THE ADOPTION AND CONTINUED USE OF CONSUMER FARM TECHNOLOGIES:
A TEST OF A DIFFUSION-FARM STRUCTURE MODEL

DISSERTATION

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By

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* * * *

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to
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# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>DEDICATION</td>
<td>ii</td>
</tr>
<tr>
<td>ACKNOWLEDGMENTS</td>
<td>iii</td>
</tr>
<tr>
<td>VITA</td>
<td>iv</td>
</tr>
<tr>
<td>PUBLICATIONS</td>
<td>v</td>
</tr>
<tr>
<td>FIELDS OF STUDY</td>
<td>vii</td>
</tr>
<tr>
<td>LIST OF TABLES</td>
<td>x</td>
</tr>
<tr>
<td>LIST OF FIGURES</td>
<td>xi</td>
</tr>
</tbody>
</table>

Chapter:

I. INTRODUCTION. ........................................... 1

   Historical and Comparative Synopsis. ............... 6
   The Economic-Constraint Model. ...................... 15
   Purposes of this Study .............................. 18

II. THEORETICAL PERSPECTIVE AND LITERATURE REVIEW ...... 21

   The History of Mass Communication and Diffusion Research 23
   Description of the Traditional Diffusion Model ........ 34
   Description of the Farm-Structure Model .............. 41
   An Eclectic Perspective for Explaining Adoption Behavior 44
   Summary of the Theoretical Perspective .............. 64

III. RESEARCH METHODOLOGY

   Sampling and Data Collection ....................... 69
   Operationalization of Variables ................... 75
   Statistical Analyses ................................ 79
Chapter 4. FINDINGS AND CONCLUSIONS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>General Overview</td>
<td>81</td>
</tr>
<tr>
<td>Correlation Findings</td>
<td>82</td>
</tr>
<tr>
<td>Regression Analyses</td>
<td>90</td>
</tr>
<tr>
<td>Path Analyses</td>
<td>99</td>
</tr>
<tr>
<td>Comparison of Actual Path Models with Expected Models</td>
<td>105</td>
</tr>
<tr>
<td>Summary and Conclusions</td>
<td>107</td>
</tr>
</tbody>
</table>

APPENDIXES

A. Table 3 - Correlation Matrix               | 115  |

B. Questionnaire                               | 119  |

BIBLIOGRAPHY                                  | 131  |
# LIST OF TABLES

<table>
<thead>
<tr>
<th>Table</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Summary Characteristics of Study Sample (N=918) Compared with the 1982 Census of Agriculture for Ohio (N=86,942).</td>
<td>74</td>
</tr>
<tr>
<td>2. Bivariate Correlations for Measures of Farm Technologies and Selected Independent Variables.</td>
<td>83</td>
</tr>
<tr>
<td>3. Correlation Matrix for Adopted Farm Technologies and Selected Independent Variables.</td>
<td>115</td>
</tr>
<tr>
<td>4. Best Regression Models for Adopted Farm Technologies and Selected Independent Variables.</td>
<td>91</td>
</tr>
</tbody>
</table>
LIST OF FIGURES

Figure | Page
-------|------
1. Proposed Path Model to Specify Relationships of the Independent Variables and Measures of Farm Adoption Technology | 66
2. Actual Path Model to Specify Relationships of the Independent Variables and the Dependent Variable "Number of Tractors Owned" | 100
3. Actual Path Model to Specify Relationships of the Independent Variables and the Dependent Variable "Horsepower of the Largest Tractor Used" | 101
4. Actual Path Model to Specify Relationships of the Independent Variables and the Dependent Variable "Number of Combines Owned" | 102
5. Actual Path Model to Specify Relationships of the Independent Variables and the Dependent Variable "Bin Capacity of the Largest Combine Used" | 103
CHAPTER I

INTRODUCTION

Historians who have attempted to unravel the rise and decline of societies invariably have examined the adoption and continued use of technologies as possible explanatory variables. The use of technologies in the production of agricultural products especially, has been paramount throughout human history in maintaining the livelihood of societies. From the first crude hand tools used for cultivation, to the complex farm equipment of this age, the adoption of technological advancements has played a major role in accelerating food production and in assuring the economic well-being of nations. The potentials of technologies to increase food supplies are especially crucial today as humanity races against time to offset hunger generated by massive population increases, with larger farm outputs (Cummings, 1971). Unless effective means are found to stabilize population growth, agricultural production will remain a critical factor in determining the physical survival of all societies.
The use of technology to spur agricultural production has affected not only the nutritional well-being of people, but also the economic livelihood of nations. In the United States, for example, the application of innovative technology has so greatly increased agricultural production, that this nation has become the chief food exporter in the world (Havens, 1982). Given this prominent economic role, the U.S. has come to rely heavily on agricultural commerce to decrease its foreign trade deficits. Therefore, continued advancements in farm production levels are essential for this country to maintain a favorable international trade balance and, hence, to help insure its economic viability.

In spite of the critical influence of agricultural technologies to the maintenance of the economic viability of the society, various groups in the U.S. perceive the adoption and continued use of innovative farm practices as being negative. Some small-scale farmers, for example, view sophisticated agricultural technologies as requiring expenditures far beyond their means. They feel financially threatened, especially when public entities such as banks and legislators favor large farm operators and corporate agriculture, which blocks the access of small-scale farmers to the financing and information necessary to adopt and maintain a sophisticated farm operation (Coughenour and Wimberly, 1982).

Conservationists also hold a negative view of agricultural innovations, such as pesticides, chemical fertilizers and complex machinery, when these inputs contribute to pollution of water
supplies, erode top soils and endanger the health of humans and wildlife (Havens, 1982). Their perceptions are reinforced by scientific data which has demonstrated a connection between environmental degradation and changes in the structure of U.S. agriculture, such as the adoption of large-scale farm technologies (Buttel and Larson, 1979).

In contrast, large-scale farm operators, agribusinesses and governmental officials often regard the adoption of complex farm technologies as representing progress (Coughenour and Wimberly, 1982). Proponents of agricultural products, such as these, contend that innovations can accelerate agricultural output while decreasing labor inputs. They also suggest that improved efficiency can bolster profits. In addition, it is argued that high farm output can advance the material welfare of society through increased food supplies (Hooks, 1980) and commerce.

Since influential segments of U.S. society, such as corporate and governmental groups, hold a positive perception of technological advancements in agriculture, it is not surprising that increased farm output through technology has been a tradition in this country. The accomplishment of increased production is assumed to be closely linked with the creation and use of technologies. As scholars such as Arthur T. Mosher (1966) have posited, among the approaches to increasing agricultural production, it is undeniable that technological innovations are needed, for without technology one
cannot improve plant breeding, pest/disease control and soil fertility. These advancements are necessary to accelerate the cultivation of crops under adverse climatic and topographical conditions, and thus produce sufficient quantities of food. Simultaneously, it is necessary to adopt the physical technologies such as chemicals and the complex farm machinery needed to implement these innovations (Cummings, 1971; Mosher, 1966).

The goal of increased farm output through technology has been pursued with vigor over the years both in the United States and abroad. In the late 1940s and early 1950s agricultural development programs were established on the assumption that the diffusion of technology and related knowledge, from high-income to low-income regions, would accelerate agricultural production. The results, however, were below expectations. In developing nations the rates of technology adoption and food production remained low (Ruttan, 1972). Consequently, by the mid-1960s, a new perspective emerged. This view called for the continued diffusion of knowledge, yet emphasized a concomitant need for greater investments in research efforts to create more sophisticated agricultural technology. It was argued that advancements in technology would enhance the probabilities of adoption. In spite of this new thrust, the diffusion of agricultural technology and food production did not accelerate overseas as rapidly as expected (Ruttan, 1972). In the U.S., innovative technologies were adopted more frequently by large-scale farm operators than by small-scale farmers. Also, higher production rates became
concentrated increasingly in larger and fewer farm operations (Stockdale, 1982).

Social scientists and economists have attributed the shortcomings of past agricultural development programs overseas and on small-scale farms in the U.S. largely to an oversimplification of approaches derived from inadequate theoretical assumptions (Mosher, 1966; Cummings, 1971; Brown, 1981; Napier, et al., 1984). These authors suggest that continued research and the diffusion of knowledge regarding innovations are necessary but not sufficient conditions to achieve widespread adoption and continued use of agricultural technologies. They argue that in spite of knowledge-related prerequisites, other factors operate to block farmers from adopting agricultural technologies. Specifically, the accessibility of economic resources and service infrastructures necessary to access agricultural technology can strongly affect adoption behavior.

The critics of the diffusion perspective imply a need for more studies regarding the diffusion of technologies, and for basing research on improved theoretical modeling. Such efforts would enable a more accurate determination of which factors may be barriers and which may accelerate the adoption and continued use of agricultural technologies. Critics have specified that the inadequacies of past scientific investigations were rooted in the inappropriate assumptions of the most prevalent theoretical model utilized in
diffusion research, namely the traditional (or classical) diffusion model. Several questions have been raised by the critics of the traditional diffusion model. Some of these questions are: What are the inadequacies of the assumptions made in the traditional model? What alternative theoretical models, if any, are available and what are their strengths and weaknesses? These and other questions associated with adoption research can be addressed by sketching the historical development of the traditional model and other competing perspectives, while noting the contributions and shortcomings of each. Such a discussion should demonstrate theoretical needs in the diffusion research tradition.

Historical and Comparative Synopsis

Adoption/diffusion has been a topic of research for many years. As early as 1903 the French sociologist Gabriel de Tarde (1903) proposed a rationale for the adoption of ideas and practices. He suggested that people imitate the behavior of others, especially opinion leaders. His contributions were largely ignored for decades. It was not until the early 1920s that research regarding diffusion studies began to appear. The decade of the 1920s has been noted as the beginning of diffusion studies in the field of rural sociology (Rogers and Shoemaker, 1971).

While rural sociology has been the leader in diffusion research, other disciplines have made contributions to the field.
Anthropology, sociology, education, communication and marketing (Rogers, 1983). It was not until the 1960s, however, that diffusion research began to emerge as a single, integrated body of knowledge, even though studies have been conducted by scientists in a variety of disciplines (Rogers and Shoemaker, 1971).

Cross-discipline efforts in diffusion research have been united largely by a common theoretical base which has been termed the traditional diffusion model. This perspective emerged in the 1950s and has become the major paradigm of diffusion research. Research conducted within this theoretical framework has focused primarily on innovations (Rogers, 1983).

The Traditional Model

The traditional diffusion perspective is basically a communication model, for it views diffusion as a process in which ideas, practices or technologies are spread through society via the transfer of information regarding the object or idea being diffused (Rogers and Adhikarya, 1979). The perspective argues that exposure to information (i.e. educational programs, media messages, and advice from influentials such as county extension agents) is the most important influence on adoption decision-making. The logic is that information positively influences adoption because people are made aware of the potential benefits accompanying innovations.

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1 See Chapter II for a more detailed discussion of the traditional diffusion model.
Proponents of the traditional diffusion model contend that primarily two factors affect adoption behavior (Rogers, 1983). The first is information regarding the innovation being diffused. The second is the social-psychological orientation of the potential adopter, such as age and innovativeness. Therefore, according to this perspective, the diffusion of information regarding the attributes of an idea, practice or technology is the primary factor affecting adoption. The paradigm further assumes that the social-psychological traits of an individual are the primary factors that can inhibit that person from adopting an innovation.

Alternative Perspectives

Since the 1970s the contentions of the traditional diffusion model have increasingly been disputed. As a result, three principle perspectives have arisen as alternatives. These are the economic constraint model, the market and infrastructure perspective and the economic history perspective. These models argue that the traditional diffusion model makes incorrect assumptions and omits factors that may impede adoption inspite of the diffusion of knowledge and the social-psychological traits of individuals.

More specifically, the economic constraint model\(^2\) proposes that a lack of material resources is the primary factor affecting adoption. The model argues that means to act are as important in the

\(^2\) See Chapter II for a more detailed discussion of the economic constraint model.
decision-making process as the adopter's knowledge and a positive attitude regarding the attributes of an idea, practice or technology which is being diffused (Napier, et al., 1984). In studies regarding the diffusion of agricultural technologies, for example, it has been shown that the availability of capital and the size of land holdings are the basic economic components that affect farmers' adoption decision-making (Havens and Flinn, 1975; Buttel and Newby, 1980; Lancelle and Rodefeld, 1980).

A second alternative to the traditional diffusion model is the market and infrastructure perspective (Brown, 1981). This approach contends that the providers of information and products affect adoption behavior by controlling who will receive the necessary information for the adoption of innovations. In addition, it proposes that these providers regulate who will have physical access to the objects or ideas being diffused. The market and infrastructure perspective, therefore, emphasizes the effect of information and product supplies on adoption behavior, and assumes that distributional inequities exist in the diffusion process. An example of the market and infrastructure's perspective would be the decision by a corporate marketing department to purposely locate retail outlets (its service "infrastructures") in proximity to specific population segments, thereby giving these people a comparative advantage over other potential adopters who do not live nearby. Such action and other potential influences of the marketplace on adoption behavior, are overlooked by the traditional
diffusion model. The traditional diffusion paradigm ignores the providers' purposeful control of communication and service infrastructures needed for adoption, and assumes that individuals have the same opportunities to adopt innovations. In essence, the traditional diffusion model suggests that inequities do not exist in the diffusion process.

The traditional diffusion model differs also from a third competing paradigm which has been called the economic history perspective (Fogel and Engerman, 1971). This perspective, which has been used mostly by economic historians, can be divided into two schools of thought, the traditional interpretation of economic history, and the reinterpretation of economic history. The traditional school focuses on inventions, but not on their diffusion and, therefore, is not relevant to this discussion. The reinterpretation school, however, does apply to the diffusion process, but its emphasis differs from that of the traditional diffusion model in the following manner: The reinterpretation school examines the needs and environments of potential adopters and how these factors may influence their decision-making. It further assesses how these adopter-related factors influence the originators of innovations to modify their ideas, practices or technologies and, thus, meet the changing demands of consumers. The logic behind this perspective is that the environment into which an innovation is adopted eventually changes and, thereby, alters its utility. This in turn may influence the diffusers to modify the product.
In contrast, the traditional diffusion model does not focus on adopters' needs, but on the intentions of those who initiate the diffusion of innovations, and on the channels used to communicate adoption-related information. The traditional model has also ignored adopter-related factors that may influence on-going modifications of innovations and continued adoption.

In sum, proponents of the competing paradigms suggest that the traditional diffusion model is governed by inadequate assumptions and fails to include important structural variables. While the shortcomings of all models have been noted in the literature, no single perspective has been offered that is capable of encompassing all aspects of the adoption process. This inadequacy of diffusion models can be attributed primarily to two causes. First, as can be noted per the preceding discussion, each theoretical perspective is limited to examinations of narrow phenomena associated with diffusion. Consequently, these constrained foci eliminate consideration of a plethora of variables which can affect adoption behavior. For example, the traditional diffusion model concentrates on the communication of knowledge in the diffusion process. The economic constraint model places primary emphasis on the relationship of financial factors to the adoption of innovations. The market and infrastructure perspective examines only the influence of market-related factors. The economic history perspective focuses on the innovation or on the adopter, with less attention to the
innovator and channels of communication. Thus, no single model encompasses all of the aforementioned factors.

A second reason for the narrow focus of most theoretical models used today in diffusion research, is their restricted temporal perspective. There are generally five main steps in the diffusion process. These phases are (Rogers, 1983) 1) knowledge, which occurs when a person first becomes aware of an innovation and may seek more information regarding it; 2) persuasion, or the attitude-formation stage when an individual forms a positive or negative opinion regarding the innovation; 3) decision, which occurs when a person decides to reject or adopt the innovation; 4) implementation, which is the act of using the innovation; and 5) confirmation, when an individual seeks information supporting the adoption decision.

A literature review has shown that most studies premised on the traditional diffusion model, for example, have examined Steps 1 through 4 of the adoption process, while neglecting Step 5, confirmation. As a result, the traditional model has tended to emphasize the initiators of adoption-related information and communication channels, for these factors predominate in the initial stages of the diffusion process. Consequently, the traditional perspective does not lend insight to consumers' needs and their subsequent confirmation decision-making regarding maintained or discontinued adoption.
In contrast, the economic history perspective does examine the later steps in the diffusion process, for it views adoption as a continuing process. It appears, however, that this and all other diffusion perspectives have failed to look beyond Step 5 into post-confirmation behavior. Depending on the nature of the information and adoption experience, in Step 5 a person may decide to continue use of the innovation, seek an expanded or revised version or reject the innovation. Only recently have scholars begun to comprehend that individuals have different and changing personal needs and environments and, therefore, may not always adopt or continue use of the objects or ideas once adoption occurs.

To meet the evolving needs of individuals, innovations have been modified or altered. Rogers (1983) suggests that there has been scant research coverage of the adoption of modified innovations, and calls for more efforts. Charters and Pellegrin (1972) were the first researchers to study this aspect of adoption behavior (Rogers, 1983). They examined, over time, the innovation of differentiated staffing in four schools, and noted that this concept became institutionalized in a different name in each school, because the term had a different meaning to each staff. Since data were collected ex-post facto, the authors were able to ascertain variances in the implementation procedures and interpretations.

Besides studying the adoption of modifications, Rogers encourages researchers to examine rejection of innovations. This adoption behavior may result, for example, if the innovation is found
to be too expensive, unsafe or inconvenient. Rejection will often result in a plateauing of the adoption rate. An example in the United States is the adoption of automobile seat belts, which leveled-off at about 20-25 percent usage (Rogers, 1983). Plateauing is represented pictorially as the right-hand leveling-off of an S-shaped curve. An S-shaped curve has been utilized by researchers to depict the diffusion of innovations over time. Diffusion often begins slowly (the left-hand tail of the S), then gains speed during a period of acceptance (the middle-S portion), then levels-off (the right-hand wing of the S). This pattern suggests the temporal stages of diffusion.

Rogers (1983) also notes the need for research regarding the discontinuance of innovations. An example of discontinuance is the prohibited use of certain synthetic fabrics once popular in the manufacture of children's clothing, but later found to be highly flammable. The discontinuance of an innovation may also be S-shaped, but is depicted as a reversed image of the adoption S-shaped curve.

In sum, research focused on the later stages of the diffusion process, confirmation and beyond, can lead to discoveries of successful innovations as well as failures, and the determining factors associated with each. Most important, such studies can determine which variables influence the continued adoption rather than the rejection or discontinuance of innovations such as farm technologies.
Unfortunately, the narrow temporal foci and restricted theoretical frameworks of the major diffusion models have precluded them from examining post-confirmation behavior and from including potentially significant variables, such as those contained within competing paradigms. In spite of these shortcomings, to date there appears to be no major consolidation of theoretical perspectives in order to increase the predictive strength of future diffusion research. Proponents of diffusion paradigms continue to cling to their respective theoretical perspectives.

The Economic-Constraint Model

An alternative theoretical perspective for explaining adoption behavior is termed the economic-constraint model (Napier, et al., 1984; Hooks, et al., 1983). The economic-constraint model dates back only to the 1970s, yet in this brief period has revealed new evidence challenging the basic assumptions of the traditional diffusion perspective. The model argues that lack of access to economic resources can prevent individuals from adopting something even if they are psychosocially inclined to do so and have been informed of the advantages of adoption (Aiken, et al., 1975; Flinn and Buttel, 1980).

More specifically, economic-constraint researchers have found that capital is needed to adopt (Aiken, et al., 1975; Havens and Flinn, 1975) and, in the case of farming, sufficient land resources are necessary to adequately implement agricultural practices and
technologies being diffused (Yapa and Mayfield, 1978). It has been further suggested that social institutions can block people from acquiring the information and material resources needed to actualize adoption (Aiken, et al., 1975; Brown, 1981). For example, banks may exclude certain individuals from the credit necessary to purchase innovations.

Per such theoretical arguments and empirical findings, proponents of the economic constraint model have made at least two major contributions to the diffusion research tradition. First, they have opened the minds of social scientists to the possibility that adoption behavior is a complex phenomenon that requires more than information and psychosocial orientations to act. Specifically, they have de-emphasized information and social-psychological variables related to people's awareness and perceptions of the entities being diffused. Concomitantly these researchers have spotlighted the effects of economic-related factors on individuals' abilities to act on suggestions to adopt.

Secondly, the economic-constraint model has begun to free potential adopters of the traditional blame for the unsuccessful diffusion of various innovations. This is being accomplished by studies that reveal the role of social institutions in blocking diffusion even when the individuals' involved in the decision-making have propensities to adopt (Bordenave, 1976).

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3 See Chapter II for an elaboration of these findings.
In spite of these completed researches, the economic constraint model has at least three major shortcomings, as was evidenced by a literature review of studies premised on this paradigm. First, like the traditional diffusion perspective, this model has produced research limited in temporal focus. Its investigations have not dealt with post-confirmation behavior in the diffusion process. This means that the model has not uncovered factors that influence people to maintain adoption, discontinue or reject innovations.

Secondly, the economic constraint model incorporates only economic-related factors in its conceptual framework. Thirdly, due perhaps to its infancy, the model has tended to include only two basic economic factors, namely capital- and land-related variables.

Given the noted inadequacies of the economic constraint model, yet its enlightening research contributions to date, one can reasonably conclude that the perspective has potential utility but limited applicability. The model's narrow conceptual framework does not enable it to meet the plethora of phenomena that may necessitate investigation in diffusion research.

In light of the preceding comparative analysis, one can describe the economic constraint model and the traditional diffusion perspective as having similar strengths and weaknesses. They both have proven utility in uncovering significant findings regarding the adoption/diffusion process. Also, each model has examined variables found to be significant influences on the adoption of ideas, practices and technologies. However, each paradigm has a narrow
conceptual framework that restricts its ability to study the effects of potentially significant extraneous variables. In addition, both theoretical perspectives have limited their temporal foci by not examining post-confirmation behavior, which includes the maintained adoption, discontinuance and rejection of innovations. In sum, both paradigms have contributed necessary but not sufficient knowledge regarding the adoption/diffusion process.

Purposes of this Study

Given the stated strengths and weaknesses of the existing adoption models, the purpose of this study was to address some of the inadequacies of existing research efforts in adoption behavior. First the study would address the neglected, late-time order in the diffusion process, specifically post-confirmation behavior. This focus can be depicted as adoption behavior at the right-hand tail of the S-shaped curve utilized by researchers to show the diffusion of innovations overtime (Rogers, 1983). Specifically, the study sought to determine which factors most significantly influence individuals in society to maintain, discontinue or reject adoption of consumer farm technologies. Farm technologies were selected as the objects

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4 In this study "technologies" denoted entities that can be reproduced, diffused and classified per their purposes. These entities can involve tools, machinery, skills or systematic operations (Solo, 1972: 3). This research focused on the diffusion of technologies (tractors and combines) utilized for agricultural production purposes. (See Chapter II for the rationale underlying the selection of tractors and combines as the objects of study.)
of study, in light of the potentially crucial impacts to be incurred on food production and the economic well-being of the United States, depending on whether these devices are maintained or not readopted in the future.

The second study objective was to create and test an eclectic theoretical model developed from selected components of the traditional diffusion perspective and the economic constraint perspective. The purpose of this type of theoretical modeling was to create a more comprehensive theory to understand adoption behavior. The eclectic model included antecedent farm structure variables, information variables, attitudes, and present farm-structure factors which were reasoned to be associated with the traditional diffusion perspective, and the economic constraint model. The eclectic perspective, was termed a diffusion-farm structure model. The underlying aim in developing this model was to inspire innovative research endeavors to create additional eclectic diffusion paradigms capable of examining other specific phenomena other than those examined.

5 "Diffusion" was defined as the communication process by which the use of ideas, techniques and technologies 1) spreads through society and 2) is maintained. Some might argue that including maintenance of use in this definition is incongruent with the static nature of diffusion. Continued use, however, is non-stationary, for it involves periodic inputs of influential communication by the diffusers, and/or information seeking by the adopters, to aid in the ongoing decision-making process. As Rogers argues (1983), people continually reevaluate their adoption decisions and subsequently modify their adoption behavior.
Variables were selected for the proposed diffusion-farm structure model per an extensive literature review, and were premised on the diffusion economic constraint model. The study proposed that the major influences on farmers' decision-making regarding the adoption and continued use of agricultural technologies, are farm structure factors such as size, access to organizational and information sources, financial risks, potential environmental impacts, and personal characteristics of the farmers.

Per the nature of factors included, this research can be classified as the sociology of agriculture—the study of farming practices, their effects on farmers and the rest of society, and the influence of non-agrarian social phenomena on farming. The "farming practice" scrutinized was the use of consumer farm technologies.
CHAPTER II
THEORETICAL PERSPECTIVE AND LITERATURE REVIEW

While the traditional diffusion model was outlined briefly in the previous chapter, the model is detailed here to establish a portion of the theoretical underpinnings of the eclectic perspective used to create hypotheses for testing. The diffusion model, which is a communication paradigm, was selected as one of the components of this study's theoretical perspective, because human behavior is conditioned by the acquisition and modification of ideas through communication (Rogers and Adhikarya, 1979). In fact, the history of mass communication research is replete with studies of media campaigns to change opinions, attitudes and actions (Katz, 1963).

The studies contributing most significantly to the development of mass communication and diffusion research will be discussed in the second section of the chapter. Since diffusion research is a specialized form of mass communication studies, one that focuses on the flow of innovative ideas rather than all types of messages, it is necessary that both the diffusion and mass communication research traditions be described here to fully explicate the theoretical foundations of the diffusion perspective.
The purpose of this account is to note the contributions and inadequacies of major mass communication theories. Specifically, this discussion will highlight the arguments, rationale and assumptions of these models, regarding which factors influence people’s ideas and behaviors.

Special emphasis will be placed on the traditional diffusion model, due to its prominence in diffusion research and, hence, its relevance to this diffusion study. The goal of this discussion is to focus attention on the shortcomings of the paradigm and, thus, substantiate the need for an adjunct perspective such as the farm-structure model which also was mentioned in the last chapter.

The next section will describe the components of the traditional diffusion model and their application to this study’s eclectic framework. The following section will explain the composition of the farm-structure model and demonstrate how this paradigm can be merged with the traditional diffusion paradigm to form an eclectic perspective that can bolster the predictive utility of diffusion research. This discourse will be followed by a discussion of the eclectic theoretical perspective developed for this study. Hypotheses regarding components of both models will be advanced for testing. The chapter will culminate with a proposed path model of study variables selected to explain adoption of specific farm technologies.
The History of Mass Communication and Diffusion Research

The mass communication research tradition can be divided into three main stages per their foci on: 1) the impact of the media, 2) the influence of intervening variables, especially interpersonal relationships, and 3) media effects (McQuail, 1981). It will be suggested later in this section that a fourth stage may be emerging.

Stage one began at the turn of the century and extended to the late 1930s. Researchers during this time period focused on the impact of the popular press, radio and cinema, which were developing rapidly in the United States and overseas. They regarded the media as all-powerful influences on the opinions and lifestyles of a rapidly expanding, appreciable body of public communication receivers termed the mass audience. The receivers were viewed as a set of defenseless minds, connected not to each other, but to the media which could change their behaviors and mandate political systems against their free wills (Katz, 1963).

The perceived influence of the media was one of the primary reasons the mass media were used so extensively by propagandists to affect opinion, especially during World War I. By the 1940s, however, social scientists were regarding these earlier views as being questionable, because they were not substantiated. Critics argued that the suppositions were not founded on empirical fact but on general observations of the audience's seeming attraction to the media. Such assumptions lacked rigorous scientific study of mass communication use and effects. Earlier researchers were not blamed,
however, for these shaky perspectives, because they had been engaged in research when the investigative methodologies of the social sciences were in their infancies (McQuail, 1981).

As scientific inquiry matured with the emergence of more sophisticated empirical methods, and researchers applied these techniques to definitive inquiries regarding the impacts of mass communication, the results of such studies revealed that the media were far less influential than previously thought. Thus, the simplistic image of the beguiled, atomized public was dispelled. This new conceptualization helped usher in stage two of mass communication research, which emphasized the influence of non-media factors. This era commenced about 1940 and extended to the early 1960s.

Major credit for this turning point in research is attributed to Lazarsfeld, et al., (1948). Their analysis of voter behavior in the 1940 presidential election, and studies by succeeding scientists, demonstrated that the power of the communication media is subject to intervening factors, such as interpersonal relationships (i.e. family, friends and community leaders) (Merton, 1949; Berelson, et al., 1954; Katz and Lazarsfeld, 1955; Menzil and Katz, 1955).

Mass communication researchers were not the only scientists to discover that interpersonal relationships were significant factors in understanding information transfer. Diffusion researchers also arrived at the same conclusion (Rogers and Beal, 1958; Lionberger, 1960). The consistency of the findings from these independent
disciplines was largely responsible for the merger of diffusion and mass communication research in the early 1960s (Lin, 1973).

Diffusion Studies in Retrospect

The formulation of the diffusion research tradition dates back to the 1930s. Pemberton was one of the first to examine empirical data in the context of the diffusion model (Lin, 1973). He sought empirical evidence for the existence of the hypothesized S-shaped curve, which is a slope depicting the adoption of innovations over time. Specifically, he examined the diffusion of culture in society (Pemberton, 1936), and became the first to demonstrate that social variables can intervene in the diffusion process. His research demonstrated that social factors can cause the diffusion of innovations to drop rather than rise in the expected S-shaped curve (Pemberton, 1937; Lin, 1973).

Soon after the general studies of Pemberton came more micro-oriented studies. Ryan and Gross (1943) were perhaps the earliest in a long line of researchers (Rogers, 1969; Lionberger and Frances, 1969) to examine the diffusion of agricultural innovations. Their initial work was focused on the adoption of hybrid seed corn in Iowa.

Overtime the diffusion research tradition became increasingly popular for the following reasons (Rogers 1983: 90). First, diffusion was relevant to all of the social sciences and, therefore, was widely used. For example, since the diffusion of technologies could be employed to examine socioeconomic development, both
economists studying economic growth, and sociologists interested in social change, could utilize the same model.

Second, diffusion research had pragmatic utility, for it often focused attention on the adoption of concrete entities such as innovative technologies. The examination of tangible phenomena as indicators of social change was widely acclaimed because such an orientation was compatible with the concrete nature of the currently popular method of social science investigation, namely empirical research. The diffusion tradition was particularly well-accepted by scientists formulating public policy, for it could readily generate the quantifiable predictors of social change outcomes required by legislators allocating public funds. Third, diffusion studies were useful for the development of innovative theoretical perspectives. Since diffusion research encompassed a large body of empirical findings which had accumulated in a gradual and orderly fashion, this tradition was well suited to higher-order deductive processes of theory formation.

Fourth, an important consideration to the users of diffusion research was its relative ease in operationalization. Since the phenomena under investigation were often easily identified, they were relatively easy to study. In addition, the methodologies of data collection and analysis were straightforward and well-formulated.
Contemporary Foci
of Mass Communication/Diffusion Research

Diffusion/mass media studies conducted from the 1960s to the present have been termed the third stage of mass communication research, a period of renewed interest in the role of the media. This was an era of re-examination in which social scientists began to question whether their immediate predecessors had underestimated the effects of the media. Such concerns were validated via recent findings, especially television and newspaper studies, which demonstrated that the mass media tended to be influential after all (Chaffee, 1972; Milburn, 1979).

This renewed interest in mass communication factors, however, did not prompt an over-emphasis of the media. Researchers continued to examine the potential effects of other variables such as interpersonal relationships (McQuail, 1981). The new awareness of the potential influence of the media was in part the product of an advanced knowledge base and improvements in research techniques. Contemporary researchers elaborated earlier models to identify intervening variables in the process of information transmission. Such researchers focused more attention on the long-run effects of intervening factors on the audience in the communication process (McQuail, 1981). For example, Rogers and Shoemaker (1971) synthesized existing mass communication/diffusion studies and summarized the findings by demonstrating that media channels are usually more effective initially in creating awareness of an
innovation, while interpersonal systems are more significant later in persuading people to adopt a new idea or technology. Such a synthesis of existing knowledge bases strongly indicates that the diffusion process is quite complex and multivariate in nature.

The third stage of media research is still evident, but it is possible that a fourth era may be evolving. This period, if it achieves notoriety, will probably emphasize the receiver of information as an active participant in the communication process. Such emphasis is probably desirable because certain inadequacies of past mass communication/diffusion research can be prevented. For example, fluctuations between emphasis on media and individual influence can be avoided.

Contemporary diffusion/communication researchers (Rogers, 1962; Fry, 1981; Van Leuven, 1981) have proposed that the mass media and interpersonal channel characteristics are not necessarily the most significant influences on receivers. Their research has demonstrated that when a receiver is deciding which channel and message to select, the most reliable predictor of the final decision is the receiver's information environment, especially the availability of communications and the likelihood that they will offer relevant information (Bostian, 1974; Katz, et al., 1974; McQuail and Gurevitch, 1974; Blumler, 1979; Chaffee, 1979; Van Leuven, 1981; Davison, et al., 1982).

Regarding the availability of information Atkin (1971) found in a political communication study that voters who were interested in
an election, actively sought campaign information. People who were less concerned about issues and read newspapers, selected information on the basis of prominent page positions. Thus, such individuals were shown to choose information on the basis of physical availability. Other studies have demonstrated that media content selection can be related to people's availability of time (Davison, et al., 1982). For example, time available for use of media can be a partial function of habit. Individuals who habitually use television for late-night viewing would probably continue to do so regardless of what programs are scheduled.

Quite often messages from available media sources are learned simply because the audience is exposed to them. Krugman (1971) has noted, for example, that repetitive television commercials can influence consumer behavior without the audience giving much thought to the messages at time of exposure. Such findings suggest that people may be influenced to adopt ideas without actively seeking information about specific objects or behavior.

Relevance of the media to the audience's needs and interests is another important consideration. Bostian and Ross (1962) found that rural Wisconsin families, who had access to essentially the same media as suburban residents, demonstrated different content preferences. The rural residents, more often than their suburban counterparts, selected agricultural magazines and farm radio programs. Such sources were relevant to rural people due to the
technical information designed to meet the needs and interests of nonmetropolitan residents.

These studies demonstrate the importance of making information available and relevant to the receiver, which in turn increases the probability the message will be adopted. Unfortunately, the traditional diffusion model, which is the prominent paradigm of diffusion research, ignores factors related to the availability and relevance of information and innovations being diffused (Brown, 1981; Bordenave, 1976). The traditional diffusion model has overlooked these variables because it views the communication of innovations as a one-way process. The model basically emphasizes the process going from the initiator of the diffusion process (the sender) to the potential adopter (the receiver). The adopter is perceived as a passive accepter (Rogers, 1983). There is no recognition in this unidirectional perspective of the need for the potential adopter to express opinions regarding the innovation being diffused. The traditional paradigm does not include two-way communication, or feedback, in its model. Therefore, the traditional diffusion perspective focuses on the sender's intent of actualizing adoption behavior (Hooks, 1980), irrespective of the adopter's needs, such as available and relevant information.

In agricultural communications, for example, the information flow is consistent with the traditional diffusion model since it is directed to the farmers. Two-way communication, which solicits the potential adopters' opinions and develops information and
technologies to satisfy such requests, is not included in the traditional model (Bordenave, 1976).

The unidirectional dimension of the traditional diffusion model can result in adverse consequences for potential adopters. First, if potential adopters are preempted from accessing information and providing feedback to the system, a potentially unfortunate result of the communication process can be a flow of information irrelevant to them, premature adoption, or the adoption of innovations which do not match their needs and are incompatible with their interests and desires (Bordenave, 1976).

Secondly, the unidirectional transfer of information per the traditional diffusion model approach may preclude the dissemination of information downward through the social classes. This disadvantage is called lateral transfer of information. For example, if the traditional diffusion perspective is used in the communication of innovations, the initiators of the products frequently use large-scale farm operators as the channels of communication. Elite farmers frequently communicate information regarding the new technologies primarily among themselves, without diffusing information downward to other classes of people. The few farmers with access to information are in a position to be the first adopters and, thereby, preclude other social classes from accessing the windfall profits associated with early adoption. These economic gains may further entrench these elites into a superior economic position for future adoption action (Brown, 1981).
The aforementioned intervening factors in the adoption/diffusion process (irrelevant and lateral communication) have been suggested as contributing to the failure of the Green Revolution. The Green Revolution was an attempt in the 1960s to rapidly modernize agricultural practices in developing nations via the diffusion of innovative farming technologies and practices. The Green Revolution was based on the traditional diffusion model assumption that information transfer is sufficient for adoption to occur. Unfortunately, numerous factors may bar many people from the information sources and other resources necessary for adoption to occur. The elites tend to adopt the innovations, and lower classes do not. The end result is often a wide development gap between upper and lower classes (Yapa, 1977).

The third disadvantage of the one-way perspective of the traditional diffusion model is that diffusion researchers utilizing this paradigm are restricted by a theoretical framework that does not emphasize the adopter's environmental factors. Hence, researchers cannot accurately predict how the relevance and accessibility of information and other resources affect adoption behavior.

This discussion indicates that contemporary investigators are questioning the traditional diffusion model and are calling for more two-way communication to discern people's needs for innovations (Rolling, et al., 1976). One alternative to the diffusion model is the information seeking model (Donohew and Tipton, 1973), which was originally developed as an explanation of communication behavior.
in decision-making. The information seeking model was later modified by Donohew and Springer (1980) for use in development programs. This model assumes that the receiver can be an initiator of information. The receiver makes known his/her information needs and, thereby, increases the availability and relevance of communication feedback. In contrast, the traditional diffusion model emphasizes message initiation and persuasion by the sender.

Increasingly researchers appear to be viewing communication receivers as assertive individuals who seek out information, rather than selecting messages after information is "trickled down" to them. The implication is that the role of a communication sender or initiator of information may be changing. The role appears to be evolving from one that operates to create a need for the message being diffused, to one which the audience calls on when there is a need (Donohew and Springer, 1980). This implies that government extension agents, for example, may cease serving as the "experts" diffusing information to farmers, and become change agents who aid people in locating information to fulfill their needs (Westley, 1973; Donohew and Springer, 1980).

With the birth of the information seeking model, and mounting theoretical assaults against the traditional diffusion model, it is highly likely that a fourth era of mass communication research may be emerging. It appears that this new period will increasingly emphasize the receiver's needs and desires in the
communication/diffusion process, by offering innovative theoretical perspectives such as the information seeking model.

In light of the preceding historical evaluation of information dissemination, the future role of the traditional diffusion model is somewhat uncertain. The basic assertion of this study is that the traditional diffusion model has made significant contributions to diffusion research; however, it has demonstrated shortcomings. It is argued that the traditional model must be elaborated, if it is to have utility in future research. To examine the merits of these arguments, a study was undertaken to test the predictive ability of a theoretical perspective which combined elements of the traditional diffusion model and the farm-structure perspective.

The following sections of this chapter will discuss the theoretical underpinnings of both theoretical models merged in this study. The eclectic model will be articulated in the context of the adoption of farm technologies presently in use on Ohio farms.

**Description of the Traditional Diffusion Model**

It has been argued that the traditional diffusion model includes two basic perspectives. The first is a view of society in general, which is similar to the structural-functionalist model. The second perspective suggests that the diffusion process is a communication model (Hooks, 1980; Hassan, 1984).

The structural-functionalist model (Turner, 1974) describes society as an organism of differentiated parts, all interdependent
and interacting. This perspective assumes that the survival of the whole depends on the adequate functioning of the parts. Concomitantly, the well-being of the parts necessitates the survival of the whole. The overall goals of the system are perceived as being positive and compatible with the needs of individual units, and necessary for the sustenance of the whole. It is assumed that there is mutual agreement among the parts regarding objectives. Any negative disruptions in the system are not attributed to weaknesses in the aims of the organization, but to dysfunctional components of the system.

In a parallel manner, the traditional diffusion model views society as a system of interrelated parts functioning to sustain each component. There is consensus among the parts regarding goals for the system. The units may be political governing bodies, businesses, churches and families (Hooks, 1980). These parts include subunits such as community leaders, farmers, pastors and family heads.

Applying this perspective to the diffusion of farm technology, the traditional diffusion model assumes that the adoption of farm innovations can improve the well-being of individual farmers and the society-at-large. Specifically, technological devices can ease farmer's workloads through greater efficiency. Farm innovations can also increase domestic food output to feed populations and to serve as trade goods. On a system-wide scale, increased supplies of agricultural products through implementation of farm technologies has
the potential of improving commerce and, thus enhance the economic well-being of an entire society (Guither, 1972).

Thus, the traditional diffusion perspective, applied to agriculture, would depict rural society as an interdependent group of people functioning to sustain the agricultural system and to improve the well-being of the nation. The common goal would be the diffusion of farm technologies to bolster agricultural production and, thus, insure the well-being of all. Since it is assumed that the parts are interrelated and function to insure the probability of survival of all other units, the traditional diffusion model makes four basic assumptions regarding the diffusion of innovations. Applying these to farm technologies, these assumptions can be stated as follows:

1) The diffusion of farm technologies as initiated by the primary units of society is necessary to sustain the material resource base and economic well-being of farmers and of all other segments of society.

2) Members of society agree that the diffusion of farm technologies is necessary to maintain and achieve high levels of social well-being.

3) Farmers will adopt farm technologies when they are made available.

4) Non-adoption is the result of individual's social-psychological traits which deviate from normal social expectations.
Thus, the structural-functionalist model suggests that the adoption of farm technologies is essential for the increased economic viability of a society. The only possible inhibitor of adoption would be the social-psychological characteristics of deviant individuals.

While the functionlistic orientation is useful in understanding some of the factors associated with adoption behavior, learning theory (Bandura, 1977) is also applicable in understanding the decision-making process associated with adoption behavior. Learning theory argues that human behavior is governed by learning experiences. It is asserted that when people learn that something is in their best interests, they will enact the behavior. Learning theory suggests that many sources exist to access knowledge of something, but asserts that the primary factor to consider in the process is being exposed to sources of knowledge. In essence, learning theory argues that a person must be exposed to an idea or concept before being able to act on the idea or concept.

The traditional diffusion perspective contends that the major source of knowledge about innovations is through communication (personal contact or media sources). This prominence given the communication factor results from the traditional paradigm's employment of a communication model in its theoretical framework. The model utilized is an adaptation of one designed by Shannon and Weaver (1949) for electrical engineering, and later used by social scientists (Hooks, 1980). The model can be diagrammed as follows:
The source initiates the communication process and the encoder constructs a message. The information is transmitted through a channel or medium to a decoder which reinterpretes the message for the receiver. The receiver can relay feedback to the source and the process can be repeated.

The traditional diffusion perspective used a modified version of the Shannon and Weaver model which was illustrated by Rogers and Shoemaker (1971) as follows:

**SOURCE -------> MESSAGE -------> CHANNEL -------> RECEIVER -------> EFFECTS**

<table>
<thead>
<tr>
<th>Inventors</th>
<th>Innovation (Perceived attributes such as relative advantage, compatibility, etc.)</th>
<th>Communication channels of a social system</th>
<th>Members</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scientists Change agents or Opinion leaders</td>
<td></td>
<td>(mass media or interpersonal)</td>
<td>Consequences over time</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1. Knowledge</td>
</tr>
</tbody>
</table>

The Traditional Diffusion Paradigms's Model of Communication
(Rogers and Shoemaker, 1971: 20)
Elements in the S-M-C-R-E Model and Corresponding elements in the diffusion of innovations
This modified model, unlike the one utilized by Shannon and Weaver, omits the component "feedback." "Effects" constitute the final step in the process and are the outcomes of the communication process. It is assumed in the model that all people have access to the information provided and that the receivers have the ability to act if they have the propensity to do so. It is further assumed that the information provided (social learning) will create a desire on the part of the receivers to act on the information acquired.

A major weakness of the diffusion model is its unidimensional direction. The traditional diffusion paradigm relies on one-way communication. It emphasizes the source's goal of diffusing information regarding an innovation to the receiver to effect adoption. The traditional diffusion paradigm applies this communication model to explain the diffusion process. An example of this model would be an agribusiness which has developed a new technology and wishes to bring about the adoption of the product. The business would be viewed as the source in the diffusion process. If the firm elected to introduce the innovation to large-scale farm operators, the diffusion model suggests that these prominent farmers would serve as the interpersonal communication links with small-scale farmers. It is likely, however, that the lower class farmers would not access necessary information on the innovation being made available because large-scale farmers would seldom interact with lower-scale farmers. The end result would be a breakdown in the
communication process to a certain segment of the market for the technology.

Thus, it can be seen that the traditional diffusion paradigm treats communication as a unidirectional process and deterministic. Consequently, researchers employing the traditional model are restricted in primarily three ways. First, they are limited to investigating the effects of communication-related variables. Secondly, they are restricted in their ability to study factors related to the needs of the receivers or potential adopters and how these affect the information components and flow. A third limitation of the traditional diffusion model is the deterministic nature of the information process. The model basically asserts that if the object or idea is relevant to the needs of the potential adopter, adoption will occur. The model assumes that the receiver possesses the means to adopt. Such an assumption is frequently not true and the failure of the traditional model to predict adoption behavior can often be attributed to this shortcoming. Consequently, elaboration of the traditional diffusion model necessitates modeling which incorporates elements of the ability to act. A contemporary perspective which argues that ability to act factors are important in decision-making is the farm-structure model (Lancelle and Rodefeld, 1980; Hassan, 1984; Hooks, et al., 1983; Napier, et al., 1984).
Description of the Farm-Structure Model

Given the rising criticisms of the traditional diffusion model, an alternative explanatory model has emerged in recent years. This perspective has been called many names but is predicated on the ability of individuals to enact their perceived desires. Researchers who have named their perspective the economic-constraint model, have demonstrated that resource-related factors are more significant than traditional diffusion-type variables in affecting adoption behavior (Lancelle and Rodefald, 1980; Napier, et al., 1984).

In a similar vein, the basic argument of the farm-structure model proposed in this study is that farmers must have access to necessary resources if they are to adopt farm technologies and/or techniques. It is argued that certain material prerequisites are necessary for people to enact desires. If these material resources are not available, the provision of information to generate positive attitudes toward adoption will be futile. People may desire to adopt the new technology but may be blocked from doing so because they do not have the material resources to act on their desires. Factors such as land and capital are important predictors of adoption behaviors.

Research has been conducted which confirmed the assertions noted above. A study by Napier and Forster (1982), for example, suggested that adoption of soil erosion control practices is a function of economic incentives rather than attitudes. If the adoption of the conservation practices was not viewed as being
profitable, they were not adopted. Research by Napier, Thraen, Gore and Goe (1984) revealed that farm-structure factors were the best predictors of adoption of soil erosion control practices, even though none of the variables included in the models explained a great deal of the variance in adoption behavior.

Access to land resources also has been shown to be significant in understanding adoption behavior (Yapa, 1977; Yapa and Mayfield, 1978). Farmers with smaller land holdings adopted innovations less frequently. One of the reasons farm size is important is that farmers do not have access to land for field trials of new agricultural technologies or techniques. They also must have land acreage relevant to certain technologies. In addition, small-farm operators often times have a much greater probability of their farm enterprises failing when agricultural innovations are adopted because they have cash-flow problems. If they encounter cash-flow problems, they may lose their farms. A bad crop year, for example, may result in default on bank loans and cause foreclosures. Recognizing these constraints, small-scale operators tend to be much more cautious in the adoption of technologies and/or techniques which have risks attached to them.

The farm-structure model also suggests that if small-scale farmers adopt techniques and/or technologies without adequate material resources, there is an increased probability that they will discontinue use. Farmers will be forced to halt use of technologies and techniques adopted if they lose their farm lands and equipment
due to bank foreclosures on loans. Operators may also voluntarily discontinue use by selling their equipment when they recognize that these technologies and techniques are incompatible with their farm operation and its resources.

In sum, research premised on alternative models to the traditional diffusion perspective have now spanned roughly a decade. These studies repeatedly have revealed that adoption behavior can be affected by factors other than those promulgated by the traditional diffusion model. The most significant of the alternative variables are related to the availability of material resources (Hooks, et al., 1983; Napier, et al., 1984; Hassan, 1984).

In light of the state-of-the-art in diffusion research, it is argued in this study that future diffusion research should place more emphasis on alternative explanatory models to the traditional diffusion perspective. In this study the proposed alternative is the farm-structure model. This perspective incorporates resource-constraint factors specific to farm operations.

It should be noted that it is not argued that the farm-structure model should be used singularly in diffusion research. The reasoning for this assertion is twofold. First, this perspective is too deterministic in terms of the effects of resource factors. The farm-structure model assumes that if a farm operator has sufficient resources to adopt and encounters no barriers, the farm technologies and techniques will be adopted. However, this perspective ignores that the farmer may not have the attitudinal propensity to adopt, as the traditional diffusion model contends. Secondly, the traditional
diffusion model is not excludable in diffusion studies because such factors as knowledge and the social-psychological traits of potential adopters have been shown to be necessary (Lionberger, 1960; Rogers, 1983) even though not sufficient conditions for adoption (Hooks, et al., 1983; Napier, et al., 1984).

An Eclectic Perspective for Explaining Adoption Behavior

Given the discussion of the strengths and weaknesses of both competing perspectives noted above, it is argued that a more comprehensive model can be developed by combining elements of both the traditional diffusion model and the farm-structure perspective. This model basically posits that potential adopters must possess a positive attitude toward the object to be adopted before adoption can occur. People must possess a propensity to act. These attitudes are formulated via learning experiences. The model argues that various socio-demographic factors will influence one's access to learning experiences and subsequently affect the rates of adoption.

The eclectic perspective also asserts that ability-to-act factors must be incorporated into adoption theory. It is argued that ability-to-act factors substantially affect adoption since people must have material resources to enact desired behaviors. Most technologies and techniques are very expensive to access, which means that people lacking necessary resources will be excluded from adopting them. Thus, the eclectic perspective which is termed the "diffusion-farm structure perspective" argues that variables representing both the traditional diffusion model and the
farm-structure perspective will be significantly related to measures of adoption behavior.

The Application

of the Diffusion-Farm Structure Perspective

to the Adoption of Farm Technologies

Any theoretical perspective has little utility unless it is applied to social phenomena in the context of prediction. To accomplish this goal, the abstract model was applied to the study of selected farm technologies.

The technologies examined in the study were as follows: number of tractors owned, horsepower of the largest tractor used, number of combines owned, and bin capacity of the largest combine used. Multiple technologies were assessed because all technologies cannot be equally applicable to all potential adopters. This factor tends to be ignored in diffusion research even though it is recognized in the abstract theoretical modeling.

Number of tractors owned was selected because the tractor is currently the most common farm technology in use (Hooks, et al., 1983). Practically any farmer in the U.S. must have at least this type of technology if the farm is to survive. The number owned, however, should differentiate adopters by category of farmer. In addition, the horsepower of tractors used also was included. Not only must a farmer have access to a tractor, but it must be of sufficient size to adequately perform the function required of it per the nature of the farm's size and operation.
Combines were also selected as study variables because these technologies, as compared to tractors, tend to be more specialized in use. Combines normally reflect specialized farming operations such as grain farms. It was reasoned that inclusion of this variable would permit measurement of the relationship between complex farm operations and adoption of relevant agricultural technologies.

The rationale used to select specifically the "number of combines owned" and the "bin capacity of the largest combine used" on the farm, was similar to that offered for the number and size of tractors.

The Traditional Diffusion Component of the Eclectic Model

The traditional diffusion model suggests that adoption decisions are affected by diffused information obtained by exposure to such sources as the mass media and formal organizations. The paradigm contends further that social-psychological variables can influence adoption behavior (Lionberger, 1960; Rogers, 1983). Therefore, information sources, the respondents' personal characteristics and selected attitudes were the factors used to represent the traditional diffusion components of the eclectic perspective.

Sources of Information

The information sources currently available to Ohio farmers were included as indexes of exposure to information systems. A factor analysis demonstrated that the various information sources could be classified into two underlying dimensions which, per the nature of
their index groupings, were named "institutional" and "noninstitutional" sources of information. The two factors were constituted as follows: 1) institutional sources of information, which include the Ohio Agricultural Research and Development Center; local farm organizations such as the Grange and 4-H; The Ohio State University staff personnel; and the Ohio Cooperative Extension Service; and 2) noninstitutional sources of information, which include farm magazines, newspapers, television and radio programs; daily nonfarm newspapers; friends; neighbors; and local merchants such as implement or fertilizer dealers.

Institutional sources of information tend to be formal organizations which exist to instruct. The instruction involves the collection, dissemination and creation of information focused on specific farm practices and technologies. Noninstitutional sources of information are not formal organizations. Such sources may instruct, but their primary purposes vary. Noninstitutional sources tend to deal with generalized issues rather than focused topics. For example, the mass media tend to offer information of general rather than specific interest. Merchants may provide specific information, but their intent is to sell and/or purchase products, not to educate people. Friends and neighbors may provide information, but do not do so in the structured manner of institutions, and their purpose is not to disseminate knowledge, but to fulfill a social responsibility.

According to the traditional diffusion perspective, exposure to information sources will create a learning situation which will
generate interest in the object being diffused and enlighten the recipient of the knowledge. The model further posits that this awareness influences the formation of a positive attitude regarding the diffused object or idea. The affirmative attitude, in turn, leads to adoption. Within these assumptions, the traditional perspective recognizes the influence of both institutional and noninstitutional information sources (Lionberger, 1969).

Therefore, per the contentions of the traditional diffusion model it was hypothesized that institutional sources of information would be significantly related to the four measures of adoption behavior.

It was further hypothesized that noninstitutional sources of information would be significantly related to the four measures of adoption behavior.

Personal Characteristics

Personal characteristics of farmers were included in the model to examine the merits of the social-psychological component of the traditional diffusion model. These traits included age, agricultural education, and years farming.

The first two factors were selected because innumerable studies have found that age (Lionberger, 1960; Michael, 1972) and education (Abd-Ella, 1981; Lovejoy and Parent, 1982) are significantly related
to the adoption of farm technologies and practices. Specifically, research has shown older farmers to be less likely than younger and middle-aged operators to adopt innovative farm practices (Copp, et al., 1958; Marsh and Coleman, 1955). Elderly farmers may, however, be receptive to new farm technologies and techniques, but due to personal considerations such as upcoming retirement and declining health, may not actualize adoption behavior (Lionberger, 1960).

Regarding education, the assumption of the traditional diffusion model is that attending school imparts knowledge which in turn influences the formation of a positive attitude toward the adoption of farm innovations. Research has shown that the correlation between the adoption of farm innovations and years of education is not always strong, since positive attitudes can be acquired outside of school (Lionberger, 1960). However, more than eight years of formal education is nearly always correlated with higher adoption rates of farm innovations (Copp, et al., 1958; Lionberger and Coughenour, 1957).

Years farming was chosen as a predictive factor because it is an indicator of learning experience, which is a variable consistent with the thesis of the traditional diffusion model. Also, years farming represents attachment to farming as a way of life, a psychological factor which research has linked to the adoption of agricultural technologies and techniques. More specifically, the perspective advanced in this study is that people engaged in farming for numerous years will have information advantages over farmers with little
experience. According to the traditional diffusion model, awareness influences adoption decision-making. Therefore, this component of the model suggests that "years farming" will be significantly related to the adoption of farm technologies and techniques.

Researchers Pampel and van Es (1977) have found that a farmer's attachment to farming is also related to his/her adoption of agricultural practices. Specifically, an operator attached to farming as a way-of-life will tend to adopt environmental conservation practices such as reduced tillage, whereas one less attached to farming and more attached to a business-orientation, will be prone to use commercial practices less respectful of the environment. This suggests that attachment to farming, measured in the context of years of farming, could reduce the adoption and continued use of consumer farm technologies if these devices were perceived by operators to be environmentally detrimental.

In sum, the traditional diffusion model asserts that the adoption of innovative technologies and techniques is related in part to farmers' personal factors, especially age, education and years of farming.

Therefore, based on the arguments advanced by the traditional diffusion model, was hypothesized that age of farm operators would be significantly related to the four measures of adoption behavior.
It was also hypothesized that agricultural education would be significantly related to the four measures of adoption behavior.

It was further hypothesized that years farming would be significantly related to the four measures of adoption behavior.

Selected Attitudes: A Conservation Criteria Index

Much of the research conducted on environmental attitudes has been focused on the explanation of environmental orientations. Buttel, et al., (1980) discovered that attitudes toward the environment tended to vary inversely with farm size. Larger farm operations tended to be less concerned about the environment. Napier, et al., (1984), however, discovered that farm size was not a significant factor in the explanation of adoption of soil erosion control practices. The best predictors of adoption of conservation tillage practices were the technologies previously adopted and the type of farm operation presently in existence.

The literature does suggest that attitudes toward the environment can influence farmers' decisions about their land holdings (Napier and Forster, 1982). If landowners perceive themselves to be stewards of the land, they will tend to be more concerned about protecting the soil and water resources. They will act on these attitudes assuming they have the necessary capital requisites to implement their preferences. This suggests that
farmers who perceive the environment to be important, when making choices about alternative actions, will opt to protect the landholdings by being less capital-intensive. This means that environmentally-concerned farmers will tend to have fewer and smaller farm technologies.

Therefore, it was hypothesized that the conservation criteria index would be significantly related to the number of farm technologies used on the farm and the size of the technologies being used.

Application of the Farm-Structure Model to this Study

The farm-structure model argues that in addition to information and the social-psychological characteristics of individuals (traditional diffusion paradigm components) other factors influence the adoption and continued use of agricultural technologies. The most significant of these are related to the availability of resources and represent farmers' abilities to act. The measures selected to represent this component of the theory are: present farm-structure factors, past farm-structure factors, and the risk-bearing orientation of farmers. The rationale for the inclusion of these factors in the model is explained in the following section.
Present Farm-Structure Factors

The inclusion of present farm-structure variables in the theoretical modeling was justified because research has shown that farmers are influenced by their farming situation at the time of adoption decision-making (Lionberger, 1960; Yapa, 1977; Napier, et al., 1984). The logic advanced by economic-constraint theorists and by the farm-structure component of this model is that farm characteristics represent measures of access to capital, land and other resources required to adopt contemporary technologies (Add-Ella, 1981; Hassan, 1984). Therefore, it is argued that farm-structure factors should be significantly related to adoption behavior and were included in the theoretical perspective developed for this study. Access to capital is necessary for farmers to purchase technologies or to adopt new practices. A farmer may wish to adopt a new technology or farming technique but may be unable to secure the money or land to implement what he/she desires to do.

The present farm-structure factors that were selected for examination in this research were as follows: acres farmed, percent grain farmer, percent livestock farmer, percent other farmer, farming status of the operator, and spouse's farming status. These variables were chosen due to their predominating significance in diffusion research literature and relevance to the farm-structure model. Each of these factors is discussed in the context of the theoretical model advanced above.
Acres Farmed

Research has shown that the size of the farm is significantly related to the adoption of farm technologies and innovations (Fliegel, 1956; Lionberger and Coughenour, 1957; Abd-Ella, 1981; Carlson and Dillman, 1983). This finding is explained in the context that many innovative agricultural technologies are designed for large-scale farms and are most relevant to those types of farming enterprises. It is also likely that large-scale farms can afford to purchase new technologies or can assume the risk associated with changing existing farm practices. In short, acres farmed is a proxy of the farm operator's ability to act.

Therefore, it was hypothesized that acres farmed would be significantly related to the four measures of adoption behavior.

Type of Farm Operation

Recent data collected by Napier, et al., (1984) have suggested that the type of farm operation is significantly associated with the adoption of farming practices. The findings revealed that farm-structure factors were better predictors than diffusion variables. Abd-Ella, et al., (1981) also demonstrated that a significant relationship existed between the diversity of a farm operation and adoption behavior. This finding suggests that since many complex agricultural technologies are designed for specialized operations, "type of farm operation" is an important variable to
include in a model predicting the adoption of consumer farm technologies.

The selected indicators of type of farm operation—percent grain, livestock and other farm—were chosen because these represent the three major types of farming operations evident in the U.S. This selection of indexes avoids the biases of traditional diffusion studies which overlooked the varying needs of adopters.

Grain farming was selected because such specialization requires complex technologies for harvesting and planting. The farm-structure model asserts that complex farm operations (i.e., grain operations) would be more likely to have sufficient land resources to utilize the massive, sophisticated farm technologies and the necessary capital to adopt these expensive machineries.

Therefore, it was hypothesized that percent grain farmer would be significantly related to the four measures of adoption behavior.

General livestock farming tends to be labor intensive and, therefore, calls for less sophisticated technologies than those required for grain farming. Consequently, livestock farmers should be less likely to need and use complex farm machinery. Therefore, the diffusion-farm structure model would argue that livestock farmers would be less prone to adopt agricultural technologies and new techniques.
Based on these contentions it was hypothesized that percent livestock farmer would be significantly related to the four measures of adoption behavior.

Percent other farmer is the third major type of farm operation existent today. This category of farmers includes the areas of farming external to livestock and grain, specifically vegetables, fruits, hay and other crops. These particular specializations do not usually necessitate high capital inputs and extensive land holdings for production. Operators of "other farming" enterprises, therefore, would be less likely to have the financial resources necessary to bear the high costs of innovative agricultural machinery and would be less likely to perceive a need for such technologies. Per the farm-structure perspective, insufficient financial resources would increase the probability that operators of "other farm" enterprises would not adopt complex agricultural technologies.

Therefore, it was hypothesized that percent other farming would be significantly related to the four measures of adoption behavior.

Farming Status

Farmers operating family farms increasingly are seeking off-farm employment (Coughenour and Wimberly, 1982; Deseran, et al., 1984). Recent research has shown that a significant correlation
exists between off-farm employment and the adoption of agricultural practices (Michael, 1972; Lovejoy and Parent, 1982). The farm-structure perspective attributes the effect of off-farm employment on adoption behavior to the availability of capital and the insufficient time resources of farmers who hold jobs off-the-farm.

More specifically, part-time farmers tend to earn relatively high incomes but tend to have less available time for farming. Data have shown that the total gross incomes for families engaged in off-farm employment tends to be higher than those of full-time farm households (Deseran, et al., 1984; Buttel and Larson, 1982). It appears, therefore, that part-time farmers are relatively more affluent. This financial advantage can be attributed to off-farm employment (Bokemeier, et al., 1983; Deseran, et al., 1984). The increased access to capital derived from part-time farming should enable part-time farmers to purchase technologies. Thus, off-farm employment status could affect adoption behavior.

It was argued in this study that part-time farmers would tend to have less need for numerous technological units because their operations would tend to be smaller. However, it was further proposed that farmers engaged in off-farm employment would require larger technologies, to use their limited time efficiently. Part-time farmers must substitute capital for labor which means that they would be more inclined to adopt labor-saving technologies and new farm techniques.
In light of these arguments, the theoretical perspective argued that farmers holding off-farm employment have greater capital resources available and, therefore, would be more likely to adopt agricultural technologies. It was also argued that part-time farmers would need labor-saving technologies to remain in production agriculture since the time they can devote to agricultural pursuits is limited.

Based on the preceding logic advanced by the farm-structure model, it was hypothesized that farming status of the operator would be significantly related to the four measures of adoption behavior.

It was further hypothesized that spouse’s farming status would be significantly related to the four measures of adoption behavior.

Past Farm-Structure Factors

Antecedent variables represent farmers’ previous commitments made to farm technologies and their past resource bases. The model suggests that these factors can influence the present use of technologies and techniques and, thus, are relevant to research which examines the continued use of agricultural technologies.

Past decisions to adopt farm technologies, for example, which have resulted in negative experiences would suggest to a farmer that these technologies are inappropriate given the farmer's resource
base. The farm-structure model would argue that the farmer would be
discouraged from continuing adoption in the future, due to the
perceived or actual incompatibility of the technologies to the farm
operation.

In contrast, if a past commitment to technologies resulted in a
positive experience, demonstrating the appropriateness of the object
being adopted, the farmer would have a propensity to maintain the
technologies and to adopt in the future. The underlying rationale
per the farm-structure model is that the successful use of farm
technologies should have improved the operator's competitive position
and, hence, should have increased the financial resources needed to
purchase technologies in the future.

Based on this study's theoretical perspective, and per the
research literature to follow, these variables were selected to
measure past farm-structure factors: horsepower of the largest
tractor used 10 years ago, bin capacity of the largest combine
used 10 years ago, parents' farming status, and acres parents
farmed.

Past Farm Technologies Used

Tractor horsepower and combine bin capacity used 10 years ago
were selected because these technologies represent past investments
made in farm technologies. To date, very few diffusion studies have
tested the predictive utilities of past adoption behaviors, yet their
significance has been demonstrated. In a recent study conducted by
Hooks, et al., (1983) the tractor size and bin capacity used 10
years ago were found to be better predictors of present farm technologies in use, than were factors suggested by the traditional diffusion model.

The farm-structure model contends that the size of tractors and combines 10 years ago are indicators of the scale of farm operations in the past. Scale normally suggests farmers' abilities to compete in the past and, thus, their likelihood of surviving and being able to support sophisticated technologies in the future.

More specifically, the farm-structure model suggests that farmers who had been engaged in farming in the past, with small-scale equipment or without farming technologies, would have been severely handicapped in their abilities to compete and survive in farming. Thus, they would be less likely in the future to adopt complex technologies such as tractors and combines.

In contrast, farmers with larger farms would have had a higher probability of survival and a greater opportunity to make future capital investments in technologies. In short, farmers who had a comparative capital advantage in the past should maintain the advantage in the present and continue the adoption of technologies.

Based on the contentions of the farm-structure model it was hypothesized that the horsepower of the largest tractor used 10 years ago would be significantly related to the four measures of adoption behavior.
It was further hypothesized that bin capacity of the largest combine used 10 years ago would be significantly related to the four measures of adoption behavior.

Characteristics of Parents

Variables associated with parents' farming status were included because the farm-structure model proposes that in the event of an intergenerational transfer of resources, the children could be enabled by the parents' resources to adopt technologies on their own farms. This contention is based on the fact that farm ownership is still an occupation strongly influenced by inheritance of financial and skill resources necessary to successfully operate the business (Lancelle and Rodefeld, 1980).

The relationship between family farming and the ability of the children to adopt technologies is highly pronounced in today's agricultural environment due to major structural changes in agriculture. Specifically, the number of farms has declined while the size of operations has tended to increase (Hambridge, 1978; Goss, et al., 1980). The larger tracts of land and the equipment necessary to farm these lands and to remain competitive, have increased the amount of capital required to purchase farms and needed technologies (Hamburger, 1978; Reeder, 1978). This situation has emphasized the necessity to inherit farm operations in order to afford the exorbitant entry costs mandated by the new structural prerequisites (Lancelle and Rodefeld, 1980).
Thus, it is argued that farm ownership is heavily influenced by inheritance, and current high costs associated with land purchase. These factors often operate to prevent people who have not inherited farms from entering farming. The farming status and economic viability of parents can influence the children's abilities to purchase farms and accompanying technologies because comparative advantages and disadvantages will be transferred across generations. Therefore, the farm-structure model argues that the parents' level of affluence can determine an individual's opportunities to own farms, and specifically to purchase the technological devices necessary to carry out production.

Per this logic, parents' level of affluence was operationalized by acres parents farmed and parents' farming status. Parents' farming status indicates whether or not the parents were engaged in farming and, hence, is a necessary variable to determine if there could have been any transfer of occupational skill resources to affect adoption behavior. Acres farmed represents the degree of affluence of the parents' farm operation and, therefore, probable indicators of their children's future abilities to adopt expensive farm technology.

Acres parents farmed also represents indirect measures of farming skill which is another resource that may be transferred from the parents to their offspring. The skills to utilize technologies, a prerequisite of their use, is a resource which may increase individuals' propensities to adopt. Relative to family farming, the
farm-structure model contends that the greater the acres farmed by the parents, the higher the probability that the farm operation was less labor intensive and utilized efficient production means such as modern technology. Parents with technological skills would tend to share these abilities with their offspring and increase the children's probabilities of adoption.

Based on the preceding contentions of the farm-structure model, it was hypothesized that parents' farming status would be significantly related to the four measures of adoption behavior.

It was further hypothesized that acres parents farmed would be significantly related to the four measures of adoption behavior.

Risk-Bearing Orientation

The farm-structure component of the theoretical model argues that the availability of economic resources influences farmers' perceptions of the risk attached to the adoption of farm technologies. In this study, these perceptions were termed the "risk-bearing orientation" of farmers. Risk was measured in the context of attitudes, because evaluation of future actions is a psychosocial process of assessment of probable outcomes. If people have limited resources at their command, then risk attached to adoption is more important to them than to persons with adequate economic resources. People with large resource bases, for example,
will have a lower probability of losing farms and livelihood if their
decision-making is incorrect, than will people with fewer resources.

The risk-bearing orientation of farmers is an important
component of a farm-structure model because research has demonstrated
that capital-intensive farming, which is prevalent today, has certain
risks attached to it. Risk-bearing orientations cannot be separated
from the adoption behavior of farmers (Mason and Halter, 1980;

Based on the arguments of the farm-structure model as advanced
in this section, it was hypothesized that the risk-bearing
orientation of farm operators would be significantly related to the
four measures of adoption behavior.

Summary of the Theoretical Perspective

The previously noted hypotheses can be summarized by stating
that past and present farm structure factors, personal
characteristics of farmers, access to different types of information,
risk orientation and the relative importance of environmental
concerns affect the number and types of farm technologies adopted.
While all of these factors are expected to have direct effects on
the dependent variables selected for study, it is also recognized
that, given the potential for multicollinearity among the independent
variables, there may be substantial indirect effects which must be
considered. The mechanisms chosen to examine the direct and indirect effects is path analysis (Blalock, 1964; Sisson, 1979).

One of the most important considerations in path modeling is a logical time-ordering of variables. Consistent with the need to specify the time sequence of the model, a path diagram was developed (Figure 1).

The path model presented in Figure 1 basically argues that past farm-structure variables and personal characteristics are the factors that occur in the most distant past. No assumptions are made about the causal relationships among these variables. These factors are argued to operate indirectly through present farm-structure variables, measures of information and orientations toward risk and conservation, to the dependent variables. It is posited that advantages and disadvantages one receives from earlier life experiences will affect later actions. Past decisions about adoption of farm technologies will affect present farm-structure factors and ultimately present technologies used.

The model also asserts that present farm-structure factors are a partial result of antecedent conditions, experiences and decisions made (past farm-structure factors) as well as personal characteristics. The present farm-structure variables are argued to affect access to information of various types (need for information dictates information-seeking behavior) and orientations toward risk and conservation (people cannot assess risk or be concerned about the environment if they must struggle to survive). In essence, it is
Figure 1. Proposed Path Model to Specify Relationships of the Independent Variables and Measures of Farm Technology Adoption
argued that present farm-structure variables operate indirectly through the measures of information access and the risk and conservation orientations, to the dependent variables.

Access to different information sources is asserted to directly influence the dependent variables but also are argued to indirectly affect them through risk and conservation orientations held. The path model as presented argues that present and past farm-structure variables affect access (various needs for information dictate sources used) as do personal characteristics (experiences over time affect the number and types of contacts made with various information sources).

The last two factors in the model are the importance of risk and conservation orientations in the decision-making process. These factors are predicted to be extremely important intervening variables. The path model asserts that the conservation orientation is the factor closest to the dependent variables because a pro-environment orientation may result in the decision to reduce the farm technologies employed on the farm. Risk is argued to operate indirectly through the conservation orientation because it is posited that farmers must reach a level of security before they can be concerned about the environment. If farmers are very concerned about risk, they will probably be willing to sacrifice the environment to achieve short-term goals, such as short-term profits.
The above-mentioned model was put to empirical test using data from a random sample of farmers operating farms in Ohio. The methods used to collect the data for testing the model are presented in the next chapter.
CHAPTER III

RESEARCH METHODOLOGY

Sampling and Data Collection

The data were collected for this cross-sectional study in the spring and summer of 1982 from 918 farmers living in Ohio. Ohio was chosen as the universe for the study because the state is a microcosm of the geography and types of farm operations throughout the U.S. Northern Ohio nurtures horticulture and sandy vineyards which are typical of parts of the West, Pacific Northwest, Adirondacks and the Finger Lakes regions of New York. The rolling hills of eastern Ohio, like other north central states, boasts of beef and swine production. Farmers in the mountainous region of southeastern Ohio struggle to extract a living from the mountain fields reminiscent of the rugged agricultural terrain of New England and the Appalachian region of the South. South central Ohioans, in the tradition of the south central and southwestern states, breed cattle and engage in mixed crop production. This area together with the Ohio River delta lands of southwestern Ohio, like the southern U.S., is also one of the tobacco producing areas in the nation. The central and western portions of the state, similar to other
midwestern states and the major grain producing states west of the Mississippi River, are noted for vast production of grains. Thus, the heterogeneity of the agricultural traditions in Ohio make the state an appropriate target population for adoption research.

In addition to selecting a state with a diversity of farming enterprises, three other precautions were taken to insure the selection of a representative sample of Ohio farmers. First, nine counties were selected at random from the Ohio Cooperative Extension Service (CES) districts in Ohio. The CES administrative districts are delineated to be representative of the different regional agricultural and community needs throughout the state. Thus, each county included in the sampling frame represents a somewhat different type of farm operation, topography, climatic condition and socio-demographic grouping of residents. The inclusive counties were Ashland, Ashtabula, Belmont, Defiance, Gallia, Hardin, Madison, Marion and Wyandot.

A second factor which contributed to the representativeness of the sample was the sampling procedure used to select the respondents. Farm operators from each selected county were systematically sampled (Blalock, 1979; Miller, 1977) using the

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6 The CES, as established by the U.S. government, exists to disseminate information to farmers and rural residents on how to improve agricultural practices and community life.
highways in the county as the means of starting the sampling procedure. Interviewers were instructed to select every tenth occupied farmstead along designated highways in the county. The sampling areas were carefully designated to ensure that all areas of the selected counties were included. The sampling was monitored to make certain that all geographical areas of the study counties were represented in the sample.

A third factor which influenced the nature of the sample was the income criterion used to select the sample. Only farm operators with gross sales of $1,000 or more during the previous crop year were included in the sampling frame. This criterion is consistent with the Department of Commerce's definition of "a farm" in the "1982 Census of Agriculture Preliminary Report" (U.S. Department of Commerce, 1983: 1). The reason this criterion was used was to make the sample characteristics comparable to the Agriculture Census for comparison purposes and to eliminate "hobby" farmers from the study.

Three other sampling restrictions were established to increase the probability of collecting valid data to test the model outlined earlier. First, only farm operators or their spouses were interviewed. This action was taken to increase the probability that valid responses to complex farm-related questions were provided.
The respondents had to be intimately associated with the decision-making process on the farm to be able to respond to the questions addressed in the questionnaire.

Secondly, to reduce errors in responses and the data collection process, survey interviewers were trained in sampling procedures, administration of the questionnaires, interpretation of questions, techniques for recording the responses, interviewing techniques and other methodological considerations. Interviewer training sessions were conducted by a professional sociologist familiar with the study design and research techniques to be used. The interviewers were obtained by the county extension agents in the study counties. The interviews were conducted on a person-to-person basis.

Thirdly, the survey instrument was pretested using several researchers from The Ohio State University College of Agriculture who were familiar with the farming community in Ohio. The purpose of this effort was to insure that the agriculture-related concepts and terminology used in the questionnaire were correct, that the instructions and questions were clear and concise, and that the questions would elicit valid responses. Some of the questions included in this survey questionnaire had been used in previous research (Hooks, et al., 1983; Napier, et al., 1980), which means that the validity and reliability of several components of the questionnaire had been established by previous research.
The questionnaire contained questions regarding the type of farm operation presently in existence, farming practices being utilized, the adoption and use of consumer farm technologies, and socio-demographic factors of the farm operation. The questionnaire also contained attitude measures of farmers' risk orientations as related to their farm operations and attitude measures of their environmental conservation orientations.

Over 95 percent of all farm operators asked to participate in the study actually completed an interview. Very little sampling error was associated with refusals on the part of farmers asked to participate in the study. Sample characteristics were compared with the "1982 Census of Agriculture Preliminary Report" for Ohio (U.S. Department of Commerce, 1983), which was the most recent available statewide data. These data are presented in Table 1. Only one factor differed to any great extent. The figures showed that fewer farmers (33.1 percent) in the study sample than in the state data (49.3 percent) were holding nonfarm jobs. The other sample characteristics, however, were very similar to census figures.

Given the comparability of the sample characteristics to the Agriculture Census, the high response rate, the large sample size, and the wide geographical distribution of the sample, it is argued that the data are quite adequate to test the theoretical perspective noted in the previous chapter.
Table 1: Summary Characteristics of Study Sample (N=918) Compared with the 1982 Census of Agriculture for Ohio (N=86,942)\textsuperscript{a}

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Age of farmer (%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(&lt;35)</td>
<td>17.9</td>
<td>17.5</td>
</tr>
<tr>
<td>(35-44)</td>
<td>23.0</td>
<td>20.5</td>
</tr>
<tr>
<td>(45-54)</td>
<td>24.9</td>
<td>22.0</td>
</tr>
<tr>
<td>(55-64)</td>
<td>22.7</td>
<td>23.2</td>
</tr>
<tr>
<td>(&gt;65)</td>
<td>10.2</td>
<td>16.7</td>
</tr>
<tr>
<td>no data</td>
<td>1.3</td>
<td>not applicable</td>
</tr>
<tr>
<td>(x = 47.8) years</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Years of farming</td>
<td>(x = 26.8) years</td>
<td>not available</td>
</tr>
<tr>
<td>Farm size by acres owned (%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(1-49)</td>
<td>27.7</td>
<td>28.7</td>
</tr>
<tr>
<td>(50-179)</td>
<td>35.5</td>
<td>41.4</td>
</tr>
<tr>
<td>(180-499)</td>
<td>27.6</td>
<td>22.4</td>
</tr>
<tr>
<td>(500-999)</td>
<td>5.9</td>
<td>5.9</td>
</tr>
<tr>
<td>(1,000-1,999)</td>
<td>1.0</td>
<td>1.5</td>
</tr>
<tr>
<td>(&gt;2,000)</td>
<td>0.1</td>
<td>0.1</td>
</tr>
<tr>
<td>no data</td>
<td>2.2</td>
<td>not applicable</td>
</tr>
<tr>
<td>(x = 175.9) acres</td>
<td></td>
<td>(x = 177.0)</td>
</tr>
<tr>
<td>Tractor ownership</td>
<td>(x = 3.3) tractors</td>
<td>(x = 2.2)</td>
</tr>
<tr>
<td>Combine ownership</td>
<td>(x = 0.9)</td>
<td>(x = 0.4)</td>
</tr>
<tr>
<td>Source of agricultural income</td>
<td></td>
<td></td>
</tr>
<tr>
<td>crops</td>
<td>50.8</td>
<td>55.0\textsuperscript{c}</td>
</tr>
<tr>
<td>livestock/other</td>
<td>39.7</td>
<td>livestock/other \textsuperscript{c}</td>
</tr>
<tr>
<td>past</td>
<td></td>
<td>other \textsuperscript{c}</td>
</tr>
<tr>
<td>3 years</td>
<td></td>
<td>no data \textsuperscript{c}</td>
</tr>
<tr>
<td>Percent of farmers employed 100 days or more off the farm</td>
<td>33.1</td>
<td>49.3</td>
</tr>
</tbody>
</table>


\textsuperscript{c} Data for 1982 crop year income only
Operationalization of Variables

Dependent Variables

Four dependent variables were selected for examination and were operationalized as follows:

The number of tractors owned and the number of combines owned were measured by the number of the machines owned by the farm operator at the time of the data collection.

The horsepower of the largest tractor used and the bin capacity of the largest combine used by the farm operator at the time of the study, were measured by horsepower and by bin capacity in bushels, respectively.

Independent Variables

Guided by the proposed theoretical perspective and existing adoption/diffusion literature, 17 independent variables were selected as predictors of the adoption and continued use of consumer farm technologies, to test the proposed theoretical perspective.

The variables chosen to represent selected components of the traditional diffusion model were the use of institutional sources of information and noninstitutional sources of information, personal characteristics and the conservation criteria index of the farmer operators.

Use of institutional and noninstitutional sources of information were measured using a scale of eight possible responses which ranged from "daily" to "never." These response categories
were weighted from 0 through 7 with 0 equaling "never" and 7 signifying "daily." Item analysis was used to evaluate the reliability of these measures and the analysis produced an alpha coefficient of 0.81 for each scale. The high alpha indicates that the scale items for each scale are highly intercorrelated and can be legitimately combined into a composite index. Subsequently, the weighting values for the scale items employed to measure use of the various information sources were summed to form composite indexes for the two variables.

*Personal characteristics* of the farmers were measured as follows: *age* of the farm operators was measured in years at last birthdate.

The operator's type of *agricultural education experience* was operationalized by an index which consisted of seven possible response categories. The categories were: 4-H, vocational education in high school, adult vocational agricultural education, college short courses, attendance at an agricultural college, and on-the-job training working for another farmer. The respondents noted all of the agricultural educational experiences the primary farm operator had received. In the operationalization of these indexes, a positive response to each of these educational experiences received a value of 1, and a negative answer received a value of 0. The values were summed to form a composite measure of agricultural educational experience.
Conservation criteria index of farm operators was operationalized by four questions which evaluated the relative importance of water pollution, soil erosion, long-term fertility of the land and wildlife survival, in decision-making regarding the adoption of farm technologies and techniques. To measure the reliability of conservation orientation indicators, an item analysis was conducted on the data which produced an alpha coefficient of 0.86. The magnitude of the coefficient indicates that the items were highly intercorrelated and could be legitimately combined into a composite index. The weighting values of the four items were summed to form a composite index score for each respondent.

Variables used to represent selected components of the farm-structure perspective were: present farm-structure factors, past farm-structure factors and the risk-bearing orientation of the farm operators.

The indicators of the present farm-structure factors were operationalized as follows:

Years farming was measured as the number of years the primary farm operator had been engaged in farming.

Acres farmed was assessed by the number of acres usually under cultivation each year by the farm operator.

Percent grain farmer was measured by the percent of the gross farm income over the last three years derived from grain crops (corn, soybeans and wheat).
Percent livestock farmer was evaluated by the percent of the gross farm income over the last three years derived from livestock production (beef, dairy, poultry, swine and sheep).

Percent other farmer was measured by the percent of the gross farm income over the last three years derived from vegetables, fruits, hay and other crops. The percentages for each component of "other farming" were summed to form the percent-other-farmer variable.

Farming status of the operator was operationalized by asking if the farm operator worked more than 100 days in nonfarm employment off the farm in the year preceding the study. This was treated as a dummy variable with a "yes" response receiving a value of 1, and a "no" response assigned a value of 0.

Spouse's farming status was measured by asking if the spouse of the primary farm operator worked more than 100 days in nonfarm employment off the farm in the year preceding the study. This factor was also treated as a dummy variable with a "yes" response assigned a value of 1, and a "no" response assigned a value of 0.

The past farm-structure factors were examined in the following manner:

Horsepower of the largest tractor used 10 years ago was measured in terms of horsepower of the largest tractor used on the farm 10 years before the study was conducted.
Bin capacity of the largest combine used 10 years ago was measured in terms of the bin capacity in bushels.

Parents' farming status was assessed by inquiring if the operator's parents were engaged in farming. A "yes" response received a value of 1, and a "no" response was assigned a value of 0.

Acres parents farmed was measured by the number of acres the operator's parents usually had under cultivation.

Risk-bearing orientation of farm operators was assessed by asking how important risk to the farm operation was in decision-making regarding the adoption of farm technologies and techniques. This variable was evaluated along a scale of responses from 0 to 8, with 0 representing "not important," and 8 indicating "very important."

Statistical Analyses

Multiple regression and path analyses were used to test the validity of the theoretical model. Linear relationships were assumed to exist among the study variables, and the attitude measures were assumed to produce metric measures (Abelson and Tukey, 1970; Kim, 1975; Labovitz, 1970). Multiple regression was employed to determine the relative explanatory power of the independent variables when all of the variables were considered simultaneously.
Path analysis was used to articulate the causal direction and causal time ordering of the independent variables in relation to each other and the dependent variables.

Missing data were assigned the variable mean and retained in subsequent analyses of the data. The assignment of mean values for missing data has been shown to be a legitimate method of handling missing data when samples are large and the correlations moderate to low (Donner, 1982). These conditions were met in this study. In addition, the amount of missing data was miniscule for every variable included in the analysis, which adds additional support for using this methodology.
CHAPTER IV
FINDINGS AND CONCLUSIONS

General Overview

Basically, the study findings revealed that the theoretical model developed for this study was quite useful in providing an explanatory perspective for two of the four dependent variables. A substantial amount of the variance in horsepower of the largest tractor and bin capacity of the largest combine presently in use on the farm was explained with the model developed for the study. The theory was shown to have much less utility in explaining the variance in the number of tractors and combines owned. These findings suggest that the theoretical perspective probably has more utility in explaining the complexity of farm technologies owned and used rather than the absolute number of technologies presently owned and used.

The regression analyses demonstrated that 1) six variables explained 24.2 percent of the variance in the number of tractors owned, 2) nine variables explained 60.5 percent of the variance in the horsepower of the largest tractor used on the farm at the time of the study, 3) five variables explained 17.3 percent of the variance in the number of combines owned by the principal farm operator, and
4) **11 variables explained 52.0 percent of the variance in the bin capacity of the largest combine used on the farm at the time of the study.**

**Correlation Findings**

The bivariate correlation findings for the dependent variables and selected independent variables included in the study analyses are presented in Table 2. The correlation matrix for all selected study variables is presented in Table 3 in the Appendixes. The .05 level of significance was used to accept or reject study hypotheses.

The correlation findings revealed that:

1) **ten of the independent variables were significantly correlated with the number of tractors owned,**

2) **sixteen of the independent variables were significantly correlated with the horsepower of the largest tractor presently being used,**

3) **thirteen of the independent variables were significantly correlated with the number of combines owned,** and

4) **fourteen of the independent variables were significantly correlated with bin capacity of the largest combine used.**

The correlation analyses revealed that the following variables were significantly correlated with the number of tractors owned:

- acres usually farmed,
- years farming,
- acres parents usually farmed,
- horsepower of the largest tractor used 10 years ago,
- bin capacity of
Table 2: Bivariate Correlations for Measures of Farm Technologies and Selected Independent Variables

<table>
<thead>
<tr>
<th>Independent Variables</th>
<th>Correlations with Dependent Variables</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number of Tractors Owned</td>
</tr>
<tr>
<td>Acres Farmed</td>
<td>0.36*</td>
</tr>
<tr>
<td>Years Farming</td>
<td>0.13*</td>
</tr>
<tr>
<td>Parents' Farming Status</td>
<td>0.04</td>
</tr>
<tr>
<td>Acres Parents Farmed</td>
<td>0.08*</td>
</tr>
<tr>
<td>Age</td>
<td>0.02</td>
</tr>
<tr>
<td>Horsepower of Largest Tractor Used 10 Years Ago</td>
<td>0.28*</td>
</tr>
<tr>
<td>Bin Capacity of Largest Combine Used 10 Years Ago</td>
<td>0.08*</td>
</tr>
<tr>
<td>Farming Status of Operator</td>
<td>-0.25*</td>
</tr>
<tr>
<td>Spouse's Farming Status</td>
<td>-0.08*</td>
</tr>
<tr>
<td>Percent Grain Farmer</td>
<td>0.03</td>
</tr>
<tr>
<td>Percent Livestock Farmer</td>
<td>0.20*</td>
</tr>
<tr>
<td>Percent Other Farmer</td>
<td>-0.15*</td>
</tr>
<tr>
<td>Agricultural Education</td>
<td>0.10*</td>
</tr>
</tbody>
</table>
Table 2 (continued)

<table>
<thead>
<tr>
<th>Independent Variables</th>
<th>Correlations with Dependent Variables</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number of Tractors Owned</td>
</tr>
<tr>
<td>Institutional Sources of Information</td>
<td>0.06</td>
</tr>
<tr>
<td>Noninstitutional Sources of Information</td>
<td>0.06</td>
</tr>
<tr>
<td>Risk-Bearing Orientation</td>
<td>-0.02</td>
</tr>
<tr>
<td>Conservation Criteria Index</td>
<td>-0.06</td>
</tr>
</tbody>
</table>

* Significant at the .05 level using a two-tailed test of significance
the largest combine used 10 years ago, farming status of operator, spouse's farming status, percent livestock farmer, percent other farmer, and agricultural education. As the number of acres usually farmed, years of farming, acres parents usually farmed, horsepower of the largest tractor used 10 years ago, bin capacity of the largest tractor used 10 years ago, percent livestock farmer and agricultural education increased, there was a concomitant increase in the number of tractors owned. All of these findings were consistent with the theoretical perspective advanced for these variables, except for percent livestock farmer. While the percent livestock farmer was significantly related as hypothesized, the theoretical model as presented suggested the relationship would be inverse. The theoretical model must be amended to explain this inconsistent finding.

The number of tractors owned was significantly related in an inverse manner with farming status of the operator, spouse's farming status and percent other farmer. All of the hypotheses regarding these three variables were consistent with the research findings and were significant at the .05 level. Therefore, the hypotheses associated with farming status of the operator, spouse's farming status and percent other farmer were accepted.

The correlations of parents' farming status, age, percent grain farmer, institutional sources of information, noninstitutional sources of information, risk-bearing orientation and conservation criteria index were shown not to be significantly related to the
number of tractors owned and, therefore, the hypotheses associated with these variables were rejected.

The correlation analysis revealed further that all of the independent variables, except risk-bearing orientation, were significantly correlated with horsepower of the largest tractor used. Risk-bearing orientation was found to be insignificant not only for this factor but also for the three other dependent variables. Therefore, the hypothesis associated with risk-bearing orientation was rejected and a composite statement regarding the failure of this variable to predict will be made later in this chapter.

The correlation analysis demonstrated that as acres farmed, parents' farming status, acres parents farmed, horsepower of the largest tractor used 10 years ago, bin capacity of the largest combine used 10 years ago, percent grain farmer, agricultural education, institutional sources of information, and noninstitutional sources of information increased there was a concomitant increase in the horsepower of the largest tractor used. All of the hypotheses regarding these variables were consistent with the research findings and, therefore, were accepted.

The remaining independent variables were inversely related to the horsepower of the largest tractor used. These were: years farming, age, farming status of operator, spouse's farming status, percent livestock farmer, percent other farmer, and conservation criteria index. The hypotheses regarding percent livestock, percent other farmer and conservation criteria index were consistent with the
findings for these variables and, therefore, were accepted. However, the findings for years farming, age, farming status of the operator, and spouse's farming status were inconsistent with the theoretical perspective. Therefore, the hypotheses associated with these three variables were rejected.

The theoretical modeling suggested that as years farming increased, farmers' learning experiences would increase their propensities to adopt more sophisticated technologies. The contradictory findings may be the result of older farmers scaling-down their farm operations in anticipation of retirement and, therefore, not requiring large equipment.

Regarding farming status of the operator and spouse, the theoretical perspective advanced for these two variables suggested that farmers seeking off-the-farm employment would need larger equipment to save time for their nonfarm job pursuits. The findings showed that equipment size decreased with off-the-farm employment. This suggests that part-time farmers may be farming fewer acres and would have less need for large equipment. Future research endeavors should examine this phenomenon.

The correlation analysis for number of combines owned showed that all study variables except age, risk-bearing orientation, agricultural education, and conservation criteria index were significantly related to this dependent factor. The findings for these latter four variables were contrary to their respective hypotheses and, therefore, were rejected.
The correlation analysis also showed that as the following variables increased, the number of combines owned increased: acres farmed, years farming, parents' farming status, acres parents farmed, horsepower of the largest tractor used 10 years ago, bin capacity of the largest combine used 10 years ago, percent grain farmer, institutional sources of information, and noninstitutional sources of information. All of the hypotheses regarding these variables were consistent with the findings and, therefore, were accepted.

There was an inverse relationship between number of combines owned and the following variables: farming status of the operator, spouse's farming status, percent livestock farmer, and percent other farmer. The hypotheses for these variables also were congruent with the findings and, therefore, were accepted.

Only three variables were not significantly related to bin capacity of the largest combine used. These were years farming, risk-bearing ability and the conservation criteria index. The hypotheses advanced for these three variables were inconsistent with the findings and, therefore, were rejected. Years farming may have been insignificant because a segment of the older farmers may not be willing to invest the enormous capital required to purchase large combines. This would be especially true if the group of older operators were in the process of diminishing the scale of their farm operation and placing more emphasis on their financial security for retirement. Younger farmers who are recent entrants to agricultural production would be unable to purchase the large combines because of
cash-flow problems. Regarding the conservation criteria index, as suggested in the theoretical perspective, conservation-minded farmers tend to be less capital-intensive.

The correlation analysis also revealed that as the following study variables increased there was an increase in bin capacity of the largest combine used: acres farmed, parents' farming status, acres parents farmed, horsepower of the largest tractor used 10 years ago, bin capacity of the largest combine used 10 years ago, percent grain farmer, agricultural education, institutional sources of information, and noninstitutional sources of information. The hypotheses associated with these variables were consistent with the findings and, therefore, were accepted.

The correlation analysis also demonstrated an inverse relationship between age, farming status of the operator, spouse's farming status, percent livestock farmer, percent other farmer and the dependent variable bin capacity of the largest combine used. The hypotheses advanced for age, percent livestock farmer and percent other farmer were consistent with the findings and, therefore, were accepted. Hypotheses for farming status of the operator and spouse's farming status were incongruent with the study results, and, therefore, were rejected. A possible explanation for this inconsistency is that part-time farmers may be farming relatively smaller acreage and, therefore, do not require sophisticated farm technologies such as combines. If part-time farmers are engaged in small-scale grain production, they would be more likely to contract
combining to individuals who have the equipment and would, therefore, not own such equipment.

Regression Analyses

Multiple regression analysis was utilized to assess the explanatory power of the independent variables when all of the variables were considered simultaneously. Standardized regression coefficients were used because betas are calculated in the same units as the dependent variable and are, therefore, more easily interpreted.

The standardized regression equation used in the analysis is as follows:

\[ Y = B_1 X_1 + B_2 X_2 + \ldots + B_k X_k + e \]

where \( Y \) = dependent variable

\( B \) = standardized regression coefficient (beta)

\( X \) = score on independent variable

\( e \) = residual error

The standardized regression coefficient (beta) is defined as the amount of change in the dependent variable, resulting from one unit change of the independent variable. The residual error (e) indicates the amount of unexplained variance not accounted for in the mathematical model.

The best regression models are presented in Table 4. These equations are defined as the statistical models that maximize the
Table 4: Best Regression Models for Adopted Farm Technologies and Selected Independent Variables

<table>
<thead>
<tr>
<th>Best regression model for number of tractors owned</th>
<th>Adjusted Coefficient of Determination</th>
</tr>
</thead>
<tbody>
<tr>
<td>[ y = 0.353X_6 + 0.274X_8 + 0.169X_{13} - 0.071X_{15} + 0.065X_{17} + 0.130X_{18} ]</td>
<td>0.242</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Best regression model for horsepower of largest tractor used</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>[ y = -0.045X_2 + 0.042X_4 + 0.063X_5 + 0.346X_6 + 0.211X_7 - 0.091X_{10} + 0.383X_{13} - 0.055X_{15} - 0.116X_{16} ]</td>
<td>0.605</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Best regression model for number of combines owned</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>[ y = 0.072X_5 + 0.299X_6 + 0.155X_7 - 0.091X_{11} + 0.082X_{18} ]</td>
<td>0.173</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Best regression model for bin capacity of largest combine used</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>[ y = 0.050X_4 + 0.73X_5 + 0.237X_6 + 0.253X_7 - 0.087X_8 - 0.088X_9 - 0.095X_{10} - 0.050X_{11} + 0.138X_{12} + 0.212X_{13} - 0.093X_{16} ]</td>
<td>0.520</td>
</tr>
</tbody>
</table>

Key:
- \( X_2 \) = Conservation criteria index
- \( X_4 \) = Institutional sources of information
Table 4 (continued)

<table>
<thead>
<tr>
<th>$X_5$</th>
<th>Noninstitutional sources of information</th>
</tr>
</thead>
<tbody>
<tr>
<td>$X_6$</td>
<td>Acres farmed</td>
</tr>
<tr>
<td>$X_7$</td>
<td>Percent grain farmer</td>
</tr>
<tr>
<td>$X_8$</td>
<td>Percent livestock farmer</td>
</tr>
<tr>
<td>$X_9$</td>
<td>Percent other farmer</td>
</tr>
<tr>
<td>$X_{10}$</td>
<td>Farming status of the operator</td>
</tr>
<tr>
<td>$X_{11}$</td>
<td>Spouse's farming status</td>
</tr>
<tr>
<td>$X_{12}$</td>
<td>Bin capacity of largest combine used 10 years ago</td>
</tr>
<tr>
<td>$X_{13}$</td>
<td>Horsepower of largest tractor used 10 years ago</td>
</tr>
<tr>
<td>$X_{14}$</td>
<td>Parents' farming status</td>
</tr>
<tr>
<td>$X_{15}$</td>
<td>Acres parents farmed</td>
</tr>
<tr>
<td>$X_{16}$</td>
<td>Age</td>
</tr>
<tr>
<td>$X_{17}$</td>
<td>Agricultural Education</td>
</tr>
<tr>
<td>$X_{18}$</td>
<td>Years farming</td>
</tr>
</tbody>
</table>
explained variance while concomitantly maintaining a .05 level of significance for inclusion. The regression findings revealed that acres usually farmed entered every mathematical equation and was the single most important variable in explaining the variance for two of the four dependent variables (number of farm tractors owned and number of combines owned). It was the second most important predictor for the other two dependent variables (bin capacity of largest combine used and horsepower of largest tractor used).

As acres usually farmed increased, there were corresponding increases in each of the dependent variables. These findings are consistent with the theoretical assertion made that larger farms require more sophisticated technologies due to a greater need for such technologies and the ability of large-scale farmers to purchase these items.

Another important independent variable was percent grain farmer. This variable entered three of the regression models (horsepower of largest tractor used, number of combines owned, and bin capacity of the largest combine used). Percent grain farmer did not enter the equation for the number of tractors owned. This finding was not totally unexpected since grain farmers would tend to substitute harvesting equipment for tractors. Grain farmers would need fewer tractors given the investment made in grain combines.

One other variable entered three regression models and exhibited relatively high beta coefficients. The variable is horsepower of largest tractor used 10 years ago. As tractor size 10 years ago
increased, there was a concomitant increase in all of the dependent variables except the number of combines owned. These findings were expected since the theoretical perspective developed for study suggests that past farming behavior tends to influence present agricultural methods such as the use of sophisticated technologies. Also, correct adoption-decisions made in the past tend to increase the adopter's ability to survive in the competitive agricultural system and to adopt in the future. This is especially true for early adopters who will reap windfall profits associated with early adoption. Such people still continue to adopt farm technologies as long as they are relevant to the farm operation.

In contrast to the horsepower of the largest tractor used 10 years ago, the bin capacity of the largest combine used 10 years ago did not enter three of the regression models. This inconsistency with the theoretical expectations can be explained in the context of the relevancy of bin capacity to farmers as an occupational group. Combine bin capacity would tend to have less influence on adoption decision-making for the farm population as a whole since this variable will not be as relevant to some operators given the specialty emphasis of the farm. Combines are relevant to fewer operators, because such equipment normally is more restricted to grain farms, while tractors tend to be prevalent on all types of farm operations.
Institutional sources of information entered two regression equations. The variable exhibited weak explanatory power as evidenced by its relatively low beta coefficients in the models.

Noninstitutional sources of information was significantly related to the dependent variable in three equations. The magnitude of the coefficients was very low for each equation. As the variable increased, there were only minor increments in the numbers and complexities of the farm technologies utilized on the farm. The fact that institutional and noninstitutional sources of information entered is consistent with the theoretical expectations derived from the diffusion perspective.

Percent livestock farmer entered two models (number of tractors owned and bin capacity of largest combine used). As percent livestock farmer increased, the number of tractors owned increased. As percent livestock farmer increased, the bin capacity of largest combine used decreased. The relationship of the percent livestock farmer and number of tractors owned was not expected since the theory argued that farm technologies of the type assessed would not be essential to livestock farmers since that type of farming would not require a large number of tractors. The findings for number of tractors owned were inconsistent with the theoretical modeling. Apparently, livestock farmers require tractors to feed and move the animals. Tractors are also probably necessary in the growth of feeds for the animals. Subsequently, the theory would have to be modified.
in this context. The findings for bin capacity of combines used were consistent with the theory.

Years farming also entered two equations (number of tractors owned and number of combines owned). Years farming was relatively unimportant as a predictive factor in both equations. As years farming increased, the number of tractors and combines owned increased. This phenomenon may be the result of learning experiences over time which increased the farmers' propensities to adopt more technologies. This logic is consistent with the traditional diffusion perspective which was the theoretical source of the years-farming factor. It may also be possible that more experienced farmers have larger farms and require more sophisticated equipment to efficiently use labor. It may also be a function of older farmers having acquired several machines over the years that have not been replaced even though they are quite old. Since the equipment is usable, the equipment is not eliminated and accumulates in terms of numbers.

The diffusion perspective, however, failed to explain why years farming did not also influence adoption of horsepower of the largest tractor used and bin capacity of the largest combine used. A possible explanation is that as years farming increases, the operators naturally are older and, therefore, may be farming smaller acreage in preparation for retirement and do not require large equipment.
Farming status of the operator entered the two equations dealing with size of farm equipment (horsepower of largest tractor and bin capacity of largest combine owned). More specifically, farm operators engaged in employment off the farm, tended to have smaller farming equipment. In general, these findings were inconsistent with the theoretical modeling which argued that part-time farmers would own and use larger equipment to save time, and that the off-farm employment would provide money to purchase larger equipment. The findings indicate that part-time farmers do not generally own and use the largest equipment. This suggests that part-time farmers may be farming fewer acres and not need the large farm equipment. The theory must be amended to reflect this empirical fact.

Age also entered two equations, but the magnitude of the beta coefficients was quite low. Specifically, as age increased, the horsepower of tractors and the bin capacity of combines decreased. Diffusion theorists would contend that this finding is consistent with their expectations, for the diffusion model suggests that older people are more resistant to the adoption of technologies than are younger people. Older people would be approaching retirement and not want to assume risk associated with loan assumptions necessary to purchase large equipment. The desire to avoid debt would prevent older people from adopting. Also, older people would probably be in the process of scaling-down the farming operation as they near retirement and have less need for large, complex farm machinery.
Four other variables entered specific regression equations, but were relatively inconsequential. Agricultural education entered one model (number of tractors owned). As agricultural education increased, the number of tractors owned also increased. This finding was consistent with the theoretical modeling which argued that knowledge gained in school influences the formation of a positive attitude toward the adoption of farm technologies. It must be noted, however, that the strength of the relationship was low.

Percent other farmer also entered one model (bin capacity of largest combine used). The farmers engaged in "other farming" (i.e. vegetables, fruits, hay and other crops) tended to adopt smaller combines. This finding was expected per the theoretical modeling.

Spouse's farming status entered two models (number of combines owned and bin capacity of largest combine used.) On farm operations in which the spouse worked of the farm, there tended to be fewer combines owned. This finding is consistent with the theoretical perspective. However, combines tended to be smaller in size when spouses were engaged in off-the-farm employment. This outcome was not expected per the farm-structure perspective which argued the contrary position. The presence of smaller combines suggests that perhaps fewer acres are being farmed and, therefore, large farm equipment is not needed when a spouse is employed off the farm. The theory must be revised in this context.

Conservation criteria index entered one model (horsepower of largest tractor used). As the relative importance of conservation
increased in decision-making regarding the adoption of farm technologies and techniques, the horsepower of tractors decreased. This finding was consistent with the diffusion perspective which argued that environmentally-concerned farmers would tend to have smaller farm technologies.

It is interesting to note that risk-bearing orientation did not enter any of the regression models. Paradoxically, this composite factor had been considered important per the farm-structure perspective. It had been argued that risk-bearing orientation cannot be separated from farmers' adoption behaviors, due to the capital-intensive nature of farming today. This expectation was unfulfilled.

Path Analyses

Figure 1 in Chapter II is a path model which represents the study's hypothesized causal relationships among the study variables, and specifies the time order and causal ordering. Figures 2-5 depict the actual path coefficients calculated from the study data.

These path diagrams were created to graphically depict and clarify the complex pattern of causal relationships among the study variables. Specifically, these models display both the direct and indirect effects of independent factors on the dependent variables.

In figures 2-5, variables X_{12} through X_{18} are exogenous, their variability is assumed to be determined by factors outside the causal model. The relationship among the exogenous variables remain
Figure 1: Actual Path Model to Specify Relationships of the Independent Variables and the Dependent Variable "Number of Tractors Owned"
Figure 3: Actual Path Model to Specify Relationships of the Independent Variables and the Dependent Variable "Horsepower of the Largest Tractor Used"
Figure 4: Actual Path Model to Specify Relationships of the Independent Variables and the Dependent Variable "Number of Combines Owned"
Figure 5: Actual Path Model to Specify Relationships of the Independent Variables and the Dependent Variable "Bin Capacity of the Largest Combine Used"
unspecified and are characterized by zero-order correlation coefficients. The remaining factors, X₁ through X₁₁, are considered endogenous, their variation is determined by other variables in the model.

The exogenous variables were treated throughout the analyses as being independent factors. The endogenous variables were regarded as dependent relative to the variables preceding them in the time ordering but as being independent relative to the succeeding variables upon which they had an effect.

Each arrow in the final models bears a path coefficient which represents the direct effect of the antecedent variable on the dependent factor. For example, \( b_{10,13} \) shows the influence of the independent variable \( X_{13} \) on the dependent factor \( X_{10} \) while holding constant all the other independent antecedent farm-structure factors and personal characteristic variables. A path coefficient is the statistical equivalent in regression analysis of the standardized regression coefficient. Therefore, the magnitude of the path coefficient indicates the average standard deviation change in the dependent variable relative to a standard deviation change in the independent variable, when all other independent factors are held constant.

The proportion of unexplained variance in the dependent variables is also noted in the path models. In the computational procedure, unexplained variance is represented by a residual coefficient symbolized as \( \sqrt{1-R^2} \) which is the square root of
the difference between total variance minus explained variance. In figure 2, the residual path coefficient for $X_1$ is $\sqrt{1-0.242}$ or .87. This is the equivalent of the e value in regression analyses.

Comparison of Actual Path Models with Expected Models

The theoretical model articulated in the form of a path diagram presented in the theory chapter was shown to be a relatively close approximation of the actual models derived from the data. The expected and actual models were more closely aligned for horsepower of the largest tractor used (Figure 3) than for the other models. In Figure 3, the risk-bearing orientation and the conservation criteria index variables acted as intervening variables between antecedent variables and the dependent variable. These factors were shown not to be linking variables for number of tractors owned, number of combines owned and bin capacity of the largest combine used models. Risk-bearing orientation and the conservation criteria index were shown not to be directly related to these dependent variables. Such findings are inconsistent with the expected path model.

Direct linkages between institutional sources of information and the dependent variables were verified for horsepower of the largest tractor used and bin capacity of the largest combine used. These linkages were consistent with the expected path model. The absence of direct linkages between institutional sources of information with
number of tractors owned and number of combines owned was inconsistent with the expected model.

The findings for access to noninstitutional sources of information were consistent for all of the dependent variables except number of tractors owned. These findings basically supported the expected model.

The findings for present farm-structure variables tended to support the expected model in that the present farm-structure variables acted as intervening variables between past farm-structure variables and personal characteristic variables and the dependent variables. While the number and type of present farm-structure variables which entered the models varied, the present farm-structure variables acted as intervening variables. Selected present farm-structure variables also operated indirectly through institutional and noninstitutional sources of information as expected.

Lastly, the past farm-structure variables and personal characteristics consistently had very little direct influence on the dependent variables with the exception of horsepower of tractors used 10 years ago and acres parents farmed. These factors were, however, shown to operate indirectly through selected present farm-structure variables as expected. None of the past farm-structure and personal characteristic variables were shown to be significantly related to institutional sources of information as expected. The expected model posited direct linkages with these factors. Several of the personal
characteristic variables were significantly related to noninstitutional sources of information as expected.

In sum, the expected path diagram derived from abstract theoretical modeling had considerable utility in terms of explaining the direct and indirect effects of the independent variables included in the models. The time ordering of variables also appeared to be correct.

**Summary and Conclusions**

Data were collected in the spring and summer of 1982 from 918 farmers living in nine counties in Ohio. The data were collected by volunteer interviewers secured by the county extension agent within the counties selected for study. The interviewers were trained in the sample selection and questionnaire administration by a professional sociologist prior to conducting the interviews. The questionnaire used in the study was formulated from previously used instruments and experiences gained from prior research projects focused on the sociology of agriculture by sociologists in The Ohio State University Department of Agricultural Economics and Rural Sociology.

One component of the data was focused on the adoption of farm technologies in the context of continued use of these machines. The size and number of farm combines and tractors were used as the dependent variables for this study.
The study was guided by a theoretical perspective developed from selected components of the traditional diffusion and farm-structure models. The basic theoretical assertions advanced in the theory were as follows:

1) access to institutional and noninstitutional sources of information will affect the number of farm technologies owned and size of technologies presently being used on the farm,

2) risk-bearing orientation and attitudes toward conservation will affect the number of farm technologies owned and size of technologies presently in use,

3) present farm-structure variables will affect the number of farm technologies owned and size of technologies presently in use,

4) past farm-structure variables will affect the number of farm technologies owned and size of technologies presently in use, and

5) personal characteristics will affect the number of farm technologies owned and size of technologies presently in use.

The study findings basically supported the theoretical modeling for the exception that risk-bearing orientation and attitudes toward conservation were not significantly related to several of the dependent variables. The best predictors of existing farm technologies owned and used on the farm were present and past farm-structure variables. Investments made in farm machinery in the past together with existing farm-structure factors combined to explain the greatest amount of the variance in the dependent variables. Wise investment decisions made in the past in terms of
farm machinery and the needs of the farm enterprise tended to influence farm technologies more than did information access, conservation and risk attitudes, and personal characteristics.

In retrospect, the finding that the theoretical model was relatively good for explaining the variance in the size of the farm technologies but inadequate for explaining the variability in the number of technologies owned is logical given the advances made in farm technologies over time. Farm technologies have been increasing in terms of size for many years, and the amount of work that can be accomplished with only one very large combine or tractor is often greater than the amount of work that could have been accomplished in the past with several machines. Subsequently, multiple units of farm equipment are not required. Also, the accumulation of used machines that have little salvage value but still are serviceable for specific tasks confounds the statistical model building. Farmers may have multiple units of farming equipment but use only a limited number of the units for most activities. They report the total number of farm machines as requested, when in fact their farming operation is dependent on a relatively small number of machines. Another condition which adversely affects the modeling for the number of machines is ownership of farm machinery by friends, neighbors and family members who share their farming equipment either on a fee-for-use or labor-sharing basis. Such a situation means that some farmers will not have to own much machinery even though they farm relatively large acreage.
A segment of the unexplained portion of the size variables is probably attributable to some of these factors as well. The contracting of grain harvest would explain why some farmers with grain operations would not have combines even though they probably could justify such expenditures of capital.

Future research should incorporate access to equipment either on a contract or loan basis. Collective ownership of very expensive equipment should also be examined because some farmers alone could not afford capital expenditures necessary to purchase farm equipment but could purchase such equipment in conjunction with others.

Specific Trends in the Findings

The study findings demonstrated that farm size was positively related to all of the dependent variables assessed. The correlations were higher for size of tractors and combines. There are two possible implications here relevant to policymakers. First, contrary to an assumption of the traditional diffusion perspective, sophisticated technological innovations may not be relevant to every farmer, especially small-scale operators. Secondly, not all farmers may have the means to adopt complex technologies.

These dual implications should suggest to researchers that even though the eclectic model demonstrated high predictive utility, a more complex rendition may be necessary to accomplish the following:
First, identify the extent of farmers' needs to adopt and maintain consumer farm technologies. In addition to the type and size of the farm operation, the influence of the topography of the farm should be considered when attempting to predict farm technologies in use. Slope of the land and terrain quality is a consideration in the type of farming practice and concomitant technology adopted (Napier, et al., 1984). Rolling hills and wetlands are not conducive to the use of large equipment.

Secondly, more emphasis should be placed on economic-related factors as they relate to the adoption of farm technologies. In addition to acreage farmed, the theoretical model suggests that other economic factors may be relevant to the issue such as the buying power of farm operators. Researchers should inquire about the success or failure of farmers in accessing financial loans when contemplating purchase of farm technologies.

Lastly, consideration should be given to the desire to purchase farm equipment. Assessments in the future should be given to propensities to adopt. Such information would add insight to the abilities to act because individuals desirous of adopting but not doing so may indicate institutional barriers to adoption.

Comparability of the Theoretical Models

Among the predictors of the dependent variables, present and past farm-structure factors, especially the latter, were the strongest. The diffusion-type factors in total were less
significant. These findings have at least two major implications which are as follows:

First, in future research efforts regarding the adoption and continued use of consumer farm technologies, scientists should consider focusing primarily on farm-structure factors, with less emphasis on diffusion-type variables. In turn, policymakers may wish to reconsider the effectiveness of the traditional diffusion-perspective approach of relying on educational-type programs to convince farmers to adopt technologies. Educational programs are futile if people cannot act on their desires.

Secondly, past farm-structure factors, with the exception of horsepower of the largest tractor used 10 years ago, may not be as significant in predicting adoption behavior, as contemporary researchers have been proposing. Even though these factors entered the models, the present farm-structure factors were better predictors. It is particularly noteworthy that parents engaged in farming did not appear to be a determinant of farm technologies but did affect present farm size. Parents' farming status appears to give advantages to farmers in terms of acres presently farmed but not in regards to technologies. It is highly likely that parents' farming status means that farmers can access technologies owned by their parents.

It is interesting to note that the conservation and risk-bearing orientations of farmers did not influence adoption decision-making about farm technologies except tractor size.
However, it is possible that the theoretical model may have excluded factors that intervene between farmers' orientations and their adoption behaviors. Based on the nature of this study's findings and implications, it is possible that intervening factors may have been economic-related. For example, farm operators may believe in the value of no-till farming as a means of conserving the fertility of the soil, but till their lands in traditional ways using sophisticated technologies because they believe these practices are more productive. Farmers may not be able to assume risks of lower production per acre which may result from soil conservation tillage systems. Future research should incorporate measures of perception of the potential return on investment in conservation practices and include these variables as intervening between the conservation orientation measures and adoption behaviors. In issue, it is possible that farmers can hold very positive conservation attitudes but be forced by economic circumstances to use conventional practices which require large-scale technologies.

Recapitulation

In summary, the research findings tended to support earlier contentions that wedging the traditional diffusion model with a farm-structure model would produce a stronger explanatory perspective than either used alone. The findings suggested that additional modeling would be necessary to explain a major portion of the
variance in the number of technologies owned and used. Several suggestions for future research were offered.

Regarding the relative importance of the two perspectives, the present and past farm-structure factors were shown to be the best predictors of the number and size of farm technologies owned and used. Thus, the farm-structure factors tended to have greater predictive ability than the traditional diffusion variables included in the analysis. These findings suggested the need for more emphasis on farm-structure-type factors and agricultural-structure variables in future research.

In general, the findings demonstrated that the eclectic theoretical model had considerable merit in predicting the phenomena under study. The predictive utility of the model, however, should be qualified only in the context of the dependent variables assessed. It is conceivable that the eclectic theoretical perspective might not be as useful in predicting the adoption of technologies other than tractors and combines. Elaboration in the suggested directions should produce a theoretical model which has even more predictive utility in the future.
APPENDIX A

Table 3 - Correlation Matrix
Table 3: Correlation Matrix for Adopted Farm Technologies and Selected Independent Variables

| Acres Farmed | Years Farming | Parents' Farming Status | Acres Parents Farmed | Age | Horsepower of Largest Tractor Used 10 Years Ago | Bin Capacity of Largest Combine Used 10 Years Ago | Farming Status of Operator | Spouse's Farming Status | Percent Grain Farmer | Percent Livestock Farmer | Percent Other Farmer | Percent Agricultural Education |
|--------------|---------------|-------------------------|----------------------|-----|---------------------------------------------|-----------------------------------------------|-------------------------------------------|-------------------------|-------------------|------------------------|--------------------|---------------------------|-------------------------------|
| Acres Farmed | 1.00          |                         |                      |     |                                             |                                               |                                           |                         |                   |                        |                    |                          |                               |
| Years Farming| -0.01         | 1.00                    |                       |     |                                             |                                               |                                           |                         |                   |                        |                    |                          |                               |
| Parents' Farming Status | 0.06 | 0.20 | 1.00 |                      |     |                                             |                                               |                                           |                         |                   |                        |                    |                          |                               |
| Acres Parents Farmed | 0.44 | -0.13 | -0.05 | 1.00 |                      |     |                                             |                                               |                                           |                         |                   |                        |                    |                          |                               |
| Age | -0.12 | 0.75 | 0.00 | -0.12 | 1.00 |                      |     |                                             |                                               |                                           |                         |                   |                        |                    |                          |                               |
| Horsepower of Largest Tractor Used 10 Years Ago | 0.09 | 0.00 | 0.10 | 0.26 | -0.09 | 1.00 |                      |                                               |                                           |                         |                   |                        |                    |                          |                               |
| Bin Capacity of Largest Combine Used 10 Years Ago | 0.19 | 0.02 | 0.05 | 0.11 | -0.04 | 0.23 | 1.00 |                                               |                                           |                         |                   |                        |                    |                          |                               |
| Farming Status of Operator | -0.18 | -0.23 | -0.16 | -0.07 | -0.16 | -0.24 | -0.09 | 1.00 |                                               |                         |                   |                        |                    |                          |                               |
| Spouse's Farming Status | -0.10 | -0.14 | -0.07 | 0.01 | -0.12 | -0.06 | -0.05 | 0.22 | 1.00 |                                               |                         |                   |                        |                    |                          |                               |
| Percent Grain Farmer | 0.30 | -0.01 | 0.10 | 0.14 | -0.04 | 0.30 | 0.22 | -0.01 | 0.01 | 1.00 |                                               |                         |                   |                        |                    |                          |                               |

116
Table 3 (Continued)

<table>
<thead>
<tr>
<th>Percent Livestock Farmer</th>
<th>Percent Other Farmer</th>
<th>Agricultural Education</th>
<th>Institutional Sources of Information</th>
<th>Non-institutional Sources of Information</th>
<th>Risk-Bearing Orientation</th>
<th>Conservation Criteria Index</th>
<th>Number of Tractors Owned</th>
<th>Horsepower of Largest Tractor Owned</th>
<th>Seed</th>
<th>Number of Combines Owned</th>
<th>Bin Capacity of Largest Combine Used</th>
</tr>
</thead>
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<tr>
<td>0.18</td>
<td>0.02</td>
<td>-0.06</td>
<td>-0.13</td>
<td>-0.00</td>
<td>-0.12</td>
<td>-0.07</td>
<td>-0.58</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Percent Livestock Farmer</td>
<td>Percent Other Farmer</td>
<td>Agricultural Education</td>
<td>Institutional Sources of Information</td>
<td>Non-institutional Sources of Information</td>
<td>Risk-Bearing Orientation</td>
<td>Conservation Criteria Index</td>
<td>Number of Tractors Owned</td>
<td>Horsepower of Largest Tractor Owned</td>
<td>Seed</td>
<td>Number of Combines Owned</td>
<td>Bin Capacity of Largest Combine Used</td>
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Table 3 (continued)

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<th>Noninstitutional Sources of Information</th>
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<th>Conservation Criteria Index</th>
<th>Number of Tractors Owned</th>
<th>Horsepower of Largest Tractor Used</th>
<th>Number of Combines Owned</th>
<th>Bin Capacity of Largest Combine Used</th>
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<td>1.00</td>
<td>1.00</td>
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<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>Noninstitutional</td>
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<td>1.00</td>
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<td>1.00</td>
<td>0.50</td>
<td>0.50</td>
<td>0.50</td>
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<tr>
<td>Sources of</td>
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<td>0.05</td>
<td>1.00</td>
<td>0.50</td>
<td>1.00</td>
<td>0.50</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Risk-Bearing</td>
<td>0.09</td>
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<td>1.00</td>
<td>0.50</td>
<td>1.00</td>
<td>0.50</td>
<td>0.50</td>
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<td>Orientation</td>
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<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Conservation</td>
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<td>0.02</td>
<td>0.50</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>Criteria Index</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of Tractors Owned</td>
<td>0.06</td>
<td>0.06</td>
<td>-0.02</td>
<td>-0.04</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>Horsepower of Largest Tractor Used</td>
<td>0.07</td>
<td>0.28</td>
<td>0.00</td>
<td>-0.11</td>
<td>0.34</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>Number of Combines Owned</td>
<td>0.07</td>
<td>0.14</td>
<td>-0.04</td>
<td>-0.05</td>
<td>0.30</td>
<td>0.33</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>Bin Capacity of Largest Combine Used</td>
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<td>0.28</td>
<td>0.04</td>
<td>-0.06</td>
<td>0.26</td>
<td>0.77</td>
<td>0.29</td>
<td>1.00</td>
</tr>
</tbody>
</table>
APPENDIX B

Questionnaire
County in which Respondent lives? __________ County

Interviewer's name __________ Address __________ Phone __________

The first few questions are about your farming operation. Please answer each question as completely as possible because the safety questions will be analyzed using this information. No one will ever see your responses except the researchers. No questionnaires will be released for any reason, so feel free to express your feelings about any issue.

1. How many acres does the principal operator of this farm usually have under cultivation each year? _______ acres

2. How many of these acres are owned by the principal farm operator? _______ acres

3. How many of these acres are rented? _______ acres

4. How many acres of land owned by the principal farm operator of this farm are not being farmed each year? (For example, land in forests or other nonagricultural purpose) _______ acres

5. How many years has the principal farm operator been engaged in farming? ___ years

6. Were the principal farm operator's parents engaged in farming? ___yes ___no

   If yes, how many acres did they farm? _______ acres

7. Were the parents of the principal operator's spouse engaged in farming? ___yes ___no

   If yes, how many acres did they farm? _______ acres
8. What types of agricultural training other than farm experience have the principal farm operator and spouse received? (Check all that are appropriate.)

<table>
<thead>
<tr>
<th>Training Type</th>
<th>Principal Farm Operator</th>
<th>Spouse</th>
</tr>
</thead>
<tbody>
<tr>
<td>4-H</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vocational Agriculture (high school)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vocational Agriculture (adult educ.)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>College Short Course</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Attended an Agricultural College</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Graduated from an Agricultural College</td>
<td></td>
<td></td>
</tr>
<tr>
<td>On-the-job training working for another farmer</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

9. What is the age of the principal farm operator? _____ years

10. How many people usually work on this farm each year? _____ number (family or household members)

11. a. How many hired employees usually work on your farm each year? _____ number of employees

   b. How many hired employees usually work more than 200 days on your farm each year? _____ number of employees

12. Approximately what percentage of your gross farm income over the last three years came from each of the following agricultural products? (If you lease your land to another farmer, estimate the percentage of income from each crop.) For example, if you received half of income from corn and half from soybeans, you would enter 50 in the blank next to corn and also next to soybeans.

<table>
<thead>
<tr>
<th>Product</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wheat</td>
<td>_____ %</td>
</tr>
<tr>
<td>Corn</td>
<td>_____ %</td>
</tr>
<tr>
<td>Soybeans</td>
<td>_____ %</td>
</tr>
<tr>
<td>Vegetables</td>
<td>_____ %</td>
</tr>
<tr>
<td>Fruits</td>
<td>_____ %</td>
</tr>
<tr>
<td>Hay</td>
<td>_____ %</td>
</tr>
<tr>
<td>Poultry</td>
<td>_____ %</td>
</tr>
<tr>
<td>Beef</td>
<td>_____ %</td>
</tr>
<tr>
<td>Dairy</td>
<td>_____ %</td>
</tr>
<tr>
<td>Swine</td>
<td>_____ %</td>
</tr>
<tr>
<td>Sheep</td>
<td>_____ %</td>
</tr>
</tbody>
</table>
   | Other    | _____ %    | (please tell us the product)

13. Do you use a tractor in your farming operation? ____ yes ____ no

   If yes, please answer the following:

   a. How many tractors do you own? _____ number of tractors

   b. How many tractors do you lease? _____ number of tractors

   c. What is the approximate horsepower of the largest tractor you use? _____ horsepower

   d. What is the approximate horsepower of the largest tractor you used 10 years ago? _____ horsepower

   ____ didn't own any 10 years ago
e. How many of the tractors used on your farm have roll-over protection structures (ROPS)? ___ number of tractors
f. How many of the people working on your farm have taken the tractor certification program? ___ number ___ don't know

14. Do you use a combine harvester in your farming operation? ___ yes ___ no
   If yes, please answer the following:
   a. How many combine harvesters do you own?
      ___ number of combines ___ none
   b. How many combine harvesters do you lease?
      ___ number of combines ___ none
   c. Approximately how wide is the header of the largest combine you are presently using? ___ feet
   d. What is the bin capacity of the combine you are using now? ___ bushels

15. Did you use a combine 10 years ago? ___ yes ___ no
   If yes, what was the header width? ___ feet
      ___ don't remember
   If yes, what was the bin capacity? ___ bushels
      ___ don't remember

16. When the principal farm operator is considering adopting a new farming practice or purchasing a piece of farm machinery, how important are the following issues in making the adoption decision? Please circle the number along the continuum that best describes how important each characteristic is in the decision to adopt or purchase.

   For example, if the issue is not important to the farm operator you would circle one of the numbers under not important; but if it is very important to the farm operator, you would circle a number under very important.

<table>
<thead>
<tr>
<th></th>
<th>Not Important</th>
<th>Somewhat Important</th>
<th>Very Important</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Initial costs</td>
<td>0 1 2</td>
<td>3 4 5</td>
<td>6 7 8</td>
</tr>
<tr>
<td>b. Maintenance costs</td>
<td>0 1 2</td>
<td>3 4 5</td>
<td>6 7 8</td>
</tr>
<tr>
<td>c. Anticipated savings in time</td>
<td>0 1 2</td>
<td>3 4 5</td>
<td>6 7 8</td>
</tr>
<tr>
<td>d. Reduction in drudgery of farm operation</td>
<td>0 1 2</td>
<td>3 4 5</td>
<td>6 7 8</td>
</tr>
<tr>
<td></td>
<td>Not Important</td>
<td>Somewhat Important</td>
<td>Very Important</td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>e. Amount of reorganization of farming operations necessary</td>
<td>0 1 2</td>
<td>3 4 5</td>
<td>6 7 8</td>
</tr>
<tr>
<td>f. Quick return on investment</td>
<td>0 1 2</td>
<td>3 4 5</td>
<td>6 7 8</td>
</tr>
<tr>
<td>g. Understanding how new techniques or technology can benefit farm operations</td>
<td>0 1 2</td>
<td>3 4 5</td>
<td>6 7 8</td>
</tr>
<tr>
<td>h. Extent to which use of new technique or technology is risky to entire farm operation</td>
<td>0 1 2</td>
<td>3 4 5</td>
<td>6 7 8</td>
</tr>
<tr>
<td>i. Impact on water pollution</td>
<td>0 1 2</td>
<td>3 4 5</td>
<td>6 7 8</td>
</tr>
<tr>
<td>j. Impact on soil erosion</td>
<td>0 1 2</td>
<td>3 4 5</td>
<td>6 7 8</td>
</tr>
<tr>
<td>k. Impact on long-term fertility of the land</td>
<td>0 1 2</td>
<td>3 4 5</td>
<td>6 7 8</td>
</tr>
<tr>
<td>l. Impact on the safety of the farm operators</td>
<td>0 1 2</td>
<td>3 4 5</td>
<td>6 7 8</td>
</tr>
<tr>
<td>m. Impact on wildlife</td>
<td>0 1 2</td>
<td>3 4 5</td>
<td>6 7 8</td>
</tr>
</tbody>
</table>

17. On the scales listed below, circle the number that best represents how often the various farming practices are used in your present farm operation. For example, if no till practices are never used, then you would circle 0. If no till practices are always used, then you would circle 7.

<table>
<thead>
<tr>
<th></th>
<th>Never</th>
<th>Occasionally</th>
<th>Frequently</th>
<th>Always</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. No till</td>
<td>0</td>
<td>1 2</td>
<td>3 4 5</td>
<td>6 7</td>
</tr>
<tr>
<td>b. Chisel plowing</td>
<td>0</td>
<td>1 2</td>
<td>3 4 5</td>
<td>6 7</td>
</tr>
<tr>
<td>c. Deep plowing</td>
<td>0</td>
<td>1 2</td>
<td>3 4 5</td>
<td>6 7</td>
</tr>
<tr>
<td>d. Rotation of row crops with cover crops each year</td>
<td>0</td>
<td>1 2</td>
<td>3 4 5</td>
<td>6 7</td>
</tr>
<tr>
<td>e. Crop residue left on land</td>
<td>0</td>
<td>1 2</td>
<td>3 4 5</td>
<td>6 7</td>
</tr>
<tr>
<td>f. Grass waterways</td>
<td>0</td>
<td>1 2</td>
<td>3 4 5</td>
<td>6 7</td>
</tr>
<tr>
<td>g. Fall plowing</td>
<td>0</td>
<td>1 2</td>
<td>3 4 5</td>
<td>6 7</td>
</tr>
</tbody>
</table>
h. Grass filter strips along fields to stop sheet erosion 0 1 2 3 4 5 6 7
i. Return of erosion prone land to grasses 0 1 2 3 4 5 6 7
j. Fall application of fertilizer 0 1 2 3 4 5 6 7
k. Holding tanks or ponds for animal wastes 0 1 2 3 4 5 6 7
l. Strip-cropping to reduce soil erosion 0 1 2 3 4 5 6 7

18. Do you have mechanical drying equipment for grain on your farm? ___yes ___no

19. Do you transport your farm products to market? ___yes ___no

If yes, how many miles (one way) do you transport your farm products to: nearest market _____miles furthest market _____miles.

If yes, do you transport your farm products to market by truck? ___yes ___no

If yes, do you transport your farm products by tractor-wagon? ___yes ___no

If yes, do you sometimes transport your farm products when it is dark (early morning or late at night)? ___yes ___no

20. Do you have liquid application equipment on your farm? ___yes ___no

If yes, check the type(s) of liquid application equipment you have. (Check all that are appropriate.)

___ herbicides
___ ammonia
___ liquid fertilizer
___ pesticides
___ other (please specify) __________________________
21. Do you have grain storage on your farm? ___yes ___no
   If yes, to what degree is it mechanized (auger and conveyor)? ___little ___some ___great deal
   If yes, what is the storage capacity on your farm? ____bushels

22. Did the principal farm operator work more than 100 days in non-farm work off-the-farm last year? ___yes ___no

23. Did the spouse of the principal farm operator work more than 100 days in non-farm work off-the-farm last year? ___yes ___no ___not applicable (no spouse)

24. Listed below are several sources of information for farm families. Circle the number along the scale that best represents how often you use each source. For example, if you read a farm magazine daily, you would circle 1 or if you never read a farm magazine you would circle 8.

<table>
<thead>
<tr>
<th>Information Source</th>
<th>Daily</th>
<th>Times Per Week</th>
<th>Once a Week</th>
<th>Once a Month</th>
<th>Times a Year</th>
<th>Times a Year</th>
<th>Once a Year</th>
<th>Never</th>
</tr>
</thead>
<tbody>
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<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>8</td>
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<td>Local farm newspapers (weekly)</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
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<td>8</td>
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<td>Farm TV programs</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>8</td>
</tr>
<tr>
<td>Farm radio programs</td>
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<td>4</td>
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<td>4</td>
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<td>County extension agent</td>
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<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>8</td>
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<tr>
<td>Ohio State University staff person</td>
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<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>Local farm organization (4H, FFA, Grange, etc.) meetings</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>8</td>
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<tr>
<td>Ohio Agricultural Research &amp; Development Center Cooperative Extension meetings</td>
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<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>8</td>
</tr>
<tr>
<td>Information Source</td>
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<td>Once Per Month</td>
<td>Once Per Year</td>
<td>Never Times</td>
<td>Times Year</td>
<td>Times Year</td>
<td>Year Never</td>
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<td>Neighbors</td>
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</tbody>
</table>

25. Which of the following farm magazines do you receive? (Check all of the magazines you receive.)

- ___ Farm Journal
- ___ Ohio Report
- ___ Hoards Dairymen
- ___ Ohio Farmer
- ___ Successful Farming
- ___ Doans Digest
- ___ Other (Please tell us the magazine)

26. How many members of your family participate in young farmer meetings sponsored by vocational agricultural departments of local schools? ____ number of people

We would like you to provide some information regarding farming accidents your farm family has experienced in the last THREE YEARS. Please think carefully about each question. "Farming accidents" refers to accidents which occurred as a result of operating or maintaining your farming enterprise.

27. How many farming accidents have occurred on your farm in the last three years to members of your family or hired employees, which resulted in the loss of 1/2 day or more of time from normal activity, required professional medical care, or resulted in death? ____ number

28. How many of the accidents noted in question 27 were associated with each of the following causes? (Record the number of accidents in each category.)

Caused by chain saws ____ number of accidents
Caused by falls ____ number of accidents
Caused by fire ____ number of accidents
Caused by poisons ______ number of accidents
Caused by explosions ______ number of accidents
Caused by animals ______ number of accidents
Caused by farm machinery ______ number of accidents
Caused by electricity ______ number of accidents
Caused by chemicals ______ number of accidents
Caused by falling objects ______ number of accidents
Caused by motor vehicles ______ number of accidents
Caused by farm tractors ______ number of accidents
Caused by other (please specify) ______ number of accidents

29. Did clothing contribute to any of the accidents? ___yes ___no
   If yes, specify __________________________________________

30.a. How many of these accidents resulted in the loss of fingers, hands, feet, arms, or legs? ______ number of accidents
   b. How many of these accidents resulted in the loss of or damage to sight? ______ number of accidents
   c. How many of these accidents resulted in the loss of or damage to hearing? ______ number of accidents

31. How many of these accidents required hospitalization? ______ number of accidents

32. How many of these accidents required stitches? ______ number of accidents

33. How many of these accidents resulted in death that could be attributed to the specific accident? ______ number of accidents

34. How many farm work-days were lost to these accidents? ______ number of days

35. How many farming accidents have you, your family members, and hired employees experienced in the last three years while engaged in farming activities on your own farm? For example, if there were 3 accidents while loading grain, then you would enter a 3 in the blank next to loading grain.

   Drying grain ______ number of accidents
   Loading grain ______ number of accidents
   Unloading grain ______ number of accidents
   Plowing ______ number of accidents
   Repairing machinery in the farm shop ______ number of accidents


<table>
<thead>
<tr>
<th>Activity</th>
<th>___ number of accidents</th>
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<tbody>
<tr>
<td>Repairing machinery while in the field</td>
<td></td>
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<tr>
<td>Clearing equipment (clearing grass, weeds, etc.) while in the field</td>
<td></td>
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<tr>
<td>Herding animals</td>
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<tr>
<td>Feeding animals</td>
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<tr>
<td>Clearing land for farming</td>
<td></td>
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<tr>
<td>Moving equipment from one field to another</td>
<td></td>
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<tr>
<td>Cutting firewood</td>
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<tr>
<td>Transporting crops to market</td>
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<tr>
<td>Picking corn</td>
<td></td>
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<tr>
<td>Storing hay</td>
<td></td>
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<tr>
<td>Mowing roads</td>
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<tr>
<td>Operating a brush hog</td>
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<tr>
<td>Laying drain tile</td>
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<tr>
<td>Combining grain</td>
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<td>Saling hay</td>
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<tr>
<td>Disking</td>
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<tr>
<td>Other (please specify type of activity)</td>
<td>___ number of accidents</td>
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</tbody>
</table>

36. Have you or a member of your farm family ever attended a farm safety meeting? ___yes ___no

37. If a farm safety course was offered close-by, would you attend? ___yes ___no ___don't know

38. Have you ever read any farm safety bulletins developed by the Ohio Cooperative Extension Service? ___yes ___no

39. Circle the number along each of the scales below that best represents how well informed you are about farm safety. For example, if you feel you are very well informed on causes of farm accidents, then circle the 7. If you feel you are not well informed, then circle the 0.

<table>
<thead>
<tr>
<th></th>
<th>Not Well Informed</th>
<th>Poorly Informed</th>
<th>Fairly Well Informed</th>
<th>Very Well Informed</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Cause of farm accidents</td>
<td>0</td>
<td>1</td>
<td>2 3 4 5 6 7</td>
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</tr>
<tr>
<td>b. Means of preventing farm accidents</td>
<td>0</td>
<td>1</td>
<td>2 3 4 5 6 7</td>
<td></td>
</tr>
<tr>
<td>c. Characteristics of farm families most likely to have accidents</td>
<td>0</td>
<td>1</td>
<td>2 3 4 5 6 7</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Not Well Informed</td>
<td>Poorly Informed</td>
<td>Fairly Well Informed</td>
<td>Very Well Informed</td>
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<td>d. Conditions which</td>
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<td>increase probability</td>
<td>4</td>
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<td>7</td>
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<td>of farm accidents</td>
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<tr>
<td>e. Aware of conditions</td>
<td>0</td>
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<td>which are dangerous</td>
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</table>

40. Which of the following safety equipment do you use on your farm? (Check each that is used.)
   ___ Fire extinguisher in shop
   ___ Hard hats
   ___ Steel toed shoes
   ___ Safety glasses
   ___ Fire sensors in farm buildings
   ___ Protective clothing when handling chemicals
   ___ Two-way radios for safety purposes
   ___ Squeeze bottle of water when working with anhydrous ammonia
   ___ Other (please specify) ____________________________

41. Do you have smoke detectors in your home? ___yes ___no

42. Do you train each family member how to turn off equipment and machines if an accident occurs? ___yes ___no

43. In how many organizations (such as 4H, FFA, NFO, Farm Bureau, Farmers Union, Grange, religious groups, and so forth) do your family members usually participate? ___total number for the family

44. Listed below are several services provided in your community. Circle the number that best represents how satisfied you are with access to each.

<table>
<thead>
<tr>
<th></th>
<th>Completely Dissatisfied</th>
<th>Somewhat Satisfied</th>
<th>Completely Satisfied</th>
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<tbody>
<tr>
<td>a. Access to emergency medical care</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
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<tr>
<td>b. Access to hospital facilities</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
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<tr>
<td>c. Access to physicians</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
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<tr>
<td>d. Access to nurses</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
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<tr>
<td>e. Access to dentists</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
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<tr>
<td>f. Access to fire departments</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
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</table>
45. **How satisfied are you with the type of services received when you have used the services evaluated in question 44?**

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<tr>
<th></th>
<th>Completely Dissatisfied</th>
<th>Somewhat Satisfied</th>
<th>Completely Satisfied</th>
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<tbody>
<tr>
<td>a. Quality of emergency medical care</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
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<tr>
<td>b. Quality of hospital facilities</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
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<tr>
<td>c. Quality of physicians' care</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
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<tr>
<td>d. Quality of nursing care</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
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<tr>
<td>e. Quality of dental care</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
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<tr>
<td>f. Quality of fire departments in your community</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
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</tbody>
</table>

Thank you for taking the time to complete this questionnaire.
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