1990

An analysis of selected Iowa farmers' perceptions regarding innovation characteristics and institutional factors influencing the adoption of low-input sustainable agricultural practices: implications for agricultural extension education

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An analysis of selected Iowa farmers' perceptions regarding innovation characteristics and institutional factors influencing the adoption of low-input sustainable agricultural practices: Implications for agricultural extension education

by

Adewale Johnson Alonge

A Thesis Submitted to the
Graduate Faculty in Partial Fulfillment of the
Requirements for the Degree of
MASTER OF SCIENCE

Department: Agricultural Education and Studies
Major: Agricultural Education
(Agricultural Extension Education)

Signatures have been redacted for privacy

Iowa State University
Ames, Iowa
1990
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CHAPTER I. INTRODUCTION

Background

The adoption of modern agricultural technologies has played a tremendous role in transforming American agriculture into one of the most productive and dynamic in the world. Lacy and Busch (1984) observed that agricultural research has tremendously changed the face of American agriculture. Productivity has increased from a situation where at the beginning of the century one farmer's output was able to feed only six other persons to over sixty others by 1980. Also with the impact of agricultural research the sector has become the largest industry in the U.S.A. with gross farm income totalling $100 billion, and agricultural exports amounting to $40 billion by 1980 (Rockefeller Foundation, 1982). However, opinions are divergent on the justifications for the huge social, economic and ethical costs at which the increased productivity has been achieved. Hightower (1973), Berry (1977), Lacy and Busch (1984) and Daubom (1986) have all expressed critical views at what they termed the "unsettling of American Agriculture" resulting from the displacement of family farmers by corporate operators and huge farm debts.

While opinions may be divergent on the negative social, economic and ethical costs of agricultural technologies, there seems to an agreement among development specialists about concerns for the sustainability of present production systems. The World Commission on Environment in its report of 1987 observed that increased agricultural productivity in the developed countries has been achieved largely as a result of ecologically unsound practices which depend on large doses of external inputs such as fertilizers, pesticides and non-renewable energy. For instance the ratio of all inputs (excluding labor) to cropland used for crops in the U.S. rose 61 percent between 1951 and 1972; while the ratio of fertilizer input
alone within the same period rose 266% (U.S.D.A, 1982). From these huge dosages of external inputs for agricultural production has arisen global concerns for such issues as the sustainability of non-renewable natural resources such as land, energy and groundwater; and the near stagnation in crop productivity in spite of the high doses of external inputs of the 1970s (Wittwer, 1978; Jensen, 1978; Cochrane, 1979; and Brown, 1981). For instance, incremental grain/fertilizer response ratio dropped from 14.8 in 1934-38 to 11.5 in 1948-52 and a low 5.8 in 1979-81 (World Commission on Environment and Development, 1987).

Other issues of concern about the sustainability of present agricultural production systems include increasing pest resistance to chemicals (Budiansky, 1984), soil erosion (Larson et al., 1983), groundwater contamination (Hallberg, 1986a), producer health and consumers safety issues and the profitability of the agricultural sector in spite of increased output (Lacy and Busch, 1984). The rising cost of basic agricultural production resources such as land, water, energy, labor and capital, the increasing international competition and the consequent declining commodities prices have led to a re-examination of the over-emphasis on the increased production focus of agricultural research to concern about sustainability (Dahlberg, 1986).

There now appears to be a consensus that the current high-input agricultural practices have contributed to environmental degradation and may be inappropriate for ecological sustainability. Ruttan (1982, pp. 350-51) observed that while agricultural research needs to continue its commitment to expanding the productive capacity of the resources used in agriculture,

"society should insist that agricultural science embrace a broader agenda that includes a concern for the effect of agricultural technologies on the health and safety of agricultural producers and consumers, a concern for the impact of agricultural practices on the aesthetic quality of both natural and artificial environments... and a concern for the implications of current technical choices on the options that will be available in the future".
In response to the widespread concern for the environmental impact of conventional agriculture has emerged the low-input sustainable agriculture movement whose primary objective is a change to a more environmentally benign farming system through the adoption of reduced-input agricultural practices. Reduced agricultural systems are systems in which direct or indirect use of purchased chemical-based input is significantly decreased in comparison with the conventional production systems (Buttel et al., 1981). Proponents of low-input sustainable agriculture argued that while the adoption of Best Management Practices (low-input sustainable agricultural practices), that are intended to reduce soil erosion, run-off, surface and groundwater contamination, might result in slight reduction in yield and entail more labor, when reduced variable cost is factored-in, comparable or even higher profits than conventional agriculture can be obtained (Locke et al., 1981). Francis (1987) identified the following as some examples of Best Management Practices (BMPs): setting realistic yield goal, use of soil testing results to match fertilizer application rates, timing of fertilizer applications, crop rotation, planting winter crops to reduce weed competition, control erosion and increase soil fertility.

However, while there seems to some gradual movement toward the adoption of some of these practices, adoption rates are generally low. Fleming (1987) proffered the following factors as contributing to farmers' reluctance to adopt low-input agricultural practices:

1. Farmers can externalize the environmental cost of the overuse of fertilizers and other chemicals.

2. Farmers tend not to change their established systems unless alternative methods provide substantially increased direct benefits; with low-input agriculture the economic pay-offs are not so obvious, at least not on the short-term basis.

3. Information describing low-input technology and reliable crop management information needed to overcome farmers' resistance to low-input systems are not readily available.
For instance, a United State Department of Agriculture (U.S.D.A.) survey conducted in 1979 indicated that at least 25% of the farmers interested in the low-input agriculture considered the university research centers and the Cooperative Extension Services either unwilling or unable to provide them with help (U.S.D.A., 1980).

4. The structure of the federal price support program encourages farmers to continue to use high-input methods (Duffy and Chase, 1989).

Since the future success of low-input sustainable agriculture production systems depends, among other factors, on the perceptions of young and or beginning farmers, it has thus become imperative to determine the perceptions of this important segment of the farming population about low-input sustainable agricultural practices.

Statement of the Problem

The impact of agricultural activities on groundwater quality has emerged during the decade as one of the most dominant environmental concerns of the government and the public at large. It has become one of the major subjects of scientific and legislative enquiries during the 1980s and might well remain so in the next decade (Youngberg, 1987)

Nation-wide, documented incidences of groundwater non-point source contamination by agricultural chemicals has led to a re-examination of the current high-input agricultural practices. In Iowa, hydro-geological studies of the Big Spring Basin, a sole agricultural zone, have illuminated the relationship between increased doses of agricultural inputs such as fertilizers and pesticides and declining groundwater quality (Hallberg, 1986a). Groundwater quality monitoring spanning over decades in the Basin revealed an increase in nitrate contamination of groundwater from less than 1 milligram per liter in the 1930s to 3 milligrams during the 1950s and 10.1 milligrams by 1983 (Hallberg, 1986b). This dramatic increase in contamination has been linked with increased nitrogen fertilizer usage in the Corn Belt from 65
pounds per acre in 1965 to 135 pounds in 1982 (Hargett and Berry, 1983). Sample analyses of wells from fourteen counties in Iowa between 1978-81 revealed that 40% exceeded EPA's maximum contaminant level of 10mg. per liter for nitrogen, while over 20% of water samples in 47 other counties exceeded this level (Hallberg, 1986a). Groundwater contamination with agricultural pesticides has also been recorded in 23 states, with California, New York and Iowa recording the highest levels of contamination (Cohen et al., 1986). The increasing levels of groundwater contamination by fertilizers and pesticides has led to questions being asked about the public health and economic implications of continued high-inputs of fertilizers and pesticides for agricultural production. The health implications of groundwater contamination can be imagined when it is estimated that more than half of the U.S.A. population as a whole and between 70-80 percent of Iowa population derive their drinking water from groundwater (Hallberg, 1986a). It is already estimated that 25 percent of Iowa's population is exposed through consumption of drinking water to detectable levels of chemicals such as nitrate and pesticides residues (Kelley et al., 1986). In geographic studies of mortality patterns, Blair and Thomas (1979) reported an increased risk of certain cancer of the lymphatic and hematopoetic system among farmers. Fraser and Chilvers (1980) have also raised concern about the association between nitrate contaminated drinking water and the incidence of methemoglobinemia in children.

Questions concerning the economics of continued high-input of fertilizers and pesticides, in the face of recorded huge leaching losses into groundwater, have also been raised. In the Big Spring Basin in Iowa, an area of 270 square Km, nitrate-nitrogen loss since 1982 has varied from 1.8 to 2.9 million pounds per year (Hallberg, 1986a). Other agronomic studies in different parts of the U. S. have revealed that 50-60 percent of nitrogen fertilizer is lost through processes other than grain harvest (Blackmer, 1986; Baker and Laflen, 1983; Hallberg, 1986b and Olson, 1985). The magnitude of these fertilizer losses in monetary terms can only be
imagined when it is estimated that Iowa farmers spend $400 million a year on nitrogen fertilizer (Hallberg, 1986b). Nitrogen loss through infiltration into groundwater in Iowa is estimated at $200 million per year (Hoyer et al., 1987). Hence from both ecological and economic standpoints, the continued use of high-input agricultural chemicals may not be justifiable. However past programs aimed at stimulating farmers' adoption of available technical solutions to groundwater contamination have achieved only minimal results as most farmers have continued to increase or maintain their level of agricultural chemical usage. Recent reports by the Federal Reserve Bank of Chicago (1989) estimated that farmers will increase their usage of fertilizers this year to 21.2 million nutrient tons, an increase of 9 percent over last year's figures. Pesticide use is also expected to rise 7 percent above last year's figures to 470 million pounds of active ingredients. Herbicides alone are expected to account for 402 million pounds of total pesticides. While the increase in fertilizers and pesticides input is said to be linked to an increase in land put into cultivation, the figures still appear high.

Lovejoy and Napier (1986) have blamed the little success achieved by past efforts to encourage farmers' adoption of soil and water conservation innovations on the American penchant for attempting a technological fix for every problem. They contended that past efforts have concentrated on telling farmers of the negative environmental impacts of their production systems in the hope of engendering attitudinal change and as a consequence the adoption of Best Management Practices. Past research findings have however shown the futility of such assumptions, as farmers are known to have continued to use practices that degrade the environment even when they: 1) are aware of the negative environmental impacts of their agricultural practices, 2) believe they have a social responsibility to protect the environment, and, 3) have favorable attitudes towards soil and water conservation (Lovejoy and Napier, 1986). Such findings have raised questions about the relevance of the traditional diffusion
model for explaining the adoption of conservation technologies (Lovejoy and Parent, 1982; Heffernan and Green, 1981; Pampel and Van Es, 1977).

Hence, the need for new perspectives have been called for in the study of the adoption and diffusion of environmental technologies, with focus on access to, and quality of information (Lovejoy and Napier, 1986), the need for the innovation (Ash, 1982), the perception of innovations (Miranowski, 1982) and institutional and economic factors related to adoption. Lovejoy and Napier (1986) recommended that the quality of information provided to client groups and methods of dissemination must be examined, observing that American farmers are heterogeneous, varying in managerial skills, assets, tenure relationship, diversification and other characteristics and hence have different information needs. Others such as Smathers (1982) contended that farmers' attitude towards conservation may be important in explaining why particular practices are currently used, observing that change is more easily accepted when viewed favorably by those it affects. He therefore, concluded that it is likely that the successful adoption of conservation practices will be influenced more by a farmer's attitude and perception than any other.

Therefore, it is necessary to study the perceptions of farmers regarding the practices they follow as they pertain to low-input sustainable agriculture. Implications from this analysis will lead to better educational programs to help these and other farmers make better and informed decisions.

Purpose and Objectives

The main purpose of the study was to identify perceptions held by selected Iowa farmers regarding the profitability, compatibility and complexity of selected low-input sustainable agricultural practices; and to analyze how these perceptions in concert with other institutional factors such as access to institutional sources of information, the level and quality of innovation information, tenure arrangement, and farmers' perceptions of the environmental
impact of conventional agricultural practices, influence their adoption of practices. The study's specific objectives included the following:

1. To identify how selected Iowa farmers perceive low-input sustainable agricultural practices in terms of their profitability, compatibility and complexity; and to analyze how these perceptions relate to their adoption.

2. To determine how adequately farmers are informed about the selected low-input sustainable agricultural practices.

3. To identify the level of farmers' access to and their perceptions of the quality of institutional information sources; and to analyze how these factors relate to their adoption of low-input sustainable agricultural practices.

4. To analyze the relationship between farmers' perceptions of the environmental impact of conventional agricultural practices (environmental attitude) and their level of adoption of low-input sustainable agricultural practices.

5. To identify and analyze the relationships between demographic and farm firm characteristics of farmers and their level of adoption of the practices.

Research Questions

In order to achieve the study's purpose and objectives the following research questions were raised:

1. What are the perceptions of Iowa farmers regarding the profitability, compatibility, and complexity of adopting selected low-input sustainable agricultural practices within their farming systems?

2. Is there any relationship between Iowa farmers' perceptions of low-input sustainable agricultural practices and their levels of adoption of these practices?

3. How well informed are Iowa farmers about the benefits and methods of adopting
selected low-input agricultural practices; and how does this impact on their adoption of practices?

4. What are the perceptions of Iowa farmers concerning the environmental impact of conventional agricultural practices and how do these perceptions impact on their adoption of low-input agricultural practices?

5. Are there any relationships between the demographic and farm firm characteristics of farmers (such as age, education, tenure arrangement and farm size) and their level of adoption of low-input sustainable agricultural practices?

Need for the Study

One area of the innovation adoption-diffusion research that has received the least attention in past studies is the relationship between the perceptions of potential adopters regarding innovations and the adoption rate (Rogers, 1983 and Ostlund, 1974). From this standpoint this study will be meeting a research need. Secondly, the on-going argument among diffusion scholars concerning the profitability of conservation technologies (Lockeretz et al., 1981 and Olson et al., 1982) demands the introduction of farmer perspectives into the whole debate concerning their perceptions of soil and water conservation technologies, hence the need for the study.

Groundwater is an invaluable resource to society, both present and future generations. Its contamination threatens the basic survival of society, hence it should be a source of serious concern. However available technical solutions for improving its quality have attracted a low level of adoption by farmers. Therefore an understanding of farmer perceptions of these technologies might be an important step in overcoming their resistance to adopt low-input sustainable agricultural practices.

From an educational standpoint, an understanding of farmers' perceptions regarding low-input sustainable agricultural innovations holds a lot of promise for devising appropriate
programs that would address their concerns about the innovations and hence encourage greater adoption. The success of sustainable agriculture will depend largely on the level of farmers’ input into the whole technology development and diffusion process. As Ehrenfeld (1988) succinctly puts it "no technology that treats the farmer as the last and bottom link in a hierarchical oriented, expert-dominated chain of transmitted wisdom has a chance to succeed".

Limitations to the Study

The following limitations should be borne in mind in the interpretation of the study’s findings:

From a methodological standpoint the nature of the research design (descriptive survey) placed a serious limitation to the establishment of causal relationship between perceptions and adoption of practices. In addition, the operationalization of the adoption variables using the innovation-adoption stages espoused in the Rogers and Shoemaker’s model (1971) placed some limitations with regard to the assumptions of an interval measurement scale. However measuring adoption as a continuous rather than as a dichotomous variable of adoption/non-adoption has its advantages (Feder et al., 1985).

Secondly the high level of homogeneity in the study population (Iowa Young Farmers Education Association) may restrict the size of the correlation coefficients between the variables. In the same vein the probable high levels of collinearity amongst the variables included in the regression equations may influence the estimation of the regression coefficients (Hinkle et al., 1988).

Delimitations to the Study

The study was limited to:

1. a descriptive survey of the perceptions and adoption of low-input sustainable fertilizer and herbicide management practices by selected Iowa farmers. The study did not
include other low-input sustainable agricultural practices.

2. The study did not attempt to establish a cause-effect relationship between perceptions of innovations and the level of adoption. The study was limited to the determination of relationships between the two sets of variables.

3. The study population was limited only to the active and associate members of the Iowa Young Farmers Educational Association, Inc.

Basic Assumptions of the Study

The study was based on the following assumptions:

1. The membership of the Iowa Young Farmers Education Association Inc. was adequately representative of most young farmers in Iowa.

2. The respondents would give valid and reliable information about their perceptions and adoption of low-input sustainable agricultural practices.

3. The selected practices adequately represented the recommended Best Management Practices for reducing groundwater contamination in Iowa.

4. The error of predictions for all the variables were equal, hence the use a multiple regression analysis was appropriate (W. Miller, Department of Industrial Education, Iowa State University, Ames, personal communication, 1990).

Operational Definitions of Terms

The variables used in the study were operationalized as defined below:

1. **Profitability:** The degree to which the farmers perceive the practices as being economically profitable in terms of their impact on farm income.

2. **Compatibility:** The degree to which farmers perceived the innovations as fitting well into their present production systems.
3. **Complexity**: The degree to which farmers perceived the adoption of the practices to involve difficult management skills.

4. **Level of information**: Operationalized as farmers' ratings of the degree to which they were adequately informed about each practice.

5. **Contact with institutional sources of information**: The frequency of contact between farmers and institutional sources of information from governmental and non-governmental agencies dealing with water quality issues within the last one year.

6. **Quality of information**: Perceptions of farmers regarding the usefulness of the institutional information in helping them to make informed decisions concerning practices.

7. **Farm size**: The total acres of land (either owned and/or rented) being operated by farmers.

8. **Share**: The ratio of total farm size to proportion rented on sharecropping basis.

9. **Cash**: The proportion of farm size rented on cash basis.

10. **Reduced fertilizer application**: Defined as the level of adoption of reduced rates of nitrogen fertilizers application.

11. **Reduced herbicide rate**: The adoption of reduced herbicide rate.

12. **Crop rotation practice**: The stage of adoption by respondents of the practice of including crops other than corn/soybean in their rotation.

13. **Soil testing**: Operationalized as the use of soil testing to determine nitrogen fertilizer rate.

14. **Timing of fertilizer application**: The shift from fall application of nitrogen fertilizer to spring/summer applications.

15. **Use of organic manures**: The taking of credits for plant and animal manure as supplements to artificial nitrogen fertilizers.
16. **Use of Nitrification inhibitors**: The level of use of nitrification inhibitors to reduce leaching losses of nitrogen.

17. **Banded application of herbicides**: The application of herbicides in bands as opposed to spraying.

18. **Mechanical cultivation**: Weed control through increased use of mechanical equipment and machineries to reduce chemical weed control.

19. **Age**: Chronological number of years since birth.

20. **Farming experience**: The number of years of a farmer's involvement in the farming occupation.

21. **Education**: The farmer's highest level of formal education.

22. **Perceptions of groundwater contamination**: Farmers' perceptions regarding the seriousness of groundwater contamination with agricultural chemicals in Iowa, their respective counties and farms.

23. **Adoption**: The use of the selected practices either on a trial basis or as standard practices by farmers on their farms.

24. **Composite adoption score**: Total number of the selected practices already adopted by farmers. It ranged from 0 to 9.

25. **Iowa Young Farmers Education Association Inc**: The population from which the study's sample was selected consisting of farmers of both sexes, who have participated within the last four years in young farmers' educational programs organized by agricultural educators in Iowa. The association's membership consists of farmers aged between 18 and 40 years as active members and older farmers who could join as associate members.
26. **Best Management Practices**: A combination of alternative land use, conservation practices, and management techniques, which when applied to a unit of land, result in the opportunity for a reasonable economic return within acceptable environmental standards.
CHAPTER II. REVIEW OF LITERATURE

The purpose of the study was to identify and analyze the perceptions of selected Iowa farmers regarding the innovation characteristics and institutional factors influencing their adoption of low-input sustainable agricultural practices.

The literature review is organized under the following sub-titles:
2. Application of the traditional model to conservation technologies.
3. Conceptual framework for the study
4. Review of past studies
5. Rationale for the study.
6. Summary of literature review.

General Theoretical Framework

Most of the previous studies of the temporal and spatial variations in agricultural innovation adoption have been conceptualized within specialized disciplines and have thus tended to concentrate on a narrow range of explanatory variables (Shaw, 1984). The most popular conceptual framework is the communication/diffusion model which emphasizes the process by which individuals are persuaded, through exposure to information, to change their attitude and adopt innovation. This model is best exemplified by the works of Rogers and Shoemaker (1971), and the Rogers' classical diffusion model (1983). Rogers and Shoemaker (1971) posit that the adoption-diffusion process begins with the awareness stage during which potential adopters gain knowledge about the innovation, followed by the persuasion stage during which potential adopters seek more information about the innovation and form either positive or negative attitudes toward the innovation; the trial stage is characterized by adopters trying out the innovation usually on a small scale; finally a decision is taken concerning the
continued adoption or rejection of innovation. The model identifies three clusters of variables relevant to the adoption-diffusion process: personal and cultural antecedents, the adoption process and the consequences of adoption. Personal antecedents include such variables as the individual’s personality and social characteristics, his/her socioeconomic status and his/her perceived need for the innovation. Among the cultural antecedents are the group’s norms, their attitude to change and the level of communication integration within the system (Taylor and Miller, 1978). The other two clusters of variables included in the Rogers-Shoemaker model are the communication subsystem which includes the amount, type and media of communication about the innovation that is available to potential adopters; and finally the consequences of adoption of new innovations on the system (Rogers and Shoemaker 1971, p. 102 and Rogers, 1983). This theoretical framework guided the operationalization of farmers’ adoption of low-input agricultural practices. The model assumes that making people aware of new ideas will lead to attitude formation, which will be conducive for acceptance and ultimately adoption.

The economic constraint model for the explanation of the adoption and diffusion of innovation is another model that has guided many past studies of the adoption-diffusion process (Berandi and Geisler, 1984; Nowak, 1987; Heffernan and Green, 1981). The main thesis of this model is that the perception of an environmental problem and as a consequence, the adoption of conservation practices, may be hindered by social and economic constraints. It is posited that the high private capital outlay (Green and Heffernan, 1987) and the perceived "weak private economic incentive" for the adoption of conservation practices might better explain the slow rate of adoption (Smathers, 1982). According to Coughenour (1984), although farmers' perception of environmental resources for agricultural production are shaped by the technologies provided by society, the perceptions are also shaped by farmers' goals, interest, capital position and technical skills. A limited-resource farmer with a short planning
horizon may fail to perceive environmental problems because he/she lacks the resources to correct the problem.

The communication/diffusion models for the explanation of innovation adoption and their implicit assumptions have advised previous approaches to technology development and dissemination. Condemning this approach to technology dissemination, Meyers (1984) observed that traditional extension rhetorics have emphasized dissemination of research ideas and information as if research groups were factories producing ready-to-use innovations needing only to be described and delivered to potential users. This approach has encouraged the compartmentalization of innovation development and diffusion and the present top-down approach to agricultural development. The model has also led to the over-emphasis in most diffusion studies on such personality variables as age, educational level and socioeconomic status as the determinants of innovativeness, thus implying an individual-blame bias (Rogers, 1983; Elliot and Golding, 1974). As a result of this individual-blame bias, crucial issues such as appropriateness of innovation, access to and quality of innovation information and farmers' perception of innovations have received disproportionately low attention.

**Application of the classical diffusion models to low-input sustainable agricultural practices**

Many previous programs aimed at promoting the adoption of agricultural conservation technologies have been predicated on the classical diffusion model which emphasizes the provision of information to potential adopters. However this approach has achieved minimal success as measured by the rate of adoption. Green and Heffernan (1987) observed that after fifty years of promoting soil and water conservation technologies through the provision of information, only minimal success has been achieved. This state of affairs, coupled with emerging research findings on studies of the diffusion of conservation technologies has led to a series of debates among diffusion scholars concerning the applicability of the traditional diffusion model to environmental technologies.
Expressing doubts about the applicability of the model to conservation technologies are scholars like Pampel and Van Es (1977), Jones (1973), Whiting (1971), who contended that variables other than those of the traditional model might be more appropriate for explaining the diffusion of conservation technologies. Pampel and Van Es (1977) adopting the economic constraint model dichotomized agricultural technologies into commercial and unprofitable categories and argued that the variables explaining the adoption of conservation technologies are different than those of commercial technologies. Swanson et al. (1986, p. 11); and Napier et al. (1984, p. 208) argued that information and educational programs, the core of the diffusion perspective, are ineffective futile means of inducing adoption of conservation technologies. In their study to test the applicability of the classical innovation diffusion model to environmental practices, Pampel and Van Es (1977) developed a four-fold typology of innovations: profitable commercial, less profitable commercial, profitable environmental, and less profitable environmental. They hypothesized the inappropriateness of the variables included in the classical diffusion-adoption model for explaining their adoption of non-commercial environmental innovations. Commercial innovations were defined as those involving the input of new techniques, skills, or activities with the goal of higher efficiency for the farm through stronger relationships between the farmer and the market system. On the other hand environmental innovations have as a first objective the preservation of resources of existing resources (Pampel and Van Es, 1977, p. 58). Using data collected from a random sample of 340 farmers from several counties in Illinois, they found that the traditional social and economic variables commonly included in the classical model were poor predictors of the adoption of environmental practices. They therefore concluded that the application of the accumulated knowledge on diffusion research to the promotion of non-commercial conservation practices must be done with extreme care (Pampel and Van Es, 1977)
Others such as Nowak and Korsching (1983), Taylor and Miller (1978), Heffernan and Green (1981), however, still see the relevance of the traditional diffusion model to conservation technologies. They argued that farmers must be aware of the need for the technology, be able to obtain valid agronomic and economic information to evaluate potential consequences; and receive assistance in transferring the technology to their unique ecological and managerial and social conditions. They observed that many farmers rejecting conservation technologies lack the necessary information and assistance needed to evaluate the economic and agronomic dimensions of the recommended practices. Institutional inefficiencies in the development and delivery of relevant information and assistance are also asserted to be a major reason conservation technologies are not adopted.

Taylor and Miller (1978) in their study of the adoption of pollution control practices among Amish and Non-Amish farmers in the Black Creek Watershed in Indiana found support for the applicability of the classical diffusion model to conservation technologies. Multiple regression analysis of data collected from 89 farmers in the watershed revealed the following:

1. Farmers' knowledge of innovations and attitudes towards them significantly contribute to the prediction of adoption.

2. Contact with formal communication agencies has a positive effect on the knowledge stage while informal communication (opinion leaders) has a positive effect on the persuasion stage.

Taylor and Miller (1978, p. 643), therefore, concluded that the classical diffusion model has general application to environmental innovation adoption. They however recommended the modifications of the model to include such variables as the farmer's orientation towards farming and the operationalization of adoption as a process, to ensure the applicability of the model to environmental innovation adoption.
Nowak (1987) observed that the diffusion and the economic constraints models are complementary rather than competing, hence he recommended a comprehensive model of adoption incorporating both perspectives for the study of the adoption and diffusion of conservation technologies. Hence the study adopted a theoretical model that incorporated the major elements of both the diffusion and economic/institutional constraint models. The information and innovation perception variables that were included in the study derived mainly from the Rogers' diffusion model. The economic/institutional model served as the framework for variables such as the quality of institutional information and land tenure arrangements.

Conceptual Model for the Study

The study was guided by a conceptual model that incorporated relevant elements from the General Decision-Making Model for the use of conservation practices developed by Ervin (1982, p. 72) and the Behavioral Model for the adoption of Best Management Practices developed by Nowak and Korsching (1983). The Ervin General Decision-making Model is comprehensive and multidisciplinary with inputs from economics, sociology, and psychology among others. The model hypothesized that four sets of factors-- personal, physical, institutional and economic--, influence one or more of the decision components. Ervin (1982) contended that the adoption and use of soil conservation practices is triggered by farm operator's perceptions of an erosion problem, which is in turn influenced by the farmer's level of education, orientation to agriculture, public conservation attitudes, physical land characteristics and educational program. The model also identified the following factors as being influential in a farmer's decision to use conservation practices:

1. Perception of the problem
2. Personal characteristics of farm operator
3. Attitudes toward practices
4. Institutional factors such as educational programs, technical assistance, e.g. , cost-
sharing

Finally the model incorporates an economic perspective including such factors as farm income, debt level, risk attitude and planning horizon.

The Nowak-Korsching Behavioral model identified the following cluster of factors as being influential in the adoption and maintenance of agricultural Best Management Practices (BMPs).

1. Farm firm characteristics: These include size of operations, farm income, tenure, debt level, planning horizon, credit availability and legal organization of the farm firm.
2. Characteristics of the operators: Including age, experience and education, and attitudinal dimensions which include stewardship, agrarianism and risk orientation.
3. Ecological characteristics: Include nature of land, the soil type and topography, and climate.
4. Integration into institutional networks: Refers to the availability and characteristics of different implementation program, the extent and the nature of the contacts with different representatives of these program, and the credibility that the representatives have in the local community.
5. Perception of the problem
6. Use of technical and financial resources: Use of financial assistance schemes such as cost-sharing and educational program demonstrating the economic advantages of BMPs.

On the basis of the conceptual models discussed above and other relevant literature, a conceptual model graphically illustrated below (see Fig. 1) was developed to guide the study.
Figure 1. Conceptual model for the adoption of low-input sustainable agricultural practices
Review of Past Studies

In spite of the debate concerning the applicability of the traditional diffusion model to conservation technologies, previous diffusion studies have established some tentative generalizations concerning predictive variables.

Information variables

Access to information, quality of information and the credibility of change agents have all been recognized as being crucial to the adoption of innovations (Lionberger and Gwin, 1982; Rogers, 1983). Nowak and Korsching (1983), Lasley and Nolan (1981), Belknap and Sauer (1988) all reported a positive relationship between farmers' contact with change agents, integration into information networks and the adoption of conservation technologies. Napier et al. (1986) found that access to institutional sources of information and risk-bearing orientation were positively related to concern for environment in decision-making. Using an interactive path model and structured questionnaire interview, Napier et al. (1986) collected data from 918 systematically drawn farmers living in nine randomly selected counties in Ohio, on the relative importance they attached to environmental concern in their decision-making. Bivariate correlations between 16 independent variables and the dependent variable (environmental concern) revealed that farmers who used more numerous institutional sources of information on a more frequent basis tended to be more concerned about environmental issues in their decision-making process. They also found that farmers who were concerned about the risks attached to adopting farm technologies tended to be concerned about environmental issues during the adoption decision-making process. However when the same data were analyzed using the interactive path model, access to non-institutional information sources was not directly or indirectly linked with the environmental concern while access to institutional sources of informational was weakly linked indirectly with environmental concerns (Napier et al. 1986, p. 112). They therefore concluded that information programs would be inconsequential to
farmers' decisions about adopting conservation practices and that farmers who are concerned about the environment must be convinced that adoption will not result in higher risks to their farms before they adopt new technologies.

However the findings reported by Nowak (1987) from data collected from 89 farmers in two watersheds in east-central Iowa, on the relative explanatory powers of economic and diffusion variables in the adoption of conservation technologies differed significantly from those of Napier and his colleagues. Farmers' adoption index were calculated for four conservation practices, namely: contour planting, strip cropping, grass waterway and buffer strips which were considered unprofitable. Pearson correlation and regression analyses to test the relationship between the adoption index, farmers' contact with extension workers and the U.S.D.A. or related agencies and the number of field days, field demonstrations or test plots visited by farmers during the previous year produced statistically significant results. From this study Nowak (1987, pp. 216-7) drew the following conclusions and implications for further studies.

1. Both economic and diffusion factors are important in predicting the adoption of conservation practices.

2. Soil and water conservation technologies cannot be treated as unidimensional technology; the attributes of innovation interact with the setting of adoption to influence subsequent adoption processes.

3. Future measures of adoption and diffusion of conservation technologies should include the process (time) dimension.

4. Measure of institutional setting must be more precise including not only the number of contacts but the nature and quality of these contacts.
Farm size

Findings concerning the relationship between farm size and the adoption of conservation technologies have not shown a high level of consistency. While Buttel et al. (1981) reported an inverse relationship between farm size and environmental attitude, Green and Heffernan (1987) reported a positive relationship between farm size and the perception of soil erosion problems. Miranowski (1982) reported that operators of larger farms tended to adopt more conservation practices than smaller operators, a finding that contradicted those of Napier et al. (1984).

Risk perceptions

Miranowski (1982) and Napier et al. (1986) found a relationship between farmers' perceived risk of adopting conservation technologies and the rate of adoption. Napier et al. (1986, p. 109) observed that farmers who are concerned about the environment must be convinced that adoption will not result in higher risk to their farms before they will adopt new technologies. They concluded that simply making farmers aware of environmental problems will not bring about adoption; empirical research demonstrating that conservation practices can be profitable without introducing more uncertainty into adopters' lives will be required. In another study concerning the perceptions of agricultural chemicals' contamination of groundwater among farmers in the Big Spring Basin area of Iowa Padgitt (1985) reported the prevalence of the “proximity principles” in farmers’ perceptions. He discovered that farmers tended to perceive groundwater contamination problems as more serious in their neighbors' farms or in the neighboring counties than in theirs. Heffernan and Green (1981) also questioned the validity of the traditional diffusion model's assumption that there was an agreement between government agencies and farmers as to the nature, existence and magnitude of resource conservation problem. They also opined that the assumption of direct relationship between perception of problem and adoption has not been supported by research findings.
However, Lasley and Nolan (1981), Lovejoy and Parent (1982) and Ervin and Ervin (1982) all reported highly significant relationships between perception of erosion problem and the adoption of conservation practices.

**Tenure arrangement**

There seems to be an agreement from previous studies that land tenure arrangement is a crucial factor in the adoption of conservation technologies. Ervin (1986), Nowak and Korsching (1983), Frey (1952) and Hauser (1976) all reported more investment on conservation technologies for owned than rented land. Baron (1981) in his analysis found that owner-operators and owners who leased their land on share terms were more likely to invest in soil-conserving practices than owners who leased their land on cash terms. In a related study, Kraft (1978) found that dairy farmers in Ontario county of New York who could not obtain long-term leases on rented land tended to exploit or "mine" it by growing continuous corn for 4-6 years and not practicing strip cropping nor growing alfalfa. In a series of studies conducted at Iowa State University to determine the influence of land tenure arrangement on the adoption of conservation practices, tenure problems were significantly related to owner resistance to conservation practices (Frey, 1952; Held and Timmons, 1958; Hauser, 1976). Hauser (1976) found that owner-operators averaged five tons annual soil loss less than strictly renter-operators. He also found a significant negative relationship between length of tenure and soil erosion (Hauser, 1976). The implications of these findings is that the term of tenure arrangement is important in determining the influence of tenure in the adoption of conservation technologies.

**Age and farming experience**

The findings of previous studies on the relationship between farmer's age and the adoption of conservation practices showed a lot of inconsistencies. Studies by Hoover and Wiitala (1980) in Nebraska, and Lasley and Nolan (1981) in Missouri found that Soil
Conservation Service cooperators were more likely to be older than non-cooperators. However, many other research findings such as Lovejoy and Parent (1982) in the Black Creek watershed in Indiana, Ervin and Ervin (1982) in Missouri, and Baron (1981) indicated that younger farmers were more likely to adopt conservation practices. For instance, Ervin and Ervin (1982) contended that younger farmers were more likely to perceive the erosion problem, view conservation practices as profitable and as a result accept the financial risk associated with adoption, due to their long planning horizon.

**Education**

Unlike age, findings of past studies investigating the relationship of education to the adoption of conservation practices have yielded fairly consistent results pointing to the existence of positive relationship. Bultena and Hoiberg (1983) in a 23-Iowa-county study, Ervin and Ervin (1982) in Missouri, and Nowak and Korschling (1983) all found that formal education was associated with the likelihood of adoption of conservation practices. However, in their study of the perception of erosion problem by selected farm operators in the Monroe county of Missouri, Green and Heffernan (1987) found a negative relationship between education and the extent to which soil erosion was considered a severe problem. Farmers with more education (operationalized in four classes of 0-6, 7-9, 10-12 and >12) were more likely to identify a soil erosion problem than farmers with less education; however the less educated were more likely to perceive their problem as severe.

**Farmers' attitudes and perceptions of problem**

Basu et al. (1982, p. 12) asserted that farmers' attitudes such as risk orientation, agrarianism and stewardship have a significant effect on their participation in conservation activities. Agrarianism, the preference for rural life has been shown by Taylor and Miller (1978) to be related to the adoption of conservation practices. Farmers who view farming as a
way of life will be more likely to adopt environmental innovations than will farmers who view farming as a commercial enterprise.

Review of Past Studies on Perceptions and Adoption of Innovation

The on-going debate regarding the applicability of the traditional diffusion model to conservation technologies has largely overlooked one crucial factor in the whole innovation-decision process. Little attention has been given to perceptions by farmers, of the technical solutions offered for overcoming groundwater quality and soil erosion problems. This neglect is not limited to the diffusion of conservation technologies alone. Rogers (1983), Ostlund (1974), and Elliot (1968) have raised the same issue concerning the whole innovation diffusion field when they condemned the paucity of materials in the diffusion literature concerning the role of farmer perceptions of innovations' attributes in the innovation-decision process. Writing on the issue, Dahlberg (1986) opined that farmers have been given little consideration in the agricultural development process due largely to the assumption by the dominant scientific culture that their values and practices are superior and hence can be imposed on the farmers. This was a phenomenon that Rogers (1983) described as the pro-innovation bias of the dominant development paradigm.

The importance of farmers' perceived attributes of innovation in determining the rate of adoption have long been recognized in the social science literature. Linton (1936) identified farmer perceptions of an innovation's attributes of utility and compatibility as being crucial in the innovation adoption process. Others such as Barnett (1953), Rogers (1983), and Fliegel and Kivlin (1962) have also recognized the importance of innovation attributes of relative advantage, compatibility, complexity, observability and trialability as factors affecting the adoption rate. Linton (1936) was one of the earliest persons to describe the relationship between the perceived attributes of innovation and its rate of acceptance. According to him
innovations are accepted by potential adopters on the basis of the two attributes - utility and compatibility. He defined utility as what the innovation appears to be good for, and compatibility as the ease with which the innovation can fit into the existing culture configuration (Linton, 1936, p. 342). An innovation can be more useful than the one it supersedes; if it requires a different kind of effort or is unpleasant to work with, then the innovation may be rejected.

Barnett (1953) identified the cost of acquiring and using an innovation, its compatibility or incompatibility with tradition and several other attributes of innovations as factors affecting the rate of adoption. Others such as Lionberger (1960) mentioned an innovation's required capital outlay for adoption, its compatibility with existing practices, its communicability and the extent to which it can be adopted first on a small-scale as crucial to the innovation-decision process. In one of the first attempts at collecting empirical data on the relationship between farmers' perception of innovation attributes and the rate of adoption, Fliegcl and Kivlin (1962) arrived at findings that confirmed the existence of such a relationship. The study covered 43 dairy practices introduced among farmers in Pennsylvania and tested 11 attributes for their relationship with the rate of adoption. Using data collected from 229 dairy farmers and a panel of 20 judges, farm practices' characteristics of complexity, compatibility, time-saving attribute and advantage showed significant relationships with rate of adoption when tested at the 95 percent confidence interval.

In spite of the long established importance of perceptions in the innovation decision-making process, few studies have been carried out to analyze the relationship between farmers' perceptions regarding innovation characteristics and the rate of adoption of environmental conservation practices (Basu et al., 1982). Carlson, Dillman and Lassey (1981), in their Idaho study, found that farmers did not adopt erosion control practices in a random or haphazard manner, observing that farmers were more likely to adopt a practice that was perceived to be
compatible with their rotation pattern than they were if they had to change their rotation pattern to accommodate the erosion control practice. Perception of profitability as opposed to actual profitability has also been shown to be a significant factor in the adoption of conservation practices such as contouring and conservation tillage (Ervin, 1982).

Basu et al. (1982), quoting from the work of Nowak, identified four characteristics that are crucial to the adoption or rejection of conservation practices. The characteristics, which are very identical to those of the Rogers' classical adoption diffusion model (1983) include:

1. **Compatibility**: defined as the extent to which the conservation measure is consistent with both a landowner's agronomic and social value systems.

2. **Complexity**: how difficult the practice is to use.

3. **Flexibility**: the extent to which a conservation practice can be manipulated to increase compatibility with the existing agricultural system.

4. **Divisibility**: extent to which a practice may be tried on a limited basis prior to full-scale adoption and the amount of investment required.

The first two characteristics identified above were included in this study, in addition to an analysis of farmers' perceptions regarding the profitability of low-input agricultural practices was included.

In a related study, Moon (1982), using a cross-sectional research design, investigated the relationship between farmers' perceptions of innovation characteristics and the adoption of conservation practices in the Four-Mile Creek in Tama county, Mud Creek in Benton county and the Rock Creek in Cedar county of Iowa. In a series of interviews, first with a sample population of 198, dropping to 141 during the fourth contact, the following findings were made:

1. Farmers' perception of the characteristics of soil conservation practices were important in explaining the adoption and maintenance of such practices.
2. Full adopters when compared to non-users tended to perceive terracing, contour planting and minimum tillage as having lower costs, as being more profitable, less consumptive of time and labor, easier to use and more compatible to existing operations.

He however identified the following issues as limitations to the generalizability of his study's findings:

1. The research design did not lend itself to the establishment of a cause-effect relationship between farmers' perception of innovation characteristics and adoption of conservation practices. He recommended the use of panel data to investigate changes in perceptions as the subjects progress along the adoption continuum.

2. Categorization of respondents into non-user, trial-users and full adopters was not precise enough to enable the monitoring of perceptual changes across the adoption process. He recommended the use of the five stages in the innovation-decision process as categorization parameters. This recommendation was incorporated into the present study.

3. He also identified the agronomic, cultural and organizational specificity of the study areas as a limitation to the external generalizability of the findings.

In another study, Green and Heffernan (1987) reported that the profitability assessments of various conservation practices by farmers in the Monroe county of Missouri showed a moderately strong relationship to their perceptions of soil erosion as a problem. Farmers who identified soil erosion as a problem were more likely to have considered terraces, crop rotation with grasses and legumes, and minimum tillage as profitable (Green and Heffernan, 1987: p. 153). However, when the data were analyzed for the extent to which soil erosion was perceived as being severe, farmers who considered their erosion problem as more severe were less likely to consider the various soil conservation practices as profitable. According to Green
and Heffernan (1987, p. 153), this finding makes a lot of sense because farmers who are experiencing severe erosion problems are more likely to feel that most conservation practices would not net any benefits.

Rationale for the Study

A study of farmer perceptions regarding the attributes of low-input sustainable agricultural practices has become necessary in view of the controversy concerning the profitability of conservation technologies. Miranowski and Alt (1978, p. 374) suggested the inclusion of farmers' subjective perceptions of innovations in adoption research models for Best Management Practices, observing that farmers' perceptions of innovation very often differ from researchers' perceptions. Hence an understanding of farmers' subjective perceptions may shed more light on farmers' decision-making process. Perceptual selectivity on the part of the potential adopter and the change agents is often a crucial factor in effective communication. The divergence in perceptions imposes limits on the ability of the potential adopters to absorb certain types of technical advice no matter how well they are written or explained. To expect farmers to adopt low-input sustainable agricultural practices simply because they have been provided information on the adverse effects of their present farm practices on groundwater quality, is not only unrealistic but oversimplistic. It assumes that farmers share the perceptions of the change agents. In the words of Burton and Kates (1964) the problem of communication is rooted in perceptions; it has to do with changing and shaping perceptions, and knowing whether an innovation is complex, compatible, risky, uncertain, useful or has advantages over old ways. A reliable prediction of the future choices of agricultural producers is likely to emerge from an understanding of their perceptions and the way they differ from those of the technologists. This forms the rationale for the study.
Summary of Literature Review

In this review, attempts have been made to put the study in perspective through an analysis of the general theoretical models that have underpinned previous innovation diffusion-adoption studies. The classical innovation-diffusion model espoused by Rogers and Shoemaker (1971) was reviewed for its applicability and limitations for the study of the adoption of conservation technologies. The current arguments regarding appropriate theoretical models for the study of the adoption and diffusion of environmental technologies were analyzed with a view to establishing the need for a comprehensive model, that incorporates the major elements of the classical diffusion and economic constraints models. The Ervin's General Decision-making model and the Nowak-Korching Behavioral model were discussed as the underpinnings for the development of a conceptual model for the study. Finally a review of past studies on the adoption of conservation technologies was carried out with a view to establishing the rationale for the present study.

To conclude this review of literature the quotation credited to Seitz and Swanson (1980) on the adoption and diffusion of conservation technologies is very instructive. They observed that:

"In essence we are painting a picture of a farm decision process that is much more complex than represented by the models we find in the literature. As we construct more appropriate models of the overall farm planning process, we may be able to improve our explanation of the soil conservation decisions made by the farm operator. We still have a long way to go to develop the types of models needed to characterize the full range of considerations that impact on farmers' decision regarding soil conservation and to enable us to perform our educational function more effectively".
Therefore, given the amount of work that remains to be done in the conceptualization of the adoption of conservation technologies, the study was essentially an attempt at describing the perceptions and adoption of selected low-input sustainable agricultural practices, by selected Iowa farmers.
CHAPTER III. METHODS AND PROCEDURES

The main purpose of this study was to determine and analyze the perceptions of selected Iowa farmers regarding the profitability, complexity and compatibility of selected low-input sustainable agricultural practices, and how these perceptions influenced their level of adoption of the practices. The study also sought to analyze farmers perceptions regarding institutional constraints such as access to institutional information, tenure arrangement and other demographic variables that influence the level of adoption of practices.

Research Design

The study adopted a descriptive survey design. This design was deemed appropriate given the exploratory nature of the study and the nature of the data to be collected.

Population and Sampling Procedures

The population of the study consisted of selected Iowa farmers and farm couples who have participated in the activities of the Iowa Young Farmers Educational Association, Inc., within the last four years. The association consists of young farmers and farm couples within the ages of 18 and 40 who participate as active members in educational, leadership, recreational and community development activities, working in close contact with agricultural educators in different parts of Iowa. In line with the philosophy of the association which stipulates that “a young farmer is any one who is willing to learn”; the population also included associate members of the Iowa Young Farmers Educational Association Inc., who are usually older than the 40 years age limit. According to Omer (1987) the membership of the association constituted, in 1986, about 5% of all the farmers in Iowa between the ages of 18 and 40. A data base containing a list of 545 farmers was accessed for sample selection. Because of the age of the data base and the problem of low response rates characteristic of past surveys of farmers in Iowa, an oversample of 300 farmers was generated using an Apple random number
generator program. It was envisaged that such an oversample would help in achieving the sample size of 150 respondents envisaged for the study.

Development of Instrument

The instrument for data collection was a mailed questionnaire. The instrument was developed in line with the main focus of the study, namely, herbicides and nitrogen fertilizer management under the low-input sustainable agricultural practices. Best Management Practices for reducing groundwater contamination by herbicides and nitrogen fertilizers were identified from literature and from recommendations being promoted by the Iowa State University Experiment Station and the Cooperative Extension Service. The selected practices and other sections of the instrument were evaluated and validated by three professors from the departments of Sociology and Agricultural Education and Studies, and an Area Extension Crop Specialist with working and research experiences in low-input sustainable agriculture. In addition, graduate students in the Iowa State University Department of Agricultural Education and Studies were asked to evaluate the questionnaire for the appropriateness of the language (see Appendix A). The questionnaire consisted of seven sections as follows:

Section 1. Consisted of items to determine the stages of farmers' adoption of the nine selected practices. The scale used incorporated the five stages of innovation diffusion-adoption developed by Rogers and Shoemaker (1971). Farmers were asked to indicate their level of adoption of practice along the following continuum:

i. Rejection; ii. Awareness stage; iii. information gathering stage; iv. trial stage and v. full adoption.

Section 2. Perception of the profitability of practices: Farmers were required to rate each practice on a scale of five ranging from "Highly unprofitable" to "Highly profitable".

Section 3. Perception of compatibility with a scale ranging from "Very incompatible" to "Very compatible".
Section 4. Perception of complexity in which farmers were requested to rate the level of difficulty of the management practices involved in adopting the practices on a scale ranging from "Very difficulty" to "Very easy".

Section 5. Contained items developed to determine how adequately farmers were informed about the practices and to ascertain the sources and quality of information available to farmers. Farmers were asked to rate the degree to which they were adequately informed about the practices on a scale that ranged from (1) completely uninformed to (5) very adequately informed.

Section 6. Consisted of items to determine farmers' perceptions regarding the seriousness of groundwater contamination by agricultural chemicals in Iowa, their respective counties and farms. They were asked to rate the problem from 'None' to 'Very serious'.

Section 7. Consisted of items to determine the demographic characteristics of respondents such as their farm size, age, level of education, years of farming experience and any general comments of respondents. They were also asked to indicate by what percentages they had reduced their inputs of fertilizers and herbicides.

Collection of Data

Using the generated random numbers, corresponding names from the data base were extracted to prepare a mailing list of respondents. Three hundred questionnaires were mailed out to the respondents during the first week in January, 1990, with a postage-paid return envelope included to facilitate a quick response. Of the 300 questionnaires mailed out during the first mailing 117 were returned only 73 of which were usable. Others were either returned undelivered or uncompleted by respondents who were not willing to participate in the survey. A follow-up mailing of 183 questionnaires to non-respondents was done three weeks later, on January 23, 1990. The second mailing resulted in the return of another 42 questionnaire
giving a total of 115 constituting a 38.3% response rate. It is, however, noteworthy to indicate that the data used for the study represented 21% of the total population.

Analysis of Data

Questionnaire items were coded and fed into the Statistical Package for Social Science (SPSSX) computer program for data analysis. The following statistical treatments were applied to the data:

1. The subprogram "Frequencies" was utilized to calculate the means, frequency count, standard deviations and percentage scores of respondents for each of the variables of interest.

2. The Post-hoc reliability tests for each of the first six sections of the questionnaire and for all the questionnaire items as a whole (except demographic data) were calculated.

3. A multiple regression model was developed to predict the composite adoption scores of respondents as a function of their perceptions of innovations and groundwater contamination; contact with and perceptions of the quality of institutional sources of information; and other demographic variables such as land tenure, age, education, level of information and farming experience.

4. F tests were calculated to locate variables contributing significantly to the regression equation.
CHAPTER IV. ANALYSIS AND FINDINGS

This chapter presents the analysis of data and the major findings of the study in line with the study’s objectives. The primary purpose of the study was to determine and analyze the perceptions of selected Iowa farmers regarding innovation characteristics and institutional factors influencing the adoption of selected low-input sustainable agricultural practices. Specifically, the study set out to determine how farmers in Iowa perceived selected fertilizer and herbicide management practices in terms of their profitability, complexity and compatibility with their farming systems. A secondary objective of the study was to analyze how these perceptions, in concert with other institutional factors such as tenure, farm size and access to information, influenced their adoption of these selected practices.

The chapter is divided into the following sections: (1) Results of post-hoc reliability tests of instrument, (2) Demographic information about respondents, (3) Descriptive statistics such as percentages and mean perceptions and adoption of selected practices, (4) Parametric tests of significant relationships between perceptions, institutional and demographic variables and the level of adoption of selected low-input sustainable agricultural practices.

Reliability Tests

In addition to the efforts to improve the instrument’s reliability during its construction, the Cronbach's alpha post-hoc procedure was conducted to determine the overall reliability of the instrument. The test revealed a fairly high level of reliability of the total instrument with an alpha coefficient of 0.89.

Demographic Information

Demographic information about respondents including their age, educational level, and farm size, proportion of total land holding rented either on cash or share cropping basis and length of farming experience were identified. The distribution of respondents by their age
groups is shown in Figure 2. Two respondents representing 1.8% were aged 19 years and below; 12 respondents (10.4%) were aged between 20 and 29; there were 68 respondents (59.1%) whose ages ranged from 30 and 39; 22 respondents (19.1%) indicated ages from 40 and 49, 7 respondents representing 6.1% were aged between 50 and 59 while only 4 respondents (3.5%) were aged above 60 years.

The distribution of respondents by years of farming experience as shown in Figure 3 indicated that 24 respondents representing 20% of all respondents had 10 years or less of farming experience; 60% had between 11 and 20 years of farming experience, 14 respondents (12.1%), between 21 and 30 years, while 8 respondents (7%) had over 30 years of farming experience. One respondent (0.9%) did not indicate how long he/she had been farming. The average length of farming experience of respondents was 17.5 years.

The distribution of respondents by level of education is presented in Figure 4. The data indicated that 37 respondents (32.2%) achieved between 10th and 12th grade of education, 39 respondents (33.9%) had some college education while 37 respondents (32.2%) completed college degrees. Only 2 respondents had graduate degrees.

Shown in Figure 5 is the distribution of respondents by the size of their farm holdings (owned and or rented). Over half of the respondents (56.6%) had farms sized 500 acres and below; 34.6% of respondents operated farms that ranged in sizes between 501 and 1000 acres; 4.4% had farms sized between 1001 and 1500 acres; 2.6% cultivated between 1501 and 2000 acres while only 2 respondents cultivated farms sized over 2000 acres. Farm sizes ranged from 6 to 3000 acres with a mean of 545.5 acres.

Adoption of Selected Low-input Sustainable Practices

One of the most important objectives of the study was to determine the level of adoption by respondents of low-input sustainable practices in nitrogen fertilizer and herbicide management.
Figure 2. Distribution of respondents by age groups

Figure 3. Distribution of respondents by years of farming experience
Figure 4. Distribution of respondents by levels of education

Figure 5. Distribution of respondents by farm size
Respondents were requested to indicate their stage of adoption of practices based on the stages of adoption espoused in the Rogers-Shoemaker model (1971). Tables 1 and 2 present the distribution of respondents according to their stages of adoption of reduced nitrogen fertilizer application rates and percentage fertilizer reduction respectively.

The data in Table 1 show that 5 respondents (4.3%) indicated they found the practice inappropriate and thus rejected it. The same number of respondents (5) indicated they had just become aware of the practice, 33 respondents (28.7%) were looking for more information before making a decision one way or the other concerning the adoption. Forty-four respondents representing 38.3% were already trying the practice on their farms while 28 respondents (24.3%) had adopted reduced nitrogen fertilizer rates as a standard practice on their farms.

Table 1. Percentage distribution of respondents by their stages of adoption of reduced nitrogen fertilizer rates

<table>
<thead>
<tr>
<th>Adoption stage</th>
<th>N</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rejection of practice due to inappropriateness</td>
<td>5</td>
<td>4.3</td>
</tr>
<tr>
<td>Just become aware of practice</td>
<td>5</td>
<td>4.3</td>
</tr>
<tr>
<td>Looking for more information before adoption</td>
<td>33</td>
<td>28.7</td>
</tr>
<tr>
<td>Trying out practice</td>
<td>44</td>
<td>38.3</td>
</tr>
<tr>
<td>Full adoption of practice</td>
<td>28</td>
<td>24.3</td>
</tr>
</tbody>
</table>

Table 2 indicated that respondents had reduced their rate of fertilizer application within the last three years by percentages ranging from 0 to 50. Thirty-eight respondents (33%) had made no reduction in their fertilizer rates within the last three years. The distribution of respondents by their percent reduction in nitrogen fertilizer rates ranged from 2 respondents making 5% reduction, 21 making 10% reduction, 1 respondent each making 14%, 17%, 18%, and 23% reduction respectively in nitrogen fertilizer rates. Eleven respondents (9.6%) had
reduced their fertilizer rates by 15%, 19 respondents had made 20% reduction, 8 respondents-25% reduction, 5 respondents-30% reduction, 3 respondents-40% reduction and 4 respondents had cut their nitrogen application level by half.

Table 2. Distribution of respondents by percent reduction in nitrogen fertilizer rates

<table>
<thead>
<tr>
<th>Percent reduction in fertilizer rates</th>
<th>N</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>38</td>
<td>33.0</td>
</tr>
<tr>
<td>5</td>
<td>2</td>
<td>1.7</td>
</tr>
<tr>
<td>10</td>
<td>21</td>
<td>18.3</td>
</tr>
<tr>
<td>14</td>
<td>1</td>
<td>0.9</td>
</tr>
<tr>
<td>15</td>
<td>11</td>
<td>9.6</td>
</tr>
<tr>
<td>17</td>
<td>1</td>
<td>0.9</td>
</tr>
<tr>
<td>18</td>
<td>1</td>
<td>0.9</td>
</tr>
<tr>
<td>20</td>
<td>19</td>
<td>16.5</td>
</tr>
<tr>
<td>23</td>
<td>1</td>
<td>0.9</td>
</tr>
<tr>
<td>25</td>
<td>8</td>
<td>7.0</td>
</tr>
<tr>
<td>30</td>
<td>5</td>
<td>4.3</td>
</tr>
<tr>
<td>40</td>
<td>3</td>
<td>2.6</td>
</tr>
<tr>
<td>50</td>
<td>4</td>
<td>3.5</td>
</tr>
</tbody>
</table>

The data in Table 3 show that 44 respondents (38.3%) indicated they found the use of nitrification inhibitor inappropriate, hence rejected its adoption. Eleven respondents (9.6%) indicated they had just become aware of the practice, 29 respondents (25.2%) were looking for more information before making a decision one way or the other concerning the adoption of the practice; 18 respondents representing 15.7% were already trying the practice on their farms while 13 respondents (11.3%) had adopted the practice as standard on their farms.

The data in Table 4 present the information on the stages of adoption of the inclusion of crops other than corn and soybeans in the farmers' rotation. The data indicate that 24 respondents (20.9%) indicated they found the practice inappropriate and had rejected it. Three respondents (2.6%) indicated they had just become aware of the practice, 20 respondents (17.4%) were still looking for more information before making a decision concerning the
adoption of the practice; 30 respondents representing 26.1% were already trying the practice on their farms while 38 respondents (33%) had fully adopted the practice.

Table 3. Percent distribution of respondents by their stages of adoption of nitrification inhibitor

<table>
<thead>
<tr>
<th>Adoption stage</th>
<th>N</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rejection of practice due to inappropriateness</td>
<td>44</td>
<td>38.3</td>
</tr>
<tr>
<td>Just become aware of practice</td>
<td>11</td>
<td>9.6</td>
</tr>
<tr>
<td>Looking for more information before adoption</td>
<td>29</td>
<td>25.2</td>
</tr>
<tr>
<td>Trying out practice</td>
<td>18</td>
<td>15.7</td>
</tr>
<tr>
<td>Full adoption of practice</td>
<td>13</td>
<td>11.3</td>
</tr>
</tbody>
</table>

Table 4. Distribution of respondents by their stages of adoption of crop rotation

<table>
<thead>
<tr>
<th>Adoption stage</th>
<th>N</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rejection of practice due to inappropriateness</td>
<td>24</td>
<td>20.9</td>
</tr>
<tr>
<td>Just become aware of practice</td>
<td>3</td>
<td>2.6</td>
</tr>
<tr>
<td>Looking for more information before adoption</td>
<td>20</td>
<td>17.4</td>
</tr>
<tr>
<td>Trying out practice</td>
<td>30</td>
<td>26.1</td>
</tr>
<tr>
<td>Full adoption of practice</td>
<td>38</td>
<td>33.0</td>
</tr>
</tbody>
</table>

The data in Table 5 regarding the stages of adoption of soil nitrogen testing by farmers show that 8 respondents (7.0%) indicated they found the practice inappropriate and had rejected it. Seven respondents (6.1%) indicated they had just become aware of the practice, 28 respondents (24.3%) were looking for more information before making a decision one way or the other concerning the adoption of the practice; 20 respondents representing 17.4% were already trying the practice on their farms while 52 respondents (45.2%) had achieved full adoption of the practice.
Table 5. Percent distribution of respondents by their stages of adoption of soil nitrogen testing

<table>
<thead>
<tr>
<th>Adoption stage</th>
<th>N</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rejection of practice due to inappropriateness</td>
<td>8</td>
<td>7.0</td>
</tr>
<tr>
<td>Just become aware of practice</td>
<td>7</td>
<td>6.1</td>
</tr>
<tr>
<td>Looking for more information before adoption</td>
<td>28</td>
<td>24.3</td>
</tr>
<tr>
<td>Trying out practice</td>
<td>20</td>
<td>17.4</td>
</tr>
<tr>
<td>Full adoption of practice</td>
<td>52</td>
<td>45.2</td>
</tr>
</tbody>
</table>

The data in Table 6 indicate that 10 respondents (8.7%) indicated they found the practice of changing the timing of nitrogen fertilizer application from fall to spring/summer application inappropriate and hence rejected it. Three respondents (2.6%) indicated they had just become aware of the practice, 8 respondents (7.0%) were at the information gathering stage in the adoption process; 15 respondents representing 13.0% were already trying the practice on their farms while 79 respondents (68.7%) had adopted the practice as standard on their farms.

Table 6. Distribution of respondents by their stages of adoption of change in the timing of nitrogen fertilizer application from fall to spring/summer

<table>
<thead>
<tr>
<th>Adoption stage</th>
<th>N</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rejection of practice due to inappropriateness</td>
<td>10</td>
<td>8.7</td>
</tr>
<tr>
<td>Just become aware of practice</td>
<td>3</td>
<td>2.6</td>
</tr>
<tr>
<td>Looking for more information before adoption</td>
<td>8</td>
<td>7.0</td>
</tr>
<tr>
<td>Trying out practice</td>
<td>15</td>
<td>13.0</td>
</tr>
<tr>
<td>Full adoption of practice</td>
<td>79</td>
<td>68.7</td>
</tr>
</tbody>
</table>

The data in Table 7 indicate that only 9 respondents (7.8%) had rejected the practice of taking credit for manure as supplements for chemical nitrogen fertilizer, due to its
inappropriateness. Just one respondent (0.9%) indicated he/she had just become aware of the practice, while 9 respondents (7.8%) were still looking for more information before making a decision about the adoption of the practice. Twenty-four respondents representing 20.9% were already trying the practice on their farms while 72 respondents (62.6%) had fully adopted the practice on their farms.

Table 7. Distribution of respondents by their stage of adoption of taking credit for green/animal manures in determining nitrogen fertilizer rates

<table>
<thead>
<tr>
<th>Adoption stage</th>
<th>N</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rejection of practice due to inappropriateness</td>
<td>9</td>
<td>7.8</td>
</tr>
<tr>
<td>Just become aware of practice</td>
<td>1</td>
<td>0.9</td>
</tr>
<tr>
<td>Looking for more information before adoption</td>
<td>9</td>
<td>7.8</td>
</tr>
<tr>
<td>Trying out practice</td>
<td>24</td>
<td>20.9</td>
</tr>
<tr>
<td>Full adoption of practice</td>
<td>72</td>
<td>62.6</td>
</tr>
</tbody>
</table>

The data on Table 8 show the distribution of respondents according to their stage of adoption of mechanical weeding to supplement chemical weed control. Sixteen respondents (13.9%) indicated they found the practice inappropriate for their farming systems and had rejected it. Seventeen respondents (14.8%) were still in the stage of gathering more information about the practice before deciding on its adoption. None of the respondents was at the awareness stage in the adoption of mechanical weeding. On the other hand, there were 36 respondents who were already trying the practice on their farms, while 45 respondents were already full adopters of the practice. Only one respondent failed to indicate his/her stage of adoption of the practice.
Table 8. Percent distribution of respondents by their stages of adoption of mechanical weed control

<table>
<thead>
<tr>
<th>Adoption stage</th>
<th>N</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rejection of practice due to inappropriateness</td>
<td>16</td>
<td>13.9</td>
</tr>
<tr>
<td>Just become aware of practice</td>
<td>0</td>
<td>0.0</td>
</tr>
<tr>
<td>Looking for more information before adoption</td>
<td>17</td>
<td>14.8</td>
</tr>
<tr>
<td>Trying out practice</td>
<td>36</td>
<td>31.6</td>
</tr>
<tr>
<td>Full adoption of practice</td>
<td>45</td>
<td>39.1</td>
</tr>
<tr>
<td>Not indicated</td>
<td>1</td>
<td>0.9</td>
</tr>
</tbody>
</table>

The data in Tables 9 and 10 show the distributions of respondents according to their stages of adoption of, and percent reduction in herbicide application rates. Table 9 shows that 13 respondents indicated they had rejected the practice due to its inappropriateness, 39 respondents representing 33.9% were already trying the practice while 37 respondents (32.2%) had achieved full adoption. However, 1 respondent indicated he/she had just become aware of the practice, while 25 respondents were still looking for more information about the practice before making a decision on its adoption.

Table 9. Distribution of respondents by their stages of adoption of reduced herbicide rates

<table>
<thead>
<tr>
<th>Adoption stage</th>
<th>N</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rejection of practice due to inappropriateness</td>
<td>13</td>
<td>11.3</td>
</tr>
<tr>
<td>Just become aware of practice</td>
<td>1</td>
<td>0.9</td>
</tr>
<tr>
<td>Looking for more information before adoption</td>
<td>25</td>
<td>21.7</td>
</tr>
<tr>
<td>Trying out practice</td>
<td>39</td>
<td>33.9</td>
</tr>
<tr>
<td>Full adoption of practice</td>
<td>37</td>
<td>32.2</td>
</tr>
</tbody>
</table>
Table 10 presents the data on the percent reduction in herbicide rates that were made by respondents within the last three years. The data show that 47 respondents representing 40.9% indicated no changes in their level of herbicide application, only one respondent each has made 3%, 35%, and 75% reduction in herbicide rates. Six respondents had reduced their herbicide rates by 5%, 16 had made a 10% reduction, 4 respondents had made 15%, 12 had made 20%, 9 had made 25%, 5 had made 30%, 3 had made 33% and 10 respondents (8.6%) had made 50% reduction in herbicide application rates during the last three years.

Table 11 presents the data showing the level of adoption of banded application of herbicides as opposed to spraying. The data indicated that a majority of the respondents, 48, representing 41.7% had rejected the practice because they found it inappropriate. Just 2 respondents indicated they had just become aware of the practice, 28 indicated they were at the information gathering stage as far as adoption was concerned. Only 15 respondents were
trying the practice on their farms while 21 respondents had achieved full adoption of the practice. One respondent failed to indicate his/her level of adoption.

Table 11. Distribution of respondents by their stages of adoption of banded application of herbicides

<table>
<thead>
<tr>
<th>Adoption stage</th>
<th>N</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rejection of practice due to inappropriateness</td>
<td>48</td>
<td>41.7</td>
</tr>
<tr>
<td>Just become aware of practice</td>
<td>2</td>
<td>1.7</td>
</tr>
<tr>
<td>Looking for more information before adoption</td>
<td>28</td>
<td>24.3</td>
</tr>
<tr>
<td>Trying out practice</td>
<td>15</td>
<td>13</td>
</tr>
<tr>
<td>Full adoption of practice</td>
<td>21</td>
<td>18.3</td>
</tr>
<tr>
<td>Not indicated</td>
<td>1</td>
<td>0.9</td>
</tr>
</tbody>
</table>

Perceptions of Innovations' Characteristics

One of the primary objectives of the study was to identify the perceptions of the respondents with regards to the profitability, complexity and compatibility of the selected practices within their farming systems; and to analyze how these perceptions impact on their level of adoption. The result of the analysis of data with regard to this objective are presented in the tables below.

The data in Table 12 represent the perceptions of respondents with regards to the profitability of the selected low-input sustainable agricultural practices. The data show that a large proportion of the respondents (40%) were neutral with regards to their perceptions of the profitability of adopting reduced nitrogen fertilizer rates in their farming operations. The same situation applied to almost all the other practices. The percentage of respondents who were neutral with regard to their perceptions of the profitability of the other practices ranged from 55% for the use of nitrification inhibitor, 38.8% for mechanical weeding, 35.7% for banded
application of herbicides, 34.8% for reduced herbicide rates, 22.6% for shift to spring/summer application of nitrogen fertilizer and 21.7% crop rotation. Only 14.8% of the respondents were neutral with regard to the profitability of soil testing. However quite a number of respondents perceived the practices as either profitable or very profitable. For reduced nitrogen fertilizer rates, 45 (39.1%) and 6 (5.2%) respondents, respectively, felt the practice was either profitable or very profitable. The data also indicated that soil testing for the determination of nitrogen rates received the highest profitability ratings among the respondents with 80.9% indicating the practice was either profitable or very profitable. The practice of taking credit for manures in determining nitrogen rates came next with 80% of respondents rating it as either profitable or very profitable. The percentage of respondents rating other practices as either profitable or very profitable ranged from 69.6% for spring/summer application of nitrogen; 49.6% for reduced herbicide rates and mechanical weed control, 47.8% for crop rotation, 43.4% for banded application of herbicides. The use of nitrification inhibitor had only 18.2% of respondents rating it as either profitable or very profitable. However very few of the respondents regarded the practices as either unprofitable or very unprofitable. The percentage of respondents who indicated this perception ranged from 33.9% for nitrification inhibitor, 30.9% for crop rotation, 20.7% for banded application, 15.6% for both reduced fertilizer and herbicides rates, 12.1% for mechanical weed control, 6.9% for spring/summer application of nitrogen and 3.4% for soil testing and taking credit for manure in the determination of nitrogen fertilizer rates. In summary, on a profitability scale ranging from 1-very unprofitable to 5-very profitable, the mean ratings for each of the practices ranged from 4.1 for both taking credit for manure and soil nitrogen testing; 3.93 for spring/summer application of nitrogen, 3.47 for mechanical weeding, 3.45 for reduced herbicide rate, 3.29 for reduced nitrogen rates, 3.22 for crop rotation and 2.78 for the use of nitrification inhibitor.
Table 12. Percent distribution of respondents according to their perceptions of profitability of selected low-input agricultural practices

<table>
<thead>
<tr>
<th>Practices</th>
<th>Highly Unprofitable</th>
<th>Unprofitable</th>
<th>Neutral</th>
<th>Profitable</th>
<th>Very Profitable</th>
<th>Mean S. D</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Reduced N fertilizer</td>
<td>5 4.3</td>
<td>13 11.3</td>
<td>46 40.0</td>
<td>45 39.1</td>
<td>6 5.2</td>
<td>3.22 .898</td>
</tr>
<tr>
<td>2. Nitrification inhibitor</td>
<td>13 11.3</td>
<td>26 22.6</td>
<td>55 47.8</td>
<td>15 13.0</td>
<td>6 5.2</td>
<td>2.78 .989</td>
</tr>
<tr>
<td>3. Crop rotation</td>
<td>11 9.6</td>
<td>24 20.9</td>
<td>25 21.7</td>
<td>39 33.9</td>
<td>16 13.9</td>
<td>3.22 .092</td>
</tr>
<tr>
<td>4. Nitrogen testing</td>
<td>2 1.7</td>
<td>2 1.7</td>
<td>17 14.8</td>
<td>53 46.1</td>
<td>40 34.8</td>
<td>4.1 .85</td>
</tr>
<tr>
<td>5. Spring/summer N.</td>
<td>2 1.7</td>
<td>6 5.2</td>
<td>26 22.6</td>
<td>44 38.3</td>
<td>36 31.3</td>
<td>3.93 .957</td>
</tr>
<tr>
<td>6. Credit for manure</td>
<td>2 1.7</td>
<td>2 1.7</td>
<td>18 15.7</td>
<td>51 44.3</td>
<td>41 35.7</td>
<td>4.1 .86</td>
</tr>
<tr>
<td>7. Mechanical weed control</td>
<td>2 1.7</td>
<td>12 10.4</td>
<td>44 38.3</td>
<td>44 38.3</td>
<td>13 11.3</td>
<td>3.47 .89</td>
</tr>
<tr>
<td>8. Reduced herbicide</td>
<td>3 2.6</td>
<td>15 13.0</td>
<td>40 34.8</td>
<td>41 35.7</td>
<td>16 13.9</td>
<td>3.45 .976</td>
</tr>
<tr>
<td>9. Banded application of herbicides</td>
<td>6 5.2</td>
<td>18 15.7</td>
<td>41 35.7</td>
<td>28 24.3</td>
<td>22 19.1</td>
<td>3.37 1.12</td>
</tr>
</tbody>
</table>
Table 13 shows the percent distribution of respondents according to their perceptions of
the compatibility of the selected low-input sustainable agricultural practices with their farming
systems. Most of the practices received favorable compatibility ratings among the
respondents. For reduced nitrogen fertilizer rates, 49 (42.6%) and 27 (23.5%) respondents,
respectively, perceived the practice was either compatible or very compatible. The data also
indicated that the practice of spring/summer application of nitrogen received the highest
compatibility ratings with 91 respondents (79.1%) indicating the practice as either compatible
or very compatible. Soil testing was perceived by 84 respondents (73%) as either compatible
or very compatible; taking credit for manures in determining nitrogen rates came next with
75.7% of respondents rating it as either compatible or very compatible. The percentage of
respondents rating other practices as either compatible or very compatible ranged from 66.1%
for reduced nitrogen rates; 52.2% for mechanical weeding; 52.1% reduced herbicide rates;
48.7% for crop rotation, 35.6% for nitrification inhibitor and 30.5% for banded application of
herbicides.

The data also show that very few of the respondents regarded the practices (with the
exception of banded herbicide application and crop rotation) as either incompatible or very
incompatible with their present management practices. The percentage of respondents who
indicated these perceptions were distributed as follows: 40.8% for banded application; 33.9%
for crop rotation; 26.1% for nitrification inhibitors; 19.1% for reduced herbicides rates; 17.3%
for mechanical weeding; 11.3% for reduced N rates; 10.4% for taking credits for manures;
6.9% for spring/summer application of nitrogen and 6% for soil N testing. The data however
show that a sizeable proportion of the respondents responded neutral when they were
requested to indicate their perceptions with regards to the compatibility of the practices. Forty­
three respondents (37.4%) indicated a neutral perception regarding the compatibility of
nitrification inhibitors with their farming operations.
Table 13. Percent distribution of respondents according to their perceptions of the compatibility of low-input agricultural practices

<table>
<thead>
<tr>
<th>Practices</th>
<th>Highly Incompatible N</th>
<th>Highly Incompatible %</th>
<th>Incompatible N</th>
<th>Incompatible %</th>
<th>Neutral N</th>
<th>Neutral %</th>
<th>Compatible N</th>
<th>Compatible %</th>
<th>Very Compatible N</th>
<th>Very Compatible %</th>
<th>Mean S.D</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Reduced N fertilizer</td>
<td>5</td>
<td>4.3</td>
<td>8</td>
<td>7.0</td>
<td>25</td>
<td>21.7</td>
<td>49</td>
<td>42.6</td>
<td>27</td>
<td>23.5</td>
<td>3.75</td>
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<td></td>
<td></td>
<td></td>
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<td>1.037</td>
</tr>
<tr>
<td>2. Nitrification inhibitor</td>
<td>14</td>
<td>12.2</td>
<td>16</td>
<td>13.9</td>
<td>43</td>
<td>37.4</td>
<td>26</td>
<td>22.6</td>
<td>15</td>
<td>13.0</td>
<td>3.105</td>
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<td></td>
<td></td>
<td></td>
<td>1.178</td>
</tr>
<tr>
<td>3. Crop rotation</td>
<td>17</td>
<td>14.8</td>
<td>22</td>
<td>19.1</td>
<td>19</td>
<td>16.5</td>
<td>30</td>
<td>26.1</td>
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<td>22.6</td>
<td>3.228</td>
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<td></td>
<td></td>
<td>1.389</td>
</tr>
<tr>
<td>4. Soil nitrogen testing</td>
<td>2</td>
<td>1.7</td>
<td>5</td>
<td>4.3</td>
<td>22</td>
<td>19.1</td>
<td>38</td>
<td>33.0</td>
<td>46</td>
<td>40.0</td>
<td>4.071</td>
</tr>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.97</td>
</tr>
<tr>
<td>5. Spring/summer N</td>
<td>5</td>
<td>4.3</td>
<td>3</td>
<td>2.6</td>
<td>15</td>
<td>13.0</td>
<td>39</td>
<td>33.9</td>
<td>52</td>
<td>31.3</td>
<td>4.14</td>
</tr>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1.03</td>
</tr>
<tr>
<td>6. Taking credit for manure</td>
<td>5</td>
<td>4.3</td>
<td>7</td>
<td>6.1</td>
<td>14</td>
<td>12.2</td>
<td>40</td>
<td>34.8</td>
<td>47</td>
<td>40.9</td>
<td>4.04</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1.09</td>
</tr>
<tr>
<td>7. Mechanical weed control</td>
<td>5</td>
<td>4.3</td>
<td>15</td>
<td>13.0</td>
<td>34</td>
<td>29.6</td>
<td>41</td>
<td>35.7</td>
<td>19</td>
<td>16.5</td>
<td>3.474</td>
</tr>
<tr>
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<td></td>
<td></td>
<td>1.058</td>
</tr>
<tr>
<td>8. Reduced herbicide</td>
<td>5</td>
<td>4.3</td>
<td>17</td>
<td>14.8</td>
<td>31</td>
<td>27.0</td>
<td>41</td>
<td>35.7</td>
<td>20</td>
<td>17.4</td>
<td>3.474</td>
</tr>
<tr>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1.058</td>
</tr>
<tr>
<td>9. Banded application of herbicide</td>
<td>25</td>
<td>21.7</td>
<td>22</td>
<td>19.1</td>
<td>32</td>
<td>27.8</td>
<td>18</td>
<td>15.7</td>
<td>17</td>
<td>14.8</td>
<td>2.825</td>
</tr>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1.345</td>
</tr>
</tbody>
</table>
The percentages of respondents who were neutral with regard to their perceptions of the compatibility of the other practices were 29.6% for mechanical weeding; 27.8% for banded application; 27% for reduced herbicide rates; 21.7% for reduced nitrogen fertilizer rates; 19.1% for soil testing; 16.5% for crop rotation and 13% for spring/summer application of nitrogen. On a 5-point compatibility scale the mean ratings for each of the practices were 4.14 for spring/summer application of nitrogen; 4.071 for soil N nitrogen; 4.04 for taking credit for manures; and 3.75 for reduced nitrogen fertilizer rates. The mean compatibility ratings for the other practices are 3.474 for mechanical weeding and reduced herbicides rates; 3.105 for nitrification inhibitor and 2.825 for banded application.

The data in Table 14 depict the distribution of respondents' perceptions regarding the complexity of the management skills they had had or would have to learn in order to adopt the selected practices. The data reveal that most respondents indicated that the management practices required for the adoption of the practices were easy to learn. Over seventy-seven percent of respondents indicated that the management skills needed for the adoption of spring/summer application of nitrogen were either easy or very easy. The percentage of respondents responding similarly for other practices were 71.4% for reduced N fertilizer; 70.5% for taking credit for manure; 67.8% for soil N testing; 58.2% for crop rotation; 53.9% for mechanical weeding; 53.1% for nitrification inhibitor; 48.7% for reduced herbicide rates and 32.2% for banded adoption of herbicides. By contrast, banded application of herbicides also attracted the highest percent of respondents (41.7%) who perceived it as either complex or very complex to adopt. Crop rotation was also perceived by 31 respondents (27%) as either complex or very complex to adopt within their present farming systems. The practices that were perceived to be easiest to adopt included spring/summer application of N fertilizer with a mean of 4.167; taking credit for manure 3.973; reduced N fertilizer 3.956; soil testing 3.947 and mechanical weeding with a mean of 3.526.
Table 14. Distribution of respondents according to their perceptions of complexity of selected low-input agricultural practices

<table>
<thead>
<tr>
<th>Practices</th>
<th>Highly complex N</th>
<th>complex N</th>
<th>Neutral N</th>
<th>Easy N</th>
<th>Very Easy N</th>
<th>Mean</th>
<th>S.D</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Reduced N fertilizer</td>
<td>2 1.7</td>
<td>10 8.7</td>
<td>20 17.4</td>
<td>41 35.7</td>
<td>41 35.7</td>
<td>3.956</td>
<td>1.025</td>
</tr>
<tr>
<td>2. Use of nitrification inhibitor</td>
<td>5 4.3</td>
<td>17 14.8</td>
<td>31 27.0</td>
<td>40 34.8</td>
<td>21 18.3</td>
<td>3.482</td>
<td>1.091</td>
</tr>
<tr>
<td>3. Crop rotation</td>
<td>17 14.8</td>
<td>14 12.2</td>
<td>16 13.9</td>
<td>39 33.9</td>
<td>28 24.3</td>
<td>3.412</td>
<td>1.375</td>
</tr>
<tr>
<td>4. Soil N testing</td>
<td>1 0.9</td>
<td>11 9.6</td>
<td>24 20.9</td>
<td>35 30.4</td>
<td>43 37.4</td>
<td>3.947</td>
<td>1.029</td>
</tr>
<tr>
<td>5. Spring/summer application of N.</td>
<td>4 3.5</td>
<td>5 4.3</td>
<td>16 13.9</td>
<td>32 27.8</td>
<td>57 49.6</td>
<td>4.167</td>
<td>1.055</td>
</tr>
<tr>
<td>6. Taking credit for manure</td>
<td>1 4.3</td>
<td>8 7.0</td>
<td>19 16.5</td>
<td>34 29.6</td>
<td>47 40.9</td>
<td>3.973</td>
<td>1.130</td>
</tr>
<tr>
<td>7. Mechanical weed Control</td>
<td>4 3.5</td>
<td>17 14.8</td>
<td>31 27.0</td>
<td>39 33.9</td>
<td>23 20.0</td>
<td>2.526</td>
<td>1.083</td>
</tr>
<tr>
<td>8. Reduced herbicide application rates</td>
<td>5 4.3</td>
<td>16 13.9</td>
<td>37 32.2</td>
<td>35 30.4</td>
<td>21 18.3</td>
<td>3.447</td>
<td>1.082</td>
</tr>
<tr>
<td>9. Banded application of herbicides</td>
<td>16 13.9</td>
<td>32 27.8</td>
<td>29 25.2</td>
<td>19 16.5</td>
<td>18 15.7</td>
<td>2.921</td>
<td>1.284</td>
</tr>
</tbody>
</table>
Banded application of herbicides was perceived as the most complex to adopt, followed by crop rotation and reduced herbicide rates.

Analysis of the Adequacy of Innovation Information

This section presents the data about the adequacy of the information about the practices that were available to respondents, the sources of the information and its quality. The respondents were asked to indicate how adequately they were informed about the benefits and methods of adopting the selected practices.

Table 15 presents the data obtained from this question. Surprisingly, the data in the table show that the majority of the respondents indicated they were adequately informed about most of the practices. For example 76.5%, 70.5%, 66.1% and 61.7% of respondents indicated they were either adequately or very adequately informed about spring/summer application of N fertilizer, mechanical weeding, taking credit for manure and soil N testing, respectively. The percentages of respondents who indicated they were either adequately or very adequately informed about the other practices varied from 56.6% for reduced N application; crop rotation (55.7%); reduced herbicide rates (51.3%); banded herbicide application (50.4%) to 46.1 % for nitrification inhibitor which also had the largest percentage of respondents (33%) who indicated they were inadequately informed about the practice. Reduced herbicides at 30.4% and reduced fertilizer and crop rotation each with 26.1% were other practices about which respondents were inadequately informed. Twenty percent of respondents were either uninformed or completely uninformed about nitrification inhibitor, 18.3% about banded herbicide application; 17.4% each about crop rotation and reduced herbicide rates; 16.5% each about reduced nitrogen rates and soil N testing; 10.4% about mechanical weeding while only 8.7% of respondents indicated they were either uninformed or completely uninformed about the benefits and methods of adopting spring/summer application of nitrogen.
Table 15. Distribution of respondents according to their perceived level of innovation information about practices

<table>
<thead>
<tr>
<th>Practices</th>
<th>Completely uninformed N</th>
<th>Uninformed N</th>
<th>Inadequately informed N</th>
<th>Informed N</th>
<th>Highly informed N</th>
<th>Mean S.D</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Reduced N fertilizer</td>
<td>5 (4.3)</td>
<td>14 (12.2)</td>
<td>30 (26.1)</td>
<td>44 (38.3)</td>
<td>21 (18.3)</td>
<td>3.54</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1.065</td>
</tr>
<tr>
<td>2. Use of nitrification inhibitor</td>
<td>9 (7.8)</td>
<td>14 (12.2)</td>
<td>38 (33.0)</td>
<td>41 (35.7)</td>
<td>12 (10.4)</td>
<td>3.289</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1.07</td>
</tr>
<tr>
<td>3. Crop rotation</td>
<td>4 (3.5)</td>
<td>16 (13.9)</td>
<td>30 (26.1)</td>
<td>40 (34.8)</td>
<td>24 (20.9)</td>
<td>3.561</td>
</tr>
<tr>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>1.081</td>
</tr>
<tr>
<td>4. Soil N testing</td>
<td>5 (4.3)</td>
<td>14 (12.2)</td>
<td>24 (20.9)</td>
<td>42 (36.5)</td>
<td>29 (25.2)</td>
<td>3.667</td>
</tr>
<tr>
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<td></td>
<td></td>
<td></td>
<td>1.118</td>
</tr>
<tr>
<td>5. Spring/summer application of N</td>
<td>4 (3.5)</td>
<td>6 (5.2)</td>
<td>16 (13.9)</td>
<td>51 (44.3)</td>
<td>37 (32.2)</td>
<td>3.974</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1.0</td>
</tr>
<tr>
<td>6. Taking credit for manure</td>
<td>5 (4.3)</td>
<td>10 (8.7)</td>
<td>23 (20.0)</td>
<td>44 (38.3)</td>
<td>32 (27.8)</td>
<td>3.772</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1.089</td>
</tr>
<tr>
<td>7. Mechanical weed control</td>
<td>3 (2.6)</td>
<td>9 (7.8)</td>
<td>21 (18.3)</td>
<td>50 (43.5)</td>
<td>31 (27.0)</td>
<td>3.851</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>.998</td>
</tr>
<tr>
<td>8. Reduced herbicide application rates</td>
<td>6 (5.2)</td>
<td>14 (12.2)</td>
<td>35 (30.4)</td>
<td>37 (32.2)</td>
<td>22 (19.1)</td>
<td>3.482</td>
</tr>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1.099</td>
</tr>
<tr>
<td>9. Banded application of herbicides</td>
<td>7 (6.1)</td>
<td>14 (12.2)</td>
<td>35 (30.4)</td>
<td>36 (31.3)</td>
<td>22 (19.1)</td>
<td>3.456</td>
</tr>
<tr>
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<td></td>
<td></td>
<td>1.122</td>
</tr>
</tbody>
</table>
Contact with Institutional Sources of Innovation Information

An important objective of the study was to identify the sources from which respondents obtained information about the selected low-input sustainable agricultural practices. The data presented in Table 16 are very revealing. The data revealed that an overwhelming majority of the respondents, 94, (83.1%), indicated they had had either frequent or very frequent contact with the mass media (especially farm magazines and newspapers) as far as obtaining information is concerned. Sixteen (14.2%) and two (1.9%) respondents, respectively, had had few or very few contacts with the mass media, for low-input sustainable agriculture information. Only 1 respondent (0.9%) had had no contact with the mass media as far as low-input sustainable agricultural information are concerned. Agricultural chemical dealers represented another important source of information for respondents, with 72.5% of respondents indicating they had had either frequent or very frequent contact with this source of information. The low levels of contacts between farmers and government institutions for information about low-input sustainable agricultural practices information becomes obvious, when only 38.4% of respondents indicated they had had either frequent (26.8%) or very frequent (11.6%) contact with the Iowa Cooperative Extension Services concerning information about low-input sustainable agriculture. Over thirty-seven percent and 17%, respectively, of respondents had had either few or very few contacts with low-input agricultural information from the Cooperative Extension Services. The percentages of respondents who had had frequent contact with information from other agencies were distributed as follows: 22.4% with the Soil Conservation Service; 18.5% with the Iowa Experiment Stations; 14.3% with the Soil Conservation District; 3.7% with the Iowa Department of Natural Resources and a mere 1.8% (2 respondents) had had contact with the Environment Protection Agency. On a scale ranging from 1-(Never had any contact), to 5 (Very frequent contact), the mean contact scores for the different sources were 4.239 for mass
media; 3.903 for agricultural chemical dealers; 3.188 for the Cooperative Extension Services; 2.705 for the Soil Conservation Services; 2.549 Iowa Experiment Station; 2.188 for the Soil Conservation District; 1.628 for the Iowa Department of Natural Resources and 1.407 for the Environment Protection Agency.

Respondents were also asked about their perceptions regarding the quality/usefulness of the low-input sustainable agricultural information they had received from the various institutional sources. The data obtained from this section are presented in Table 17. The data followed the same pattern as those presented in Table 16. However, there appears to a discrepancy between the ratings of level of contact and the quality. The information from the mass media and agricultural chemical dealers, respectively, still received the highest percentage of respondents 74.1% and 64.6% who rated them either useful or very useful. Fifty-nine percent and 50.4% of the respondents, respectively, rated information from the Cooperative Extension Service and the Experiment Station either as useful or very useful, percentages that were higher than those for level of contact. Information from the Soil Conservation Services and District Commissioners were rated as either useful or very useful by 33.3% and 23.3% of respondents, respectively. Only 8.7% and 7.7% of the respondents, respectively, rated the information from the Iowa Environmental Protection Agency and the Department of Natural Resources as either useful or very useful in helping them make a decision about the adoption of the selected low-input fertilizer and herbicide management practices.

**Perceptions of Groundwater Contamination by Agricultural Practices**

Respondents were asked to indicate their perceptions regarding the seriousness of groundwater contamination by agricultural chemicals in Iowa, their counties and on their farms. The information obtained from this question is presented on Table 18.
Table 16. Distribution of respondents according to their perceived levels of frequency of institutional contacts

<table>
<thead>
<tr>
<th>Agencies</th>
<th>Never</th>
<th>Very few</th>
<th>Few</th>
<th>Frequent</th>
<th>Very Frequent</th>
<th>N %</th>
<th>N %</th>
<th>N %</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Soil Conservation Service</td>
<td>15</td>
<td>35</td>
<td>31</td>
<td>13.4</td>
<td>3.1</td>
<td>7.63</td>
<td>1.085</td>
<td></td>
</tr>
<tr>
<td>2. Soil Conservation District</td>
<td>36</td>
<td>39</td>
<td>34</td>
<td>8.7</td>
<td>1.2</td>
<td>18.1</td>
<td>3.6</td>
<td></td>
</tr>
<tr>
<td>3. Cooperative Extension Service</td>
<td>8</td>
<td>19</td>
<td>17</td>
<td>23.0</td>
<td>42</td>
<td>37.5</td>
<td>30.26</td>
<td></td>
</tr>
<tr>
<td>4. Iowa Environment Protection Agency</td>
<td>80</td>
<td>23</td>
<td>20</td>
<td>4.0</td>
<td>7.1</td>
<td>2.9</td>
<td>1.1</td>
<td></td>
</tr>
<tr>
<td>5. Iowa Dept of Natural Resources</td>
<td>61</td>
<td>37</td>
<td>54</td>
<td>27.9</td>
<td>12</td>
<td>10.6</td>
<td>5.1</td>
<td></td>
</tr>
<tr>
<td>6. Iowa Experiment Station</td>
<td>27</td>
<td>22</td>
<td>23</td>
<td>8.5</td>
<td>1.9</td>
<td>18</td>
<td>15.9</td>
<td>44</td>
</tr>
<tr>
<td>7. Ag. Chemical Dealers</td>
<td>5</td>
<td>4</td>
<td>4.4</td>
<td>1.9</td>
<td>7.1</td>
<td>1</td>
<td>0.9</td>
<td></td>
</tr>
<tr>
<td>8. Mass Media e.g., (Farm Magazines)</td>
<td>1</td>
<td>2</td>
<td>1.9</td>
<td>16.4</td>
<td>14.2</td>
<td>44</td>
<td>38.9</td>
<td>50</td>
</tr>
</tbody>
</table>
Table 17. Distribution of respondents according to their perceptions of quality of institutional information

<table>
<thead>
<tr>
<th>Agencies</th>
<th>Of no use</th>
<th>Little use</th>
<th>Barely useful</th>
<th>Useful</th>
<th>Very Useful</th>
<th>Mean SD</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N   %</td>
<td>N   %</td>
<td>N   %</td>
<td>N   %</td>
<td>N   %</td>
<td></td>
</tr>
<tr>
<td>1. Soil Conservation Service</td>
<td>14 12.2</td>
<td>23 20.7</td>
<td>37 33.3</td>
<td>24 21.6</td>
<td>13 11.7</td>
<td>2.991</td>
</tr>
<tr>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1.187</td>
</tr>
<tr>
<td>2. Soil Conservation District</td>
<td>28 26.2</td>
<td>21 19.6</td>
<td>33 30.8</td>
<td>18 16.8</td>
<td>7  6.5</td>
<td>2.579</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1.229</td>
</tr>
<tr>
<td>3. Coop. Extension Services</td>
<td>10  8.9</td>
<td>9  8.0</td>
<td>27 24.1</td>
<td>47 42.0</td>
<td>19 17.0</td>
<td>03.50</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1.139</td>
</tr>
<tr>
<td>4. Iowa Environment Protection Agency</td>
<td>44 42.7</td>
<td>33 32.0</td>
<td>17 16.5</td>
<td>8  7.8</td>
<td>1  0.9</td>
<td>1.922</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>.997</td>
</tr>
<tr>
<td>5. Iowa Dept. of Natural Resources</td>
<td>38 36.5</td>
<td>32 30.8</td>
<td>26 25.0</td>
<td>8  7.7</td>
<td>0  0.0</td>
<td>2.038</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>.965</td>
</tr>
<tr>
<td>6. Iowa Experiment Station</td>
<td>14 13.1</td>
<td>9  8.4</td>
<td>30 28.0</td>
<td>36 33.6</td>
<td>18 16.8</td>
<td>3.327</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1.124</td>
</tr>
<tr>
<td>7. Ag. Chemical Dealers</td>
<td>7  6.2</td>
<td>7  6.2</td>
<td>26 23.0</td>
<td>37 32.7</td>
<td>36 31.9</td>
<td>3.779</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1.147</td>
</tr>
<tr>
<td>8. Mass Media e.g., (Farm Magazines)</td>
<td>2  1.8</td>
<td>3  2.7</td>
<td>24 21.4</td>
<td>56 50.0</td>
<td>27 24.1</td>
<td>3.920</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>.850</td>
</tr>
</tbody>
</table>
The data revealed the operation of the proximity principle in which farmers tended to perceive the problem as more serious the further away the area of interest was from them. For instance while 12 respondents (10.8%) perceived the problem as being very serious in Iowa as a whole, only 5 respondents each (4.5%) expressed similar perceptions with regard to their counties and their farms. Also while 27 respondents (24.3%) indicated that the problem was serious in Iowa, 16.2% indicated it was serious in their counties, only a mere 6.3% of the respondents indicated they had serious groundwater contamination problem on their farms. In the same vein, while only 1 respondent indicated that the problem did not exist in Iowa, as many as 22 indicated the same opinion about their farms. In general, it appears that respondents did not seem to perceive the problem of groundwater contamination as very serious. For instance on a scale that ranged from 0=none to 4=very serious, the mean score for perception of groundwater contamination ranged from 3.26 in Iowa, 2.748 for the counties to 2.261 for the respondents' farms.

Relationship between the Adoption of Innovations and the Dependent Variables

The multiple regression procedure was used to test the conceptual model developed for the study (see Fig. 1). The model predicted the adoption of the selected low-input practices by respondents as a function of the following variables:

1. Their perceptions of the profitability, complexity and compatibility of the practices.
2. The level of innovation information and contact with institutional sources of low-input agriculture information
3. The demographic and farm firm characteristics of farmers.

The results of the multiple regression analysis in predicting the adoption of each practice are presented from Tables 19 through 28.
Table 18. Distribution of respondents according to their perceptions of groundwater contamination by agricultural chemicals

<table>
<thead>
<tr>
<th>Areas</th>
<th>None</th>
<th>Minor</th>
<th>Somewhat Serious</th>
<th>Serious</th>
<th>Very Serious</th>
<th>Mean S.D</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>%</td>
<td>N</td>
<td>%</td>
<td>N</td>
<td></td>
</tr>
<tr>
<td>1. In Iowa</td>
<td>1</td>
<td>0.9</td>
<td>20</td>
<td>18.0</td>
<td>51</td>
<td>45.9</td>
</tr>
<tr>
<td>2. In your County</td>
<td>3</td>
<td>2.7</td>
<td>50</td>
<td>45.0</td>
<td>35</td>
<td>31.5</td>
</tr>
<tr>
<td>3. On your Farm</td>
<td>22</td>
<td>19.8</td>
<td>55</td>
<td>49.5</td>
<td>22</td>
<td>19.8</td>
</tr>
</tbody>
</table>
Table 19 shows that two variables, the perception of the practice's profitability and the frequency of institutional contacts of farmers gave the best prediction of the level of adoption of reduced nitrogen fertilizer rates. The perceptions of profitability explained 12.5% of the variance in adoption, while institutional contact explained 5.44%. The coefficients of prediction for both variables were very highly significant.

Table 19. Results of regression analysis in predicting the adoption of reduced nitrogen fertilizer rates

<table>
<thead>
<tr>
<th>Variables</th>
<th>Multiple R</th>
<th>Cumulative Percentage of variance predicted</th>
<th>Variable standard error</th>
<th>Beta</th>
</tr>
</thead>
<tbody>
<tr>
<td>Perception of profitability</td>
<td>.345</td>
<td>12.56</td>
<td>.457</td>
<td>.294***</td>
</tr>
<tr>
<td>Frequency of institutional contact</td>
<td>.426</td>
<td>18.10</td>
<td>.445</td>
<td>.220**</td>
</tr>
</tbody>
</table>

**P=.01.  
***P=.001.

Table 20. Results of regression analysis in predicting the adoption of nitrification inhibitor

<table>
<thead>
<tr>
<th>Variables</th>
<th>Multiple R</th>
<th>Cumulative Percentage of variance predicted</th>
<th>Variable standard error</th>
<th>Beta</th>
</tr>
</thead>
<tbody>
<tr>
<td>Perception of profitability</td>
<td>.297</td>
<td>8.81</td>
<td>.428</td>
<td>.294***</td>
</tr>
<tr>
<td>Level of information</td>
<td>.369</td>
<td>13.70</td>
<td>.445</td>
<td>.220**</td>
</tr>
</tbody>
</table>

**P=.01.  
***P=.001.
Table 20 shows the results of the regression analysis regarding the adoption of nitrification inhibitor by respondents. The perceptions of profitability and the degree to which farmers were adequately informed about the practice gave the best prediction of the adoption of the practice. Perceptions of profitability explained 8.81% of the variance in adoption while the level of information explained 4.87%. Both coefficients of predictions were highly significant at 0.001 and 0.01 levels, respectively. The obtained F-values for the two variables, 9.861 and 7.99 respectively, were significant at greater than 0.001 levels.

Table 21. Results of regression analysis in predicting the adoption of crop rotation

<table>
<thead>
<tr>
<th>Variables</th>
<th>Multiple R</th>
<th>Cumulative Percentage of variance predicted</th>
<th>Variable standard error</th>
<th>Beta</th>
</tr>
</thead>
<tbody>
<tr>
<td>Perception of compatibility</td>
<td>.592</td>
<td>34.99</td>
<td>.403</td>
<td>.438***</td>
</tr>
<tr>
<td>Perception of complexity</td>
<td>.613</td>
<td>37.61</td>
<td>.397</td>
<td>.223*</td>
</tr>
</tbody>
</table>

*P=.05.  
***P=.001.  

The results of the regression analysis to predict the adoption by farmers of the practice of including crops other than corn and soybean in the rotation are presented in Table 21. Two variables, farmers' perceptions of the compatibility and complexity of the practice were the best predictors of their level of adoption. No other variables met the criteria set by the regression equation. Perception of the practice's compatibility was the best predictor, accounting for 34.9% of the variance in adoption. When the perception of innovation's complexity entered the regression equation the proportion of variance accounted for increased to 37.61%. In other words the perception of complexity explained only 2.7% of adoption.
The coefficients of prediction for the two variables were highly significant at 0.001 and 0.05 levels, respectively. The obtained F-values of 54.9 and 30.44, respectively, for the variables were significant at greater than 0.001 levels.

Table 22 shows the results of the regression analysis in predicting the adoption of soil nitrogen testing by farmers. Two variables, perceptions of complexity and the degree to which farmers were adequately informed about the practice gave the best predictions of the adoption of the practice. Perceptions of complexity explained most of the variance accounting for 31.7% compared to the level of information about the practice that explained only 7.2%. The regression coefficients of predictions were highly significant at greater than 0.001 level, respectively. F-values of 46.35 and 31.54, respectively, for the variables were significant at greater than 0.001 levels.

Table 22. Results of regression analysis in predicting the adoption of soil nitrogen testing

<table>
<thead>
<tr>
<th>Variables</th>
<th>Multiple R</th>
<th>Cumulative Percentage of variance predicted</th>
<th>Variable standard error</th>
<th>Beta</th>
</tr>
</thead>
<tbody>
<tr>
<td>Perception of complexity</td>
<td>.563</td>
<td>31.67</td>
<td>.406</td>
<td>.427***</td>
</tr>
<tr>
<td>Level of information</td>
<td>.623</td>
<td>38.90</td>
<td>.386</td>
<td>.301***</td>
</tr>
</tbody>
</table>

***P=.001.

The results of the regression analysis in predicting the adoption by farmers of the practice of shifting the application of nitrogen fertilizers from fall to spring/summer application are presented on Table 23. Three variables, perception of the compatibility and profitability of the practice and the frequency of institutional contact were the best predictors of the level of
adoption. No other variables met the criteria set by the regression equation. Perceptions of the practice’s compatibility was the best predictor, accounting for 33.5% of the variance in adoption. When the two other variables, perception of innovation’s profitability and frequency of institutional contact, entered the regression equation the cumulative percentage of variance explained increased to 41.78%. The perception of profitability explained only 5.7% of adoption while institutional contact explained only 1.5%. The coefficients of prediction for the three variables were very highly significant. The obtained F-values for the variables were significant at greater than 0.001 levels.

Table 23. Results of regression analysis in predicting the adoption of spring/summer application of nitrogen fertilizers

<table>
<thead>
<tr>
<th>Variables</th>
<th>Multiple R</th>
<th>Cumulative Percentage of variance predicted</th>
<th>Variable standard error</th>
<th>Beta</th>
</tr>
</thead>
<tbody>
<tr>
<td>Perception of compatibility</td>
<td>.579</td>
<td>33.5</td>
<td>.328</td>
<td>.391***</td>
</tr>
<tr>
<td>Perceptions of profitability</td>
<td>.627</td>
<td>39.27</td>
<td>.313</td>
<td>.287**</td>
</tr>
<tr>
<td>Frequencies of institutional contact</td>
<td>.646</td>
<td>41.78</td>
<td>.308</td>
<td>.159*</td>
</tr>
</tbody>
</table>

*P=.05.  
**P=.01.  
***P=.001.

The data on Table 24 show the results of the regression equation developed to analyze the variables that predict the adoption of the practice of taking credits for green and animal manures by farmers in the determination of nitrogen fertilizer rates. The only variable that met the criteria set by the equation was the perceptions of innovation's compatibility with respondents' farming systems. This variable explained 24% of total variance in the adoption of practice.
The regression coefficient and the obtained F-value of 31.95 were both significant at greater than the 0.001 level.

Table 24. Results of regression analysis in predicting the adoption of taking credit for manures in determining nitrogen fertilizer rates

<table>
<thead>
<tr>
<th>Variables</th>
<th>Multiple R</th>
<th>Cumulative Percentage of variance predicted</th>
<th>Variable standard error</th>
<th>Beta</th>
</tr>
</thead>
<tbody>
<tr>
<td>Perception of compatibility</td>
<td>.490</td>
<td>24.03</td>
<td>.310</td>
<td>.490***</td>
</tr>
</tbody>
</table>

***P=.001.

Table 25. Results of regression analysis in predicting the adoption of mechanical weed control

<table>
<thead>
<tr>
<th>Variables</th>
<th>Multiple R</th>
<th>Cumulative Percentage of variance predicted</th>
<th>Variable standard error</th>
<th>Beta</th>
</tr>
</thead>
<tbody>
<tr>
<td>Perception of compatibility</td>
<td>.490</td>
<td>24</td>
<td>.391</td>
<td>.584***</td>
</tr>
<tr>
<td>Farm size</td>
<td>.570</td>
<td>32.53</td>
<td>.371</td>
<td>.300**</td>
</tr>
<tr>
<td>Years of farming experience</td>
<td>.614</td>
<td>37.66</td>
<td>.358</td>
<td>-.227*</td>
</tr>
</tbody>
</table>

*P=.05.
**P=.01.
***P=.001.

The results of the regression analysis to determine the variables predictive of the adoption of mechanical weed control by farmers are presented on Table 25. Three variables, farmers’ perceptions of the compatibility, their farm size, and years of farming experience were the best predictors of the level of adoption. No other variables met the criteria set by the regression equation. Farmers’ perceptions of the compatibility of practice with their farming systems was
the best predictor, accounting for 24% of the variance in adoption. When the two other
variables, farm size and years of farming experience entered the regression equation the
cumulative percentage of variance explained increased to 37.66%. The total farm size
accounted for 8.48% of variance while years of farming experience explained only 5.13% of
adoption. The coefficients of prediction for the three variables which were .584; .300 and
-.227, respectively, were significant at the 0.001, 0.005 and 0.05 levels, respectively. The
negative regression coefficient obtained for farming experience indicated a negative influence
of the variable on the level of adoption of mechanical weeding by respondents. The obtained
F-values for the variables were significant at greater than 0.001 levels.

Table 26. Results of regression analysis in predicting the adoption of banded application of
herbicides

<table>
<thead>
<tr>
<th>Variables</th>
<th>Multiple R</th>
<th>Cumulative Percentage of variance predicted</th>
<th>Variable standard error</th>
<th>Beta</th>
</tr>
</thead>
<tbody>
<tr>
<td>Perception of compatibility</td>
<td>.650</td>
<td>42.28</td>
<td>.417</td>
<td>.583***</td>
</tr>
<tr>
<td>Level of innovation information</td>
<td>.720</td>
<td>51.81</td>
<td>.329</td>
<td>.312***</td>
</tr>
<tr>
<td>Perception of groundwater contamination</td>
<td>.736</td>
<td>54.17</td>
<td>.322</td>
<td>-.158*</td>
</tr>
</tbody>
</table>

*P=.05.  
***P=.001.

The results of the regression analysis in predicting the adoption by farmers of banded
application of herbicides are presented on Table 26. Three variables, perceptions of the
practice's compatibility, respondents' level of innovation information and their perceptions of
the seriousness of groundwater contamination gave the best prediction of the level of adoption.
No other variable met the criteria set by the regression equation. Perceptions of the practice's compatibility predicted a large proportion of the variance in the dependent variable (adoption of practice), accounting for 34.28%. When the two other variables were entered in the regression equation the cumulative percentage of predicted adoption increased to 54.17%. The proportion of the predicted adoption accountable to the other variables were 9.53% for level of innovation information, and just 2.35% for the perceptions of farmers regarding the seriousness of groundwater contamination. The coefficients of prediction for the three variables were highly significant at 0.001 and 0.001 and 0.05 levels respectively. The negative regression coefficient for perceptions of ground water contamination indicates a negative relationship between the variable and the adoption of banded application of herbicides. The obtained F-values for the variables were significant at greater than 0.001 levels.

Table 27 presents the results of the regression analysis in predicting the adoption of reduced herbicides application rates. Four variables, namely the adequacy of innovation information available to farmers, the proportion of farm rented on share basis, respondents' perceptions of practice's compatibility and their total farm size were the best predictors of the level of adoption. The level of innovation information accounted for 17.25% of the total 34.87% variance explained by the four variables. The proportion of the cumulative variance explained by the other variables were 9.26% for the proportion farm rented on share cropping basis, perceptions of the practice's compatibility- 4.28% and total farm size- 4.08%. The coefficients of prediction for the four variables were significant at the 0.0001, 0.005, 0.005 and 0.05 levels, respectively. The obtained F-values for the variables were all significant at greater than 0.001 levels.
Table 27. Results of regression analysis to predict the adoption of reduced herbicides rates

<table>
<thead>
<tr>
<th>Variables</th>
<th>Multiple R</th>
<th>Cumulative Percentage of variance predicted</th>
<th>Variable standard error</th>
<th>Beta</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level of innovation information</td>
<td>.415</td>
<td>17.25</td>
<td>.431</td>
<td>.352***</td>
</tr>
<tr>
<td>Proportion of farm rented on share basis</td>
<td>.515</td>
<td>26.51</td>
<td>.408</td>
<td>.297**</td>
</tr>
<tr>
<td>Compatibility of practice</td>
<td>.555</td>
<td>30.79</td>
<td>.398</td>
<td>.273*</td>
</tr>
<tr>
<td>Farm size</td>
<td>.591</td>
<td>34.87</td>
<td>.388</td>
<td>.211*</td>
</tr>
</tbody>
</table>

*P=.05.
**P=.01.
***P=.001.

In order to get the whole picture of the variables influencing the total adoption process, a regression equation was developed for the composite adoption index. This procedure predicted the total number of low-input sustainable agricultural practices adopted by the respondents as a function of their perceptions of the innovations, the level of innovation information, the frequency of institutional contacts, their perceptions of groundwater contamination, their demographic and farm firm characteristics. The results of the regression and Pearson correlation coefficient analyses are presented in Tables 28 and 29.

The data in Table 28 show that when the composite adoption index was considered as a whole, only two variables met the regression criteria. The composite perceptions of innovations' compatibility explained most of the variance in adoption of innovations, explaining 20.58%. The other significant variable was the composite measure of the adequacy
of the innovation information available to the farmers which predicted 5.03% of the variance in the number of practices adopted by respondents. The coefficients of prediction for the two variables were highly significant at 0.0001 and 0.05 levels, respectively. The obtained F-values of 25.66 for the perceptions of compatibility, and 16.87 for the level of innovation information were both significant at greater than 0.0001 level of significance.

Table 28. Results of regression analysis in predicting the total number of low-input practices adopted by respondents

<table>
<thead>
<tr>
<th>Variables</th>
<th>Multiple R</th>
<th>Cumulative Percentage of variance predicted</th>
<th>Variable standard error</th>
<th>Beta</th>
</tr>
</thead>
<tbody>
<tr>
<td>Composite perceptions of</td>
<td>.454</td>
<td>20.58</td>
<td>1.63</td>
<td>.382***</td>
</tr>
<tr>
<td>compatibility</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Level of innovation information</td>
<td>.506</td>
<td>25.6</td>
<td>1.59</td>
<td>.236*</td>
</tr>
</tbody>
</table>

*P=.05.
***P=.001.

The relationships between the composite adoption index and the composite scores on perceptions of innovations, level of innovation information, perceptions of groundwater contamination, level of institutional contacts, age, years of farming experience, level of education, farm size and tenure arrangement are shown on Table 29.

The data on Table 29 reveal that only those variables dealing with farmers' perceptions of innovations, the level of innovation information and institutional contacts showed significant
correlation coefficients with the composite adoption of low-input sustainable agricultural practices.

Table 29. Pearson correlation coefficients between composite adoption index and dependent variables

<table>
<thead>
<tr>
<th>Variables</th>
<th>Coefficient</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Composite perceptions</td>
<td>.348</td>
<td>.000</td>
</tr>
<tr>
<td>profitability</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Composite perceptions of compatibility</td>
<td>.454</td>
<td>.000</td>
</tr>
<tr>
<td>Composite perceptions of complexity</td>
<td>.295</td>
<td>.001</td>
</tr>
<tr>
<td>Composite level of information</td>
<td>.352</td>
<td>.000</td>
</tr>
<tr>
<td>Composite level of institutional contacts</td>
<td>.168</td>
<td>.046</td>
</tr>
<tr>
<td>Perceptions of contamination</td>
<td>.064</td>
<td>.264</td>
</tr>
<tr>
<td>Farm size</td>
<td>-.053</td>
<td>.300</td>
</tr>
<tr>
<td>Percentage of farm owned</td>
<td>-.010</td>
<td>.459</td>
</tr>
<tr>
<td>Percentage of farm rented on share basis</td>
<td>.094</td>
<td>.174</td>
</tr>
<tr>
<td>Percentage of farm rented on cash</td>
<td>-.091</td>
<td>.183</td>
</tr>
<tr>
<td>Age</td>
<td>-.100</td>
<td>.161</td>
</tr>
<tr>
<td>Years of farming experience</td>
<td>-.124</td>
<td>.108</td>
</tr>
<tr>
<td>Level of education</td>
<td>-.058</td>
<td>.282</td>
</tr>
</tbody>
</table>
The perceptions of innovations' compatibility, as was the case with the multiple regression analysis, yielded the highest coefficient of 0.454 which was significant at greater than 0.0001 level. The adequacy of the innovation information available to respondents also yielded a highly significant correlation coefficient of .352 at the 0.0001 level.

Other variables that yielded significant coefficients at the 0.05 level of significance, included the perceptions of complexity and profitability of innovations, and the respondents' levels of institutional contacts. Other variables such as age, level of education, farm size, tenure arrangement, years of farming experience and perceptions of groundwater contamination which are characteristic of the classical diffusion model yielded no significant correlation coefficient with the composite adoption index at the 0.05 level. In fact, respondents' age and years of farming experience, tenure (defined as the percentage of land rented on cash basis) and their levels of education yielded a negative, though non-significant relationship with the adoption of practices.
CHAPTER V. DISCUSSIONS

The main purpose of this study was to determine the perceptions of selected Iowa farmers regarding innovation characteristics and institutional constraints influencing their adoption of low-input sustainable agricultural practices. The following objectives were specifically set for the study:

1. To identify the perceptions of Iowa farmers regarding the profitability, complexity and compatibility of selected low-input sustainable fertilizer and herbicide management practices.

2. To determine the levels of adoption of the selected practices and analyze the relationships between adoption and farmers' perceptions of practices.

3. To determine the degree to which farmers are adequately informed about the benefits and methods of adopting the practices and their levels of contact with institutional sources of such information.

4. To analyze the impact of access to and contact with institutional sources of information on the adoption of low-input sustainable practices.

5. To determine demographic and farm firm characteristics of respondents and analyze their impact on the levels of adoption of practices.

The findings of the study as they relate to the stated objectives are discussed in this chapter with implications for educational programs. The discussions are organized under the following sections: (1) Discussions related to the demographic and farm firm characteristics of the respondents, (2) Discussions relevant to the adoption of practices, (3) Discussions related to the perceptions of innovations characteristics, (4) Discussions related to the level of innovation information and institutional contact, (5) Discussions related to the perceptions of
groundwater contamination, (6) Discussions pertaining to the educational implications of findings.

Discussions Related to the Demographic and Farm Firm Characteristics of Respondents

One of the primary objectives of the study was to describe the demographic and farm firm characteristics of selected Iowa farmers with the object of finding their relationships to the level of adoption of low-input sustainable agricultural practices. The study found that the respondents were highly educated and experienced farm operators. The demographic information showed that most respondents (69.4%) were aged between 20 and 39, had at least either high school (32.2%) or some college education (33.9%) or had completed college degrees (32.2%). The group's average years of farming experience was 17.5 years with farm holdings ranging from 6 to 3000 acres. The average farm size was 545.5 acres either owned and or rented. These findings are consistent with those of Bunting (1986) and Omer (1987), who reported similar findings regarding the demographic and farm firm characteristics of the membership of the Iowa Young Farmers Educational Association Inc. This finding shows that the group represents an enormous educational resource and responsibility for agricultural and extension education programs. It is however instructive that most of the demographic and farm firm variables such as age, level of education, farm size, and tenure arrangement were not significantly related to the adoption of low-input agricultural practices. In fact, age, farm size, level of education, tenure arrangement, and farming experience yielded negative, though non-significant correlation coefficients to the composite adoption index. The only exceptions were the variables dealing with the proportion of land rented on share basis and total farm size which yielded, low, though significant regression coefficients with the adoption of reduced herbicides rates. Farm size and years of farming experience also yielded
significant, but low regression coefficient with the adoption of mechanical weeding. The study revealed that the longer the respondents' years of farming experience, the less likely it was that they would adopt mechanical weeding. These findings are consistent with those of Van Es (1977); Buttel et al. (1981); and Napier et al. (1984); all of whom observed that variables characteristic of the classical diffusion model were not good predictors of the adoption of conservation technologies. The results of the study as they relate to demographic and farm firm variables tended to support the on-going arguments concerning the applicability of the classical model to the adoption of conservation technologies (Pampel and Van Es, 1977; Jones, 1973; and Nowak and Korschling, 1983). Another explanation for the findings might be related to the possible high level of homogeneity among the respondents and the high collinearity among the variables, which might have accounted for the lack of significant correlation coefficients (Hinkle, Wiersma and Jurs, 1988). In summary, the study did not find enough support for the aspect of the conceptual model dealing with personal and farm firm variables (see p. 22).

Discussions Related to the Findings about Adoption of Practices

Contrary to the generally held view concerning farmers' resistance to the adoption of low-input sustainable agricultural practices, the findings of the study with regard to the level of adoption show that many farmers were either trying out the practices on their farms or in fact indicated they were already using some of the practices as standard on their farms. For instance, 62.2% of respondents claimed they were either trying or were fully adopting reduced nitrogen fertilizer rates. The only exceptions were practices such as the use of nitrification inhibitor, banded application of herbicides and mechanical weeding which are generally known to be very incompatible with conventional agricultural practices. Similar findings concerning the adoption of sustainable agricultural practices have been reported by Malia and
Korschning (1989). It would however be presumptuous to conclude that farmers have made complete conversion to sustainable agricultural practices. Given the nature of the research design, this conclusion cannot be justified. For instance, a farmer who had made some reduction in nitrogen fertilizer rates, that were from the beginning very excessive could claim to be adopting reduced nitrogen fertilizer rates. The implication of this information is the need for more field research to obtain more precise and valid information. Another important finding of the study relates to the large number of respondents who indicated they were still looking for more information about some of the practices in order to aid decision-making. The implications of this finding with regard to extension education programs, given another finding of the study which revealed the low level of institutional contacts between farmers and government agencies such as the extension services and the Iowa State University Experiment Station, are very great. If these farmers at the persuasion stage in the innovation-decision process are to decide in favor of sustainable agricultural practices, they would need to be provided with adequate agronomic and economic information about the practices.

Discussions Relevant to the Perceptions of Innovations

The main dependent variable in this study was the perceptions of respondents regarding the profitability, complexity and compatibility of the selected practices. It was found that respondents generally had positive perceptions of most of the practices. With regard to the perceptions of the profitability of practices, soil testing, taking credits for manure and spring/summer application of nitrogen fertilizer received the most favorable profitability perceptions of respondents. For instance, 80% of respondents indicated that both soil nitrogen testing and taking credits for manure were profitable. However, a large number of the respondents gave neutral profitability ratings to some of the practices, such as reduced nitrogen rates, the use of nitrification inhibitors, and mechanical weeding. This finding calls for more
intensive educational programs to promote sustainable agriculture; as in the words of Heffernan and Green (1981), farmers adoption of conservation practices are likely to be predicated on the availability to farmers of valid agronomic and economic information about the consequences of the innovation. The study also found similar findings regarding the perceptions of the compatibility and complexity of the selected practices. Spring/summer application of nitrogen fertilizer, taking credits for manure and soil nitrogen testing in that order received very positive compatibility ratings by the respondents. However, banded application of herbicides, crop rotation, reduced herbicide rates and mechanical weeding received lower compatibility ratings. This might be understandable in the case of mechanical weeding and the inclusion of crops other than soybeans/corn in a farmers' rotation, which might not be very compatible with the highly specialized row-crop cultivation that characterizes most Iowan farms. Regarding the perceptions of the complexity of the management skills needed to adopt the practices; the study found that most respondents perceived most of the practices as requiring easy management skills. Spring/summer application of nitrogen fertilizer, reduced fertilizer rates, taking credit for manure, and soil nitrogen testing were perceived by most respondents to require easily learned management skills. Banded herbicide application, crop rotation, use of nitrification inhibitors and reduced herbicides rates received higher complexity ratings than the other practices. This finding is similar to those reported for the perceptions of profitability and compatibility. In summary it appears that respondents were having more problems with practices associated with herbicide management and crop rotation.

In addition to determining the perceptions of respondents about the practices, the study also formulated a regression equation to predict the adoption of practices as a function of respondents' perceptions of innovation. The findings of this study lend a lot of support for the section of the conceptual model dealing with the impact of perceptions on the adoption of practices. Respondents' perceptions of compatibility and profitability yielded correlation
coefficients with composite innovation adoption index that were significant at the 0.0001 level of significance. The perception of practice complexity also yielded a coefficient that was significant at the 0.001 level. The perception of compatibility was the best predictor of composite adoption index of respondents, explaining 20.58% of variance in adoption index. However when the practices were considered individually, the perceptions of profitability was a predictor of the level of adoption of nitrification inhibitor and reduced nitrogen fertilizer rates while the perception of complexity was the best predictor of the level of adoption of soil nitrogen testing (31.67%). The perception of practice compatibility was also a good predictor of the adoption of crop rotation, spring/summer application of nitrogen fertilizer, taking credit for manures, and mechanical weed control. In conclusion the perceptions of the compatibility of practice with existing farming systems of respondents was the most important factor in the adoption of low-input sustainable practices. This finding makes a lot of sense when it is realized that the adoption of low-input sustainable agricultural practices may not necessarily provide better economic incentives to farmers when compared to the conventional high-input practices (Smathers, 1982; Pampel and Van Es 1977; and Olson et al., 1982). It is therefore to be expected, in the absence of real economic incentive, that the adoption of low-input sustainable practices should be predicated on their compatibility with existing farming systems. This finding is also consistent with those of past studies by Linton (1936); Barnett (1953); Fliegel and Kivlin (1962) and Carlson et al. (1981). For instance, Carlson et al. (1981) found that Idaho farmers did not adopt erosion control practices in an haphazard manner, observing that farmers were more likely to adopt a practice that was perceived to be compatible with their rotation pattern than they were if they had to change their rotation pattern to accommodate the erosion control practice. In conclusion, the findings of this study with regard to the importance of farmers' perceptions of innovation in determining the rate of adoption of low-input sustainable practices has a lot of implications for educational programing. It underscores
the need to consider and influence farmers perceptions of the characteristics of practices, if we are to motivate them to adopt low-input practices. For, according to Miranowski (1982), and Smathers (1982), it is likely that the successful adoption of conservation practices will be influenced more by a farmer's attitude and perceptions than any other factor.

Discussion Related to the Level of Innovation Information and Institutional Contacts

The determination of the adequacy of innovation information and the level of institutional contact of respondents and the analysis of their impact on the adoption of practices was an important objective of the study. Surprisingly, the findings of the study showed that many of the respondents indicated that they were adequately informed about the practices, in spite of the low level of institutional contacts. For instance over 50% of respondents indicated they were adequately informed about the benefits and methods of adopting each of the practices with the exception of nitrification inhibitor. However most of the information was obtained from the mass media and farm chemical dealers which were the two sources with which the respondents were in very frequent contact. Over 83% and 72.5% of respondents, respectively, indicated they had very frequent contact with these two sources of low-input sustainable agriculture information. The most significant and instructive finding of the study with regard to respondents' level of institutional contacts was the perceived low level of contact between farmers and government agencies such as the Cooperative Extension Service, the Experiment Station and the Soil Conservation Services and Districts. The implications of the over-reliance of farmers on the mass media and agricultural chemical dealers for innovation information, and the perceived inadequacy of government agencies to provide such information to farmers are significant. In the first instance, it might be foolhardy to expect chemical dealers to put themselves out of business by promoting low-input agricultural chemical management. In the same vein, it is doubtful whether the mass media, apart from its proven effectiveness in
creating awareness about innovation, is really very effective in stimulating active adoption of innovations. The failure of government agencies to provide useful information about low-input agricultural practices has been documented by many past studies. The United States Department of Agriculture (1980) reported that at least 25% of the farmers interested in the low-input agriculture considered the university research centers and the Cooperative Extension Services either unwilling or unable to provide them with help. It would appear that almost 10 years after the observation was made, the situation has not changed considerably. This sentiment was reflected in the general comments made by most of the respondents in response to the open-ended question on this issue. In fact one of the respondents suggested that the Iowa State University is deliberately yielding to pressure (political and economic) from some powerful groups to kill low-input sustainable agriculture. Such comments and feelings put the credibility of the university as a change agent in jeopardy. The need to intensify educational programs about sustainable agriculture becomes more pressing when it is recognized that the level of innovation information and institutional contacts were good predictors of the adoption of the selected practices using regression analysis. For instance, apart from the perception of compatibility, the only other variable that offered prediction of the composite adoption index was the level of adequacy of information about practices that were available to farmers. Both variables, the level of innovation information and institutional contact yielded significant correlation coefficients with composite adoption index. The variances in the adoption of some of the practices were also explained by the two variables. These findings are in consonance with the findings of researchers such as Nowak and Korsching (1983); Taylor and Miller (1978); Lasley and Nolan (1981); Belknap and Saupé (1988) all of whom reported positive relationships between farmers' contact with change agents, integration into information networks and the adoption of conservation technologies.
Discussions Related to the Perceptions of Groundwater Contamination by Agricultural Practices

The findings of the study with regard to the perceptions of the seriousness of groundwater contamination by respondents revealed that respondents tended to underestimate the seriousness of the problem when it pertains to their farms and their counties. For instance, the study found that while 35.1% of respondents rated the problem as serious in Iowa as a whole, only 10.8% rated groundwater contamination as a serious problem on their farms. This finding would appear to contradict the reports of recent surveys pointing to the seriousness of groundwater contamination in Iowa (Hallberg 1986a; Cohen et al., 1986; Kelley, 1986). For instance Kelly (1986) estimated that 25% of Iowa's population are already exposed to detectable levels of chemicals such as nitrate and pesticides. The findings of this study are similar to those reported by Padgitt (1985) who observed similar operation of the proximity principle in the perceptions of groundwater contamination problems by farmers in the Big Spring Basin in Northeast Iowa. This finding calls to question the effectiveness of the massive campaign to highlight the extent and danger of groundwater contamination in the state. Apparently, these messages are not getting to the farmers. It also brings up a lot of implications for a new approach to promoting sustainable agriculture. Rather than spend all of our time hammering about the extent of groundwater contamination in rural Iowa, maybe we should be spending more time promoting alternative farming systems that are more benign to the environment. It is the contention of this study that we have spent too much time shouting about the problem of environmental degradation so much so that we have forgotten to sell alternative approaches. As Napier et al. (1986) succinctly puts it, simply making farmers aware of environmental problems will not bring about adoption; he contends that empirical research demonstrating that conservation practices can be profitable without introducing more uncertainty into adopters' lives will be required. The findings of the study revealed that we
have not done enough of providing farmers with such information. This is an issue that might become one of the biggest challenges of the 1990s and how far we succeed in this task will greatly impact the adoption of sustainable agricultural practices.

Discussions of the Educational Implications of the Findings of the Study

The overarching goal of the study was to be able to draw implications for agricultural and extension education programs in low-input sustainable agriculture. The findings of the study have indicated that young Iowa farmers represent a formidable educational resource and challenge. Not only are they well educated and highly experienced in the farming business, but the future of sustainable agriculture and the agriculture sector as a whole depends to a great extent on these young men and women. The group also represents a fairly homogeneous collection as revealed by the failure of demographic variables to predict the level of adoption of the practices. The implications of this information for designing specific educational programs for this segment of the farming community are very great.

One of the most revealing findings of the study, and which also has a lot of educational implications, pertains to the low frequency of institutional contacts between the farmers and government agencies. The implications of this finding calls for the intensification of research in the area of sustainable agriculture. The success of the extension services in being able to provide relevant agronomic and economic information about sustainable agriculture depends to a large extent on the availability of such information from the technical agriculture research sectors. The present situation in which most farmers claimed to be relying mostly on the mass media and agricultural chemical dealers for low-input agriculture information might be counter-productive to the goal of sustainable agriculture. This observation is not meant to denigrate the important role of the mass media and the chemical dealers in promoting sustainable agriculture.
It is only meant to re-emphasize the need for a collective approach, involving both the public and private sectors, in the promotion of sustainable agriculture.

A lot of educational implications can be drawn regarding the findings of the central role that farmers' perceptions of innovation characteristics play in the adoption of low-input sustainable agricultural practices. The finding re-emphasizes the calls of people like Miranowski (1982) and Smathers (1982), who contended that farmers' perceptions of low-input agricultural practices and the shaping of these perceptions might be the most important issue in the promotion of sustainable agriculture. The shaping of perceptions is an educational task that would require the provision of empirical evidence through on-farm research, demonstrations and one-on-one contact between farmers and the technology-development-dissemination systems. Particular efforts need to be focussed on making low-input sustainable agricultural practices as compatible as possible with the existing farming systems in which farmers operate. Low-input sustainable agricultural practices will be adopted in proportion as they do not require very radical changes in the existing farming systems of the potential adopters.
The main purpose of the study was to determine the perceptions of selected Iowa farmers regarding innovation characteristics and institutional constraints influencing their adoption of selected low-input sustainable agricultural practices. Specifically, the study set out to identify the perceptions of Iowa farmers regarding the profitability, compatibility and complexity of selected low-input sustainable agricultural practices in nitrogen fertilizer and herbicide management; and to analyze how these perceptions, in concert with institutional and demographic variables, impact on the adoption of practices. The purpose of this chapter is to give an overview of the research procedures and the findings of the study. It is organized under the following sub-headings: (1) Summary of Research Procedures (2) Findings and Conclusions, (3) Recommendations and (4) Recommendations for Further Research.

Summary

The study was motivated by the need to meet the research need pertaining to the relationship between innovation characteristics and the adoption of low-input sustainable agricultural practices, a subject which has received serious mention in the literature in the wake of the argument about the applicability of the classical diffusion model to the explanation of the adoption of conservation technologies (Pampel and Van Es, 1977; Minanowski, 1982 and Smathers, 1986). The study adopted a descriptive survey design and was guided by a conceptual model that predicted the adoption of low-input sustainable agriculture practices as a function of: (1) Respondents' perceptions of innovation, (2) Farm firm variables such as farm size and tenure, (3) Personal demographic variables such as age, education and years of farming experience, (4) Diffusion variables including level and quality of innovation information and institutional contacts.
The population of the study consisted of active or associate members of the Iowa Young Farmers Educational Association, Inc. An oversample procedure was conducted to ensure adequate response rate. An Apple random-number computer program was used to select a sample of 300 respondents. The instrument, a mailed questionnaire, was sent out to the respondents in the first week of January, 1990. The initial mailing resulted in the return of 87 usable questionnaires. A second follow-up procedure resulted in a total of 115 questionnaires representing a 38.3% response rate but 21% of the total population. The post-hoc reliability testing of the seven-section questionnaire yielded a reliability coefficient of 0.89.

The data generated through the questionnaire were coded and fed into the Statistical Package for Social Sciences (SPSSX) computer program. The following statistical treatments were conducted on the data: Frequencies subprogram to produce percentages, frequencies counts, means, and standard deviations; post-hoc reliability test, multiple regression and Pearson correlation coefficient analyses. These statistical analyses were chosen for their appropriateness for the research objectives.

Findings and Conclusions

From the data analysis the following findings and conclusions were drawn:

1. Respondents demographic information: Majority of the respondents (69.5%) were aged between 20 and 39 years. Their average years of farming experience was 17.5 years. Over 66% of all respondents have had either high school or some college education, while 32.2% had completed college.

2. Farm firm characteristics: The size of the farm operations ranged from 6-3000 acres with a mean farm size of 545.5 acres. The proportions of farm areas rented either on cash or share basis ranged from 0 to 100 percent.

3. Perceptions of innovations characteristics: In general most respondents had fairly
positive perceptions regarding the profitability, compatibility and complexity of the practices. The only exceptions were crop rotation, banded application of herbicides and the use of nitrification inhibitor.

4. Respondents' perceptions of groundwater contamination: Respondents underestimated the seriousness of groundwater contamination on their farms, though most of them recognized the seriousness of the problem at the state level.

5. Level of innovation information: Most respondents indicated that they were adequately informed about most of the practices. Over 50% of respondents expressed this opinion.

6. Frequency and quality of institutional contacts: Majority of the respondents (over 50%) have had very few or inadequate contacts with government agencies such as the Cooperative Extension Services, the Experiment Station and the Soil Conservation Service and Districts with regards to low-input agriculture information. However mass media (e.g., farm magazines) and agricultural chemical dealers were the most frequently contacted sources of information. Respondents however gave more positive responses to the question of quality of information.

7. Relationship between tested variables and the adoption of practices: Demographic and farm firm characteristics and the perceptions of groundwater contamination were poor predictors of the level of adoption of innovations. Diffusion variables such as the adequacy of innovation information and level of institutional contact were significantly related to the adoption of innovations. Perceptions of innovations especially the perceptions of practices' compatibility were the best predictor of the level of adoption.

Conclusions

1. Iowa's young farmers represent a formidable educational resource requiring specific educational programs with regards to the diffusion and adoption of low-input
sustainable agricultural practices.

2. The findings of the study did not provide a clear-cut answer to the on-going arguments concerning the applicability of the classical diffusion model to low-input sustainable agriculture. However, the personal characteristics of farmers were not significant predictors of the adoption of many of the selected low-input sustainable agricultural practices among the study's population.

3. The levels of innovation information and institutional contact of farmers are important variables determining the levels of adoption of sustainable agricultural practices in nitrogen fertilizer and herbicide management by farmers in Iowa.

4. Government agencies such as the Cooperative Extension Service need to strengthen their efforts in providing farmers with agronomic and economic information that are necessary to help them make a shift to a sustainable agricultural system.

5. Any appropriate conceptual model for explaining the adoption of low-input sustainable agricultural practices would have to include farmers' perceptions of the compatibility, complexity and profitability of the practices.

6. One of the most critical factors in the adoption of sustainable agricultural practices in herbicide and nitrogen fertilizer management is the compatibility of practices with the existing farming systems of farmers.

Recommendations

On the basis of the study's findings and conclusions, the following recommendations are put forward for the promotion of low-input sustainable agricultural practices.

1. The membership of the Iowa Young Farmers Educational Association, Inc., constitutes an important segment of the Iowa farming community, hence should be considered for specific educational programs concerning sustainable agriculture.
2. The Iowa State University Experiment Station, the Cooperative Extension Service and other agencies such as the Soil Conservation Service should intensify their research and programmatic activities in the area of sustainable agriculture, to meet the great demand for information about the profitability, complexity and compatibility effects of the adoption of the system.

3. Farm magazines and other mass media are effective sources for the dissemination of sustainable agriculture information which should be explored by government agencies.

Recommendation for Further Studies

On the basis of the findings of the study and some of the unresolved questions that emerged therewith, the following recommendations for further studies are proffered:

1. The study should be replicated using a more heterogeneous population such as all the farmers in Iowa, in order to throw more light on the impact of personal and farm firm characteristics on the adoption of low-input sustainable agricultural practices.

2. One of the major problems encountered with the operationalization of the adoption variable in the study was the assumption of an interval scale for statistical analysis. Hence future measures of the level of adoption could include a measure of the time of adoption and the proportion of total farm holding on which practice is being used.

3. A more reliable study would be produced through the use of field research, interviews, and observation to ascertain actual adoption of innovations.
BIBLIOGRAPHY


ACKNOWLEDGEMENTS

I give thanks to God who makes all things possible. My profound gratitude goes to my major professor, Dr. Robert Martin, whose guidance and financial support made the project a reality. His encouragement and support throughout my graduate study is most commendable. I would also like to extend my thanks to the other members of my graduate committee: Drs. Julia Gamon and Mike Warren for their assistance and advice. I would also like to thank Dr. William Miller, of the Department of Industrial Education, for helping me with statistical analysis.

I am indebted to my parents, Mr. and Mrs. Alonge, and especially, to my parents-in-law, Mr. and Mrs. O. Z. Ojo, for standing by my wife and me throughout the duration of my study. This same sense of indebtedness is extended to all my friends, brothers and sisters for their emotional support. Prince Adewale Adediran, Mr. and Mrs. Femi Olajoyegbe and Mr. Niyi Alako, Tunji Adesokun, Wole Kolawole, Gbenga Ojo, Rotimi Oluborode, Dele Gazal, Mrs. Warren, Mr. Ogunleye and The Fadeyis deserve special mention for their support and care.

I am most indebted to my loving wife, Funmilayo Arike, whose perseverance, love and devotion during our two years of being apart and during our moments of trial, gave me the courage to survive the most difficult time of my study in the United States. Adebowale will come again.

My final gratitude goes to the Federal Government of Nigeria for funding my graduate program at Iowa State University.
APPENDIX A. QUESTIONNAIRE
December 18, 1989

Dear Iowa Young Farmers:

In an effort to analyze the use and determine the educational implications of low input sustainable agricultural practices in Iowa, the Department of Agricultural Education/Studies of the Iowa State University solicits your participation in a survey of selected Young Farmers in Iowa. In the survey we are seeking information about your perceptions and level of adoption of selected low input sustainable agricultural practices. We are also interested in finding out your concerns about the level of information available to you about these practices.

Your name was selected in a random sample of farmers who have been involved in young farmer educational programs in Iowa. Let us emphasize that your participation in the survey and any information supplied by you will be treated with utmost confidentiality. We are only interested in group data. The survey has been coded to enable us to contact those who might not return the questionnaire on time. The code numbers on the survey forms will be removed and destroyed as soon as we receive the questionnaire.

Please complete and return the questionnaire within two weeks of receipt, in the postage-paid business reply envelope. It should take on the average between 15 to 20 minutes to complete the questionnaire. If however, you do not wish to participate in the study, kindly return the blank questionnaire.

Thanks for sparing us some of your time to participate in the survey.

Sincerely,

Robert A. Martin
Associate Professor

Adewale Alonge
Research Assistant

Enclosure
Section I. Adoption of Practices

Below is a list of low-input sustainable agricultural practices; using the scale below, circle the number that corresponds to the degree to which you have adopted them.

Scale:

1 = I have just become aware of the practice.
2 = I am still looking for more information about the practice before making a decision.
3 = I am now trying the practice on portions of my farm.
4 = I have now adopted the practice as standard practice on my farm.
NA = I find the practice inappropriate and have decided not to use it.

1. Reduction in the rate of nitrogen fertilizer application.
2. Use of nitrification inhibitors to reduce leaching losses of nitrogen fertilizer.
3. Include crops other than corn/soybean in my rotation.
4. Soil testing to determine the rate of nitrogen fertilizer application.
5. Change in the timing of nitrogen fertilizer application from fall to spring/summer.
6. Give credit to animal/green manures as supplements to artificial nitrogen fertilizer.
7. Weed control through increased use of mechanical cultivation.
8. Reduction of the rate of herbicide application.
9. Banded application of herbicides

Section II. Profitability of Practices

Using the 1 to 5 scale described below (5 = Highly Profitable to 1 = Highly Unprofitable), indicate your perception about the profitability (effect on farm income) of the listed practices by circling the number.

1 2 3 4 5
Highly Unprofitable Neutral Highly Profitable

1. Reduction in the rate of nitrogen fertilizer application.
2. Use of nitrification inhibitors to reduce leaching losses of nitrogen fertilizer.
3. Include in rotation, crops other than corn/soybean.
4. Soil testing to determine the rate of nitrogen fertilizer application.
5. Change in the timing of nitrogen fertilizer application from fall to spring/summer.
6. Give credit to animal/green manures as supplements to artificial nitrogen fertilizer.
7. Weed control through increased use of mechanical cultivation.
8. Reduction of the rate of herbicide application.
Section III. Compatibility of Practices

Using the 1 to 5 scale described below (5 = Very Compatible to 1 = Very Incompatible), indicate how you perceive the practices as compatible (fit well into) with your present farm management practices by circling the appropriate number to the right.

1  2  3  4  5
Very Incompatible  Very Compatible

1. Reduction in the rate of nitrogen fertilizer application.  
2. Use of nitrification inhibitors to reduce leaching losses of nitrogen fertilizer.  
3. Include in rotation, crops other than corn/soybean.  
4. Soil testing to determine the rate of nitrogen fertilizer application.  
5. Change in the timing of nitrogen fertilizer application from fall to spring/summer.  
6. Give credit to animal/green manures as supplements to artificial nitrogen fertilizer.  
7. Weed control through increased use of mechanical cultivation.  
8. Reduction of the rate of herbicide application.  

IV. Adaptability of Practices

Using the 1 to 5 point scale described below (5 = Very Easy to 1 = Very Difficult), indicate your perceptions (opinions) regarding the level of difficulty you will or have had in learning the management skills needed to adopt the following practices on your farm. (Circle the number).

1  2  3  4  5
Very Difficult  Very Easy

1. Reduction in the rate of nitrogen fertilizer application.  
2. Use of nitrification inhibitors to reduce leaching losses of nitrogen fertilizer.  
3. Include in rotation, crops other than corn/soybean.  
4. Soil testing to determine the rate of nitrogen fertilizer application.  
5. Change in the timing of nitrogen fertilizer application from fall to spring/summer.  
6. Give credit to animal/green manures as supplements to artificial nitrogen fertilizer.  
7. Weed control through increased use of mechanical cultivation.  
8. Reduction of the rate of herbicide application.  
Section V. Level of Information

Using the 1 to 5 scale described below (5 = Highly Informed to 1 = Not Informed), circle the number that indicates how adequately you are informed about the benefits and the methods of adopting the practices listed below.

<table>
<thead>
<tr>
<th>Number</th>
<th>Not Informed</th>
<th>Highly Informed</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1. Reduction in the rate of nitrogen fertilizer application.
2. Use of nitrification inhibitors to reduce leaching losses of nitrogen fertilizer.
3. Include in rotation, crops other than corn/soybean.
4. Soil testing to determine the rate of nitrogen fertilizer application.
5. Change in the timing of nitrogen fertilizer application from fall to spring/summer.
6. Give credit to animal/green manures as supplements to artificial nitrogen fertilizer.
7. Weed control through increased use of mechanical cultivation.
8. Reduction of the rate of herbicide application.

Section VI. Information Sources

Below is a list of agencies connected with providing information about the low-input practices listed above. On a scale of 1 to 5, indicate the frequency (5 = Very Frequent, 1 = Never) of your contact with such information from the agencies, and the usefulness (5 = Very Useful to 1 = Of No Use) of the information in helping you adopt the practices.

<table>
<thead>
<tr>
<th>Frequency of Contact</th>
<th>Usefulness of Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>NEVER</td>
<td>VERY FREQUENT</td>
</tr>
<tr>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>5</td>
<td>1</td>
</tr>
</tbody>
</table>
Section VII. General Information

1. Using the statements below, indicate how serious the problem of groundwater contamination by agricultural chemicals is in the following areas. (5 = Very Serious to 1 = None).

<table>
<thead>
<tr>
<th></th>
<th>None</th>
<th>Minor</th>
<th>Somewhat Serious</th>
<th>Serious</th>
<th>Very Serious</th>
</tr>
</thead>
<tbody>
<tr>
<td>In Iowa as a whole</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>In your county</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>On your farm</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

2. A. How many acres do you presently cultivate? _____
   B. How many of these acres are rented on:
      1. A share basis? _____
      2. A cash basis? _____

3. Check the range that includes your age (in years):
   ___ A. 19 or under
   ___ B. 20 to 29
   ___ C. 30-39
   ___ D. 40 to 49
   ___ E. 50 to 59
   ___ F. 60 and above

4. How long (years) have you been farming? _____

5. Check your highest level of formal education?
   ___ 1. Elementary, 0-6 years
   ___ 2. 7-9 years
   ___ 3. 10-12 years
   ___ 4. Some College
   ___ 5. Completed College
   ___ 6. Postgraduate Degree

6. A. Have you reduced your level of application of the following inputs in the last 3 years?
   i. Nitrogen fertilizer _____ Yes _____ No
   ii. Herbicides _____ Yes _____ No
   B. If you answered yes to either or both items in 6a, what percent of reduction of application have you made?
      i. Nitrogen fertilizer _____ %
      ii. Herbicides _____ %

Section VIII. General Comments

Please give us your comments regarding factors influencing the adoption or non-adoption of low input agricultural practices by Iowa farmers or if you have any comments about the questionnaire.
APPENDIX B. FOLLOW-UP LETTER
January 22, 1990

Dear Iowa Young Farmer:

A few weeks ago you received a questionnaire from our department, in connection with your perceptions and adoption of Low Input Sustainable Agricultural Practices (LISA). We are very much aware of your very busy schedule, we will however appreciate it if you can spare us a few minutes of your time to respond to the questionnaire. Your participation is very crucial to the success of the study. We are therefore forwarding you a new questionnaire and a stamped return envelope to enable you to complete the survey at your earliest convenience.

Thanks once again for your cooperation.

Sincerely,

Robert A. Martin
Associate Professor

Adewale Johnson Alonge
Research Assistant

Enclosure
APPENDIX C. HUMAN SUBJECT APPROVAL
INFORMATION ON THE USE OF HUMAN SUBJECTS IN RESEARCH
IOWA STATE UNIVERSITY

(Please follow the accompanying Instructions for completing this form.)

1. Title of project (please type): **PERCEPTION OF INNOVATIONS AND INSTITUTIONAL CONSTRAINTS AS FACTORS INFLUENCING THE ADOPTION OF LOW_INPUT AGRICULTURAL PRACTICES BY YOUNG FARMERS OF IOWA.**

2. I agree to provide the proper surveillance of this project to insure that the rights and welfare of the human subjects are properly protected. Additions to or changes in procedures affecting the subjects after the project has been approved will be submitted to the committee for review.

   **ADEWALE JOHNSON**
   **ALONGE**
   **Typed Name of Principal Investigator**
   **11-17-89**
   **Date**
   **Signature of Principal Investigator**

   **223 CURTISS HALL**
   **Campus Address**
   **294-0901**
   **Campus Telephone**

3. Signatures of others (if any) Date Relationship to Principal Investigator

   **11-17-89**
   **MAJOR PROFESSOR**

4. ATTACH an additional page(s) (A) describing your proposed research and (B) the subjects to be used, (C) indicating any risks or discomforts to the subjects, and (D) covering any topics checked below. CHECK all boxes applicable.

   - [ ] Medical clearance necessary before subjects can participate
   - [ ] Samples (blood, tissue, etc.) from subjects
   - [ ] Administration of substances (foods, drugs, etc.) to subjects
   - [ ] Physical exercise or conditioning for subjects
   - [ ] Deception of subjects
   - [ ] Subjects under 14 years of age and/or
   - [ ] Subjects 14-17 years of age
   - [ ] Subjects in institutions
   - [ ] Research must be approved by another institution or agency

5. ATTACH an example of the material to be used to obtain informed consent and CHECK which type will be used.

   - [ ] Signed informed consent will be obtained.
   - [ ] Modified informed consent will be obtained.

6. Anticipated date on which subjects will be first contacted: Month Day Year

   **12 10 89**

   Anticipated date for last contact with subjects:

   **2 10 90**

7. If Applicable: Anticipated date on which audio or visual tapes will be erased and/or identifiers will be removed from completed survey instruments:

   **6 1 90**

8. **Signature of Head or Chairperson** Date Department or Administrative Unit

   **11/1/89**

9. **Decision of the University Committee on the Use of Human Subjects in Research:**

   - [ ] Project Approved
   - [ ] Project not approved
   - [ ] No action required

   **George G. Karas**
   **Name of Committee Chairperson**
   **Date**
   **Signature of Committee Chairperson**