fertilizer applications according to the soil type of the particular field:

n=269   (circle one number)

64%   Yes

36%   No

Q-16. Of the total acres that you had in crop production in 1989, how many acres were in:

[Note: The "none" column accounts for all growers who did not respond to the question. Other crops written in by growers are provided at the bottom of the table in [].]

n=322

	[None]	0-40	41-120	121-320	321-640	640-1,000	over-1,000
1. Silage corn	83%	14%	2%	1%	<1%	0%	0%
2. Sweet corn	86%	14%	<1%	0%	0%	0%	0%
3. Popcorn	87%	11%	1%	1%	0%	0%	0%
4. Soybean	38%	24%	20%	13%	4%	0%	<1%
5. Forages	71%	19%	8%	2%	<1%	0%	0%
6. Pasture	70%	24%	6%	0%	<1%	0%	0%
7. Small grains	63%	25%	10%	2%	<1%	0%	0%
8. Dry beans	89%	10%	<1%	<1%	0%	0%	0%
8. Snap beans	87%	2%	1%	1%	5%	0%	0%
9. Government Programs							
(CRP, 092, Set-Aside) .	42%	38%	18%	2%	1%	0%	0%
10. *Other:	86%	8%	3%	1%	1%	0%	<1%

[Corn (6), Hay(6), buckwheat, peppermint, spearmint, pickles, potatoes, pumpkins, tomatoes, truck garden, wheat, alfalfa hay]

Now, we would like to know something your pest control practices considering all of your farmed fields in 1989.

Q-17.   Which of the following pest and weed control practices did you use on your farm in 1989? If you used any of the ones listed, what percentage of all your fields did you use them on?

	Did not use	Did use		0-25%	Percentage of fields used on 25%-50%	50%-75%	75%-100%	100%
n=252 1. Herbicides	12%	88%	n=226	7%	7%	10%	19%	57%
n=230 2. Insecticides ...	43%	57%	n=137	14%	12%	27%	15%	32%
n=201 3. Fungicides	88%	12%	n=26	46%	12%	15%	8%	19%
n=200 4. Nematicides ...	94%	6%	n=15	33%	20%	27%	13%	7%
n=227 5. Cultivation	30%	70%	n=157	12%	8%	15%	18%	47%
n=203 6. Scouting	59%	41%	n=8	75%	13%	16%	21%	46%

Q-18. When using pesticides, are you most likely to apply:

(circle one number)

n=241

34%   Less than the rate on the label

65%   Equal to the rate on the label

1%   More than the rate on the label

Q-19. Who scouted your fields for insects and diseases in 1989?

(circle all that apply)

n=251

8%   Private consultant

14%   Agriculture supplier scout

17%   Seed corn company

8%   Soil Conservation District scout

67%   Yourself

18%   No one

2%   Other* [Employees, friends, Seed Bean Co.]

What percentage of the time did you make pest management decisions on your scouted fields based on information from scouts in 1989?

n=162

24%   Used up to 50% of the time
21%   Used up to 99% of the time
55%   Used 100% of the time

Q-20.　Please indicate the number of acres each of the following practices were used on for all of your fields.

n=268			[% of Growers using method]	Acres (mean)
	1.	Clean till (moldboard plow) .	[70%]	194
	2.	Conservation till (minimum till)	[51%]	373
	3.	No-till	[18%]	156
	4.	Cover crops.	[29%]	116
	5.	Crop rotation (2 yrs. maximum in 1 crop)	[47%]	244

Q-21.　Fertilizers play an important role in today's farm operation. How much do you agree with the following statements about fertilizer use?

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
n=266 1. In general, applying extra fertilizer is good insurance ...	18%	48%	21%	10%	2%
n=267 2. Minimizing use of fertilizer increases farm profits	9%	41%	20%	26%	3%
n=268 3. Usually, fertilizer application recommendations call for more than is really needed	6%	41%	28%	22%	3%
n=265 4. The cost of a little extra fertilizer is a small price to pay for the security it gives ..	7%	47%	25%	18%	3%
n=269 5. It is too expensive to use all the fertilizer that is usually recommended	6%	42%	20%	26%	7%

Q-22. What is the source of your irrigation water for all of your irrigated fields?

n = 132

42%	River or stream
4%	Lake
38%	Pond
55%	Well
14%	Other (*rain, clouds, nothing)

Q-23. What do you use in deciding when to irrigate?

n = 117

28%	Computer assisted irrigation scheduling program
51%	Visible signs of water stress
9%	Use a soil moisture gauge
19%	Set weekly application rate
17%	Other (*weather, clouds, my neighbor)

The following 2 questions deal with your irrigation practices for your non-corn fields.
IF YOU DO NOT IRRIGATE THESE FIELDS, GO TO Q-26.

Q-24. What kind of irrigation system do you use for your non-corn fields:

n = 87   (circle all that apply)

74%	Soft hose traveller
16%	Hard hose traveller
70%	Pivot

Q-25. In 1989, how many acre-inches of water on the average did you put on all your fields:

n = 96   (circle one number)

19%	0 acre-inches
3%	0-2 acre-inches
37%	2-4 acre-inches
24%	4-6 acre-inches
13%	6-8 acre-inches
3%	more than 8 acre-inches

Q-26. Among the following information sources for farm management decisions, which source do you use as your principle source of information for the listed practices?
(*Circle one number for each)

		Fertilizer application	Pesticide/ herbicide use	Irrigation practices	Tillage practices
		n=268	n=244	n=128	n=239
1.	Cooperative Extension Service ..	30%	18%	38%	23%
2.	Farmer Organizations	4%	4%	0%	4%
3.	Seed company	9%	13%	8%	7%
4.	Farmer magazines	13%	11%	9%	20%
5.	Neighbor and friends	12%	11%	11%	15%
6.	Local Ag Suppliers	52%	45%	3%	4%
7.	Label directions	11%	44%	3%	2%
8.	Personal experience	44%	29%	72%	74%

[*Note: Although respondents were asked to choose only one answer, the question was difficult to understand and more than one answer was chosen by the respondents.]

Q-27. How useful is the information that you receive from the sources below for your farm management practices:

			Not Useful	Somewhat Useful	Useful	Very Useful
n=258	1.	Cooperative Extension Service	6%	24%	46%	23%
n=204	2.	Farmer groups/association	28%	51%	19%	2%
n=232	3.	Seed company	15%	40%	38%	8%
n=240	4.	Magazine/journal	6%	44%	41%	9%
n=241	5.	Neighbors and friends ...	9%	42%	39%	10%
n=250	6.	Ag suppliers (dealers) ...	4%	16%	60%	19%
n=238	7.	Label Directions	5%	11%	42%	42%
n= 48	8.	*Other_____	21%	29%	25%	25%

[Private consultants (6), personal experience (6), SCS (3)]

Section V. ENVIRONMENT/OPINIONS: Recently, there has been increased concern with environmental problems in St. Joseph County.

Q-28. In comparison to other Michigan counties, how would you rate the condition of the environment in St. Joseph County:

n=285   (circle one number)

6%	much worse than most
16%	worse than most
49%	about the same as most
26%	better than most
3%	much better than most

Q-29. When compared to all other problems facing you as a farmer, how important is environmental quality?

n=289   (circle one number)

2%	not important at all
12%	somewhat important
43%	important
43%	very important

Q-30. The issues below are problems in some parts of the country. How much of a problem do you feel each of these things is in St. Joseph County:

(circle one number for each)

		Not a problem	Slight problem	Medium problem	Big problem
n=278	1. Air pollution	43%	35%	16%	5%
n=280	2. Trash and litter	9%	32%	36%	22%
n=279	3. Loss of topsoil	6%	26%	43%	25%
n=289	4. Drinking water quality	12%	23%	36%	29%
n=285	5. Lake and stream pollution ..	8%	29%	40%	22%

Section VI. BACKGROUND: In order to find out how different kinds of people feel about different issues, your answers to some background questions are very important.

As with all information in this survey, your answers to the following questions will be kept confidential.

Q-31. Are you:

n=299   (circle one number)

             95%   adult male

             5%   adult female

Q-32. What is your age?

n=298

             4%   · 20 to 30 years old

             20%   31 to 40 years old

             23%   41 to 50 years old

             26%   51 to 60 years old

             27%   older than 60 years

Q-33. How many years have you been farming?

n=290

             14%   1 to 10 years

             26%   11 to 20 years

             23%   21 to 30 years

             18%   31 to 40 years

             19%   more than 40 years

Q-34. How many people currently live in your household?

n=299   Number of adults

        6%   one adult
        79%   two adults
        15%   three or more adults

     Number of children

        53%   no children
        29%   one to two children
        15%   three to four children
        3%   five or more children

Q-35. Of the following farm journals and magazines, which are the ones you read regularly?

n=285   (circle all the numbers that apply)

68%	Michigan Farmer
36%	Furrow
37%	Prairie Farmer
65%	Successful Farming
62%	Farm Journal
1%	Solutions
43%	Farmer's exchange
38%	Farmer's advance
18%	Others* [Farm Industry News (6), Farm Futures (7), Progressive Farmer (4)]

Q-36. Do you read any of the following newspapers/journals?

n=262   (circle all that apply)

56%	Sturgis Journal
45%	Kalamazoo Gazette
36%	Three Rivers Commercial
6%	Elkhart Truth
10%	South Bend Tribune
13%	Detroit News
13%	Wall Street Journal

Q-37. Which of the following groups do you belong to or have belonged to:

n=286   (circle all that apply)

53%	Farm Bureau member
6%	Michiana Irrigation Association
9%	School Board
1%	City Council
12%	Township Board
27%	Other associations
34%	None of the above

Q-38. What is the highest level of formal education you completed?

n=298   (circle one number)

14%	Less than high school
42%	High school graduate
17%	Some college
5%	Associate's or technical degree
15%	College graduate
7%	Graduate or professional degree

Q-39. What was the range of your gross farm sales last year?

n=282   (circle one number)

37%	Less than $15,000
18%	$15,000 to $49,999
14%	$50,000 to $99,999
7%	$100,000 to $149,999
10%	$150,000 to $249,999
7%	$250,000 to $499,999
6%	over $500,000

Q-40. How was your farm organized in 1989?

n=297   (circle one number)

84%	Family or individual ownership
6%	Partnership (formal written agreement)
2%	Limited partnership
4%	Family-held corporation
1%	Non-family coporation
3%	Other* [Rented (4), family partnership (2), school]

FINAL COMMENTS SUBMITTED BY RESPONDENTS

1. Resident of Jackson County. Seasonal-summers only in St. Joseph Co. Land in 092.

2. Signed into 0-92 government program.

3. Did not farm in 1988-1989.

4. I am not the farm owner, not the planter-done on shares. All info not available to me.

5. Let's clean up our water and keep it clean.

6. 27 acres are in 10 year grass program.

7. You do not know what we really go through. Good luck in the coming year on your stats-we find that most are a year or two behind on what is really happening in the Ag and Hort business. Thanks anyway. Veg-growers need help!!! Now-Get on the ball and Help!!! us Now-Please!!!!!.

8. I think a better job could be done with some of the labels.

9. Thank you for including me in your survey. The end results or findings may or may not be helpful. We farmers are only stewards of the land. We must take our responsibility seriously. We are either part of the solution or part of the problem.

10. All hay and no corn. Rest not applicable.

11. I've raised corn every year except for last year. I will be raising corn again this year.

12. I only have 22 acres of farm land and it is all in the land bank. I am 79 years old and in ill health so don't farm anymore.

13. Corn farm in the set aside program.

14. I worked as a professional chemist for my principal source of income. Since I lived on the family farm, I managed it 100%; did some farm work; and since retiring have done 100% of the farm work but up to that time used mostly teenaged boys with farm background. The farm has always been a secondary source of income.

15. It is difficult to be 100% accurate on all questions but I believe common sense goes a long ways in all types of farming.

16. Rotate all crops every two years because of atrazine. Use only the amount recommended.

17. Our area has problems with high nitrate levels in the water. I'm not so sure that they might have always been there. Fourteen years ago when we moved on the farm, our well was 100 ft. and our nitrate level was 20-we put in a new well 200 ft. down to get away from high nitrates.

   My thinking is that with irrigation, we're speeding up or doubling the amount of water going through the soil. Because of this fast movement and depending on how much nitrogen was used at one given time, maybe we're putting extra nitrates in the water. I would like to know if we are! I know soil types are going to make a difference.
   I don't agree with the government going to different locations or wells and taking samples and telling us we have to do something because we have too high of nitrates. Those nitrate levels I feel have always been there. We need some new test wells on different soil types with different farming practices to find out if we are adding to the problem.

18. This questionnaire asks about costs, profits, etc... but nowhere was the cost of property taxes addressed. You can't compare the cost of farms and private homes on these matters.

19. I don't know. My husband passed away three years ago and I have had to have help since, and I paid for what they told me.

20. CRP and that's it.

21. Renters farm my land. I'm sure they report on my acreage since I don't always know what they are doing.

22. I think we have a very good soil conservation board and faculty.

23. Test soil and do exactly as recommended from tests.

24. I strongly believe that the irrigation practices of St. Joseph County should be watched very close for long term effects of ground water pollution and runoff. With the amount of pesticides and herbicides used and the seed corn use of irrigation in our county, we are at risk for major long term problems. Lets make sure we are doing everything possible to monitor what is taking place before it becomes too late. Just because we have the water does not and should not allow mismanagement of that resource.

25. Took soil sample to MFI seed and they put in the proper amounts.

26. The big farmers and seed corn companies in St. Joseph County are a disgrace for the future of this land and environment.

27. Too much chemical fertilizer going into our drinking water.

28. I have used herbicides and pesticides as near as I could at the amount on the label, also fertilize at the general recommendation rate-but for concern of groundwater contamination-through experience and reading, I have stopped using herbicides and pesticides and much less fertilizers and am trying to go back to the sensible way we used farm! Rotation, green manure, winter cover crops-a "Love that soil" approach. Some say "it can't be done!" but they have never tried it so how do they know what will work? In my opinion, greed has taken over for common sense.

29. Most of this farm was owned by great-grandfather—of mine of my mother's side. We moved out to the farm where my son lives in 1932. My father was a tool and die maker and general repair for Fairbanks and Morris Co. The company moved most of the plant out of three Rivers to Beloit, Wis. I had never dreamed of being a farmer. Graduated from Three Rivers High School from a business course. Grandmother had 137 acres. We acquired the place where my wife and I live from a sister of mine, 101 acres, a few years ago and the one that joins on the E side of this place, 140 acres. We also bought A 60 acre lot with no buildings on the last side on ——Rd. There is about 52 acres of timber.

30. I have 42 acres of which 26 acres are tillable. I have not planted any corn in the last 6 years. 6 years ago I rented this land. Farmers who planted did not establish a base so I lost out any allotment.

31. The worst and most pressing problem in ST.Joe County is soil erosion, both wind and water. As a seed corn producer, I feel we must get this situation under control and soon. The soils here are extremely productive and respond well to irrigation; however, they are fragile.Over fertilization is a problem in that we really don't know how much is needed to produce a consistent, high-quality seed corn crop. Seed contracts are very competitive and you must be a top notch producer to attract and keep a company. Can you see the problem? Can you help?

32. I don't think much of questionnaires. Some of M.S.U. ideas I don't agree with even though I went there 20 years ago.

33. This country needs it's Trash cleaned up to help solve a lot of problems, and the time for applying fertilizer should be regulated. This would help the water. A lot of fertilizer is not used up because it's not applied at the right time control it it's going to be a must.

34. Outlaw irrigation!! Clean up the nitrates in the water!!Help keep the small farm alive? Discourage Big Corporate Farms. Encourage L-I-S-A Practices Low Input Sustainable Agricultural Practices.

35. I have participated in the 0-92 program in 1988 1989 & 1990.

36. My neighbor, who is Amish, helps me farm.

37. I was in the 0-92 farm program in corn.

38. Yes I would like to know if I can see the results of this survey.

39. 39.3 former corn acres in CRP (widow of owner)

40. Will we get a copy of survey?

41. This land is rented. The renter raised corn-17 1/2 acres.

42. Note: 300 acres irrigated 346 acres non irrigated

43. We purchased our farm in 1980. It is 60 acres of prime hunting and waterfowling. Our intention at that time was to provide an area for our future children (which we now have) to be able to observe and hunt the animals that I enjoyed so much when I was younger. It is our goal to manage this property for their education and personal satisfaction.

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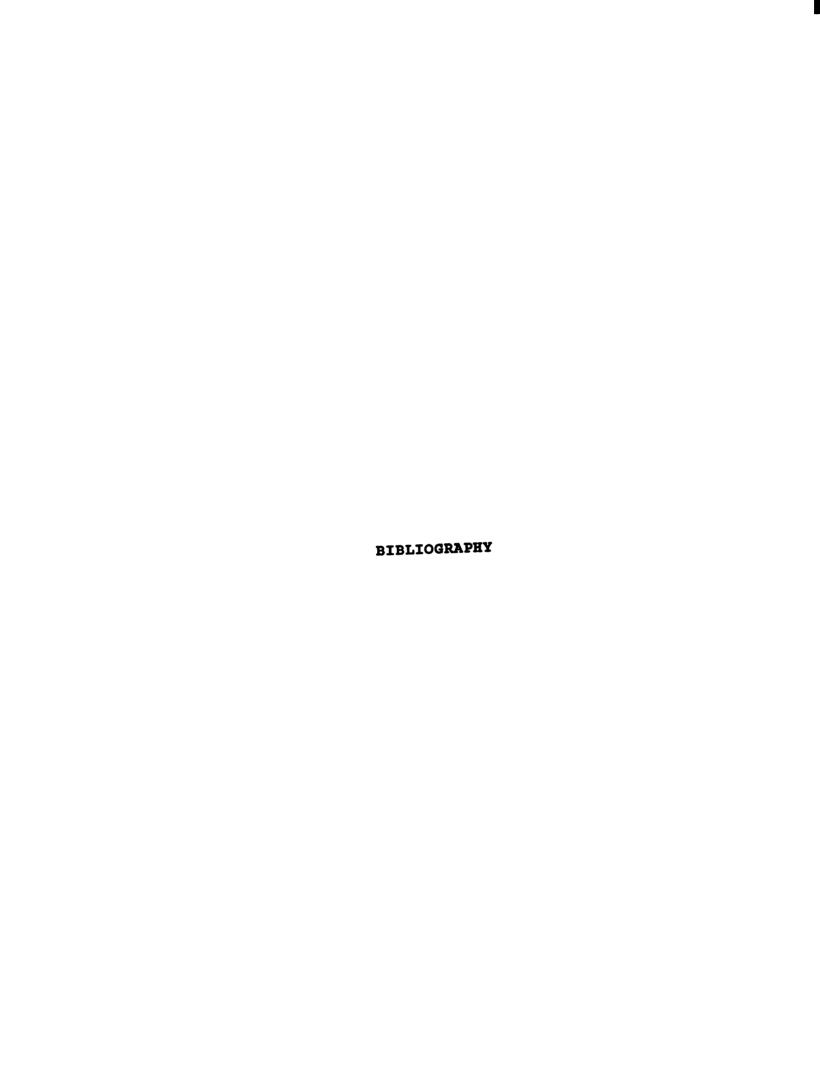Thomas, Arthur C. (1987, December). Risk attitudes measured by the interval approach: case study of Kansas farmers. American Journal of Agricultural Economics, 1101-1105.

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