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Sociological factors influencing the decisions of Iowa farmers to adopt needed soil conservation practices

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Sociological factors influencing the decisions of Iowa farmers to adopt needed soil conservation practices

by

Donald Joseph Wagener

A Dissertation Submitted to the
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INTRODUCTION

Soil Erosion in Iowa and the United States

Soil erosion is widely recognized as having far-reaching ecological, political, and social implications. Excessive loss of topsoil through erosion, and the resulting nonpoint source pollution, are of concern today, both to farm and nonfarm populations alike. A poll in 1979 found that soil erosion is viewed with concern by citizens nationwide. In fact, half of those surveyed perceived the misuse of soil and water resources to be a "serious" problem (Harris, 1980).

The rationale for maintaining a productive soil resource is well described in the literature (Beasley, 1972; Batie and Healy, 1980; Sampson, 1981). The contemporary prominence of soil erosion in the public mind, suggests several researchable questions. For example: How aware is the public about current soil erosion conditions, and what factors are important to explaining the differential levels of awareness? What is the nature and extent of soil erosion today? What are its diverse effects? Can the loss of soil be effectively remedied, and, if so, how should this be accomplished?

Some of these questions are most appropriately addressed from the perspectives of the natural sciences. Others require the insights of social scientists. It is only recently that social scientists have displayed interest in soil conservation issues, and the domain of their inquiries is only now being forged. Yet, at a minimum, it is increasingly recognized that soil erosion, and the use of conservation practices, are more than merely technological issues. Social factors are seen by many decision makers as important, both to the prediction of future erosion levels, and to promoting the effective use of conservation practices.

This dissertation examines some sociological factors that are felt to affect the adoption of soil conservation practices. The introductory section discusses soil erosion as a societal issue. It provides a description of the nature and extent of erosion, as well as of the implementation of new conservation practices. Soil erosion is shown to be a sociological, as well as an economic and ecological, problem. There is also a presentation of the sampling and data collection procedures, and a description of the format of the dissertation.

Awareness of the erosion problem

Soil erosion and the massive sedimentation that it produces have been recognized for more than 40 years as being serious resource problems in the United States. Resource use patterns and climatic conditions created alarm in the 1930s amidst the most dramatic displays of erosion in the history of the country. After the 1930s, however, the fervor declined as environmental and economic conditions changed and as many resource users adopted management and production techniques that reduced the actual and visible amounts of soil erosion. Surplus food production necessitated various commodity and land retirement programs which complemented conservation objectives. Poorer, more erosive lands, were often withdrawn from intensive use, thus reducing strain on the land resource base (Walker, 1977:1; Halcrow et al., 1982:xi).

This trend remained fairly stable through the 1960s. In the early 1970s, however, agricultural production in the United States rose in response to increased foreign and domestic demands for foodstuffs. The increased pressure on cropland brought an exacerbation of soil erosion. In addition to the intensification of food-producing pressures on the land, a major focus in the mid-1970s was the environmental impacts of soil erosion. One of the most notable of these impacts was sedimentation (Paarlberg, 1980; Clark et al., 1985). Taken together, the soil erosion and water quality issues, as well as other off-farm impacts, have led to a renewed interest in soil conservation and have given rise to many questions about the extent and effectiveness of conservation programs (Halcrow et al., 1982:xi; Clark et al., 1985). Clearly, the increased utilization of cropland has aggravated conflicts between production and resource conservation goals.

The growth of public interest in soil erosion problems is partly attributable to Congressional actions. In a report of the General Accounting Office to Congress in 1977, attention was drawn to the fact that severe deficiencies in federal conservation programs prevented realization of the goal of increased soil retention on cropland. After 40 years of public policy to control soil erosion, at an expenditure of over 20 billion dollars, approximately 25 percent of the cropland acreage in the United States was shown to be losing five or more tons of soil per acre per year (Korsching and Nowak, 1980). This evidence, along with other criticisms of governmental conservation activities, led to passage, in 1977, of the Soil and Water Resources Conservation Act (RCA). This Act provided for a comprehensive assessment of the nation's soil and water resources, as well as the surveying of public consciousness about soil erosion problems (Ervin and Ervin, 1982).

Another Congressional stimulus for soil conservation, although occurring prior to the RCA legislation, was Section 208 of the Federal Water Pollution Control Act Amendments of 1972. This law, directed toward improved water quality, identified agricultural nonpoint sources as major contributors to the pollution of waterways and mandated that there be a development of plans to restrict nonpoint sources of pollution (Ervin, 1981; Heffernan and Green, 1981). Emerging from Section 208 planning was a new program of cost sharing and of technical assistance to farmers. Additionally, there was a strong commitment to increased research on soil erosion and its control (Ervin and Ervin, 1982:2).

Nature and extent of the problem

At the basis of soil erosion problems is the physical transport of soil by wind and water. Erosion is defined simply as the movement of soil or its component parts. Energy for this soil movement comes mainly from wind, the impact of raindrops, or moving water (National Agricultural Lands Study, 1980:11). The term "erosion" requires care in interpretation. It refers to the gross movement of soil from the slope segment that is being studied. It is not sediment yield, which is defined as the net sum of soil loss from all slope segments of a field. Neither is it soil loss, for all transported soil is not lost from a field or from a farm (Walker, 1977:77-79).

Critics of the erosion concept note that nearly 75 percent of detached and transported soil is deposited on another land site and, therefore, has not been truly "lost" to production potential. In fairness, however, it should be noted that the soil particles that tend to erode are those that are rich in nutrients, viz., organic and clay particles. Furthermore, erosion causes significant qualitative changes in soil itself. Hillslopes are exposed to loss of nutrient rich organic and clay materials, while downhill soils are covered with eroded matter. Many of the nutrients associated with transported topsoil from hillslopes are carried away by surface runoff. The topsoil that is deposited by this runoff, although of good quality, may be inferior to that which covers up, in addition to creating problems of en masse deposit (National Agricultural Lands Study, 1980:24-25).

In considering the nature and extent of erosion, rates of soil movement become important. The standard means for expressing soil erosion rates is in terms of gross tons of movement per acre per year (t/a/y). A field with an erosion rate of 10 t/a/y is losing an inch of topsoil every 15 to 20 years (National Agricultural Lands Study, 1980:18).

Erosion estimates expressed in t/a/y are frequently calculated through the use of the Universal Soil Loss Equation (USLE). This equation combines the factors of rainfall, soil erodibility, slope length and gradient, cropping and management practices, and the use of soil conservation practices to produce a predicted amount of average soil loss for a given area. The USLE is discussed at length elsewhere, and the reader is referred to these sources for a discussion of the equation (Wischmeier, Smith, and Uhland, 1958; Hudson, 1981).

Erosion rates exceeding T-value are considered excessive. This situation occurs on more than 236 million acres of U.S. cropland (National Summary, 1984).[1] The so-called T-value, or soil loss tolerance, refers to the maximum rate of loss that will permit a high level of crop productivity to be maintained over an indefinite period of time. A widely used indicator of T-value is 5 t/a/y. It should be noted that no single tolerance rate will apply to all soils, however. Some soils cannot withstand this level of loss, and caution must be exercised in using T-values for purposes other than as a conventional objective for erosion-control programs (Cory, 1977:5; National Agricultural Lands Study, 1980:23; Office of Technology Assessment, 1982:12).

Erosion rates tend to be greatest on cropland and grazed forest land, where they exceed 5 t/a/y on all but the best land capability classes. Also, they are especially dramatic in certain regions of the country, including the Corn Belt area of the Midwest. Nationally, nearly 44 percent of all cropland has erosion rates equal to, or exceeding, T-value (National Summary, 1984).

Erosion problems are of particular concern in Iowa, where three-fourths of the land is in crops, and where agriculture and agriculturally-related businesses and industries are major sources of economic sustenance. Iowa is

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[1]Cropland here includes row crops, as well as closely grown crops such as wheat, oats, and hay.

among the top two corn and soybean producing states in the nation, and produces roughly 10 percent of the nation's food supply. Unfortunately, Iowa's prolonged production capabilities are being jeopardized by an average yearly erosion rate of 9.6 t/a/y. Seventy-five percent of the cropland in the state has erosion rates of T-value or more, putting it at the top of all states in the amount of high erosion cropland (National Summary, 1984).

Prior to being farmed, the topsoil in Iowa ranged between 14 and 16 inches in depth. Today, after 100 years of farming, 6 to 8 inches has been lost. Unless there are changes in these rates, only 4 to 6 inches of topsoil will be left on most of Iowa's sloping soils in 25 years. At an average erosion rate of 13 t/a/y, or one-twelfth inch of topsoil per year, all of Iowa's topsoil on sloping gradients could be gone in 100 years (U.S. Department of Agriculture, 1979).[2] Similar situations exist in some of the other high producing agricultural areas of the United States (e.g., the Palouse area in Washington and Idaho). This nation is slowly, and in some cases quickly, losing its most basic

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[2]It should be noted that erosion losses are unevenly distributed throughout the state, and that this erosion effect could take place more quickly in some areas than in others. For example, the sloping hills and highly erodible loess soils of southwestern Iowa are particularly vulnerable to rapid erosion.

natural resource -- fertile soil. Clearly, the causes and consequences of this situation need to be better understood.

Effects of soil erosion

Two primary effects of soil erosion have been mentioned. The first, and most obvious, is topsoil movement. Large amounts of topsoil are eroded each year from sloping lands. The topsoil that is deposited after transport may be inferior to the land it covers. Related to the problem of topsoil loss is the effect this loss has on the physical environment. Sedimentation is the most pervasive of all water pollutants. In addition to water quality damages associated with sedimentation, there are harmful effects inflicted on aquatic life and on human health and recreation. As noted by Crosson and Miranowski (1982) and Clark et al. (1985), perhaps the strongest case that can be made for erosion control is its impact on reducing off-farm impacts that occur from soil erosion.

Probably the foremost impact of soil erosion, in the minds of many persons, is its effects on agricultural productivity. If the current high rates of soil erosion continue, what are the likely consequences for sustained high yield agricultural production for both domestic and foreign markets? As long as there is an abundance of surface soil, even heavy losses from erosion have little effect upon crop yields. But, as surface soil becomes continually shallower, productivity of the soil begins to break down rapidly. Erosion occurs at an ever-increasing rate due to the subsoil's deficiency in organic matter and the reduced capacity for water infiltration. The effect is a decline in fertility and smaller crop yields. The ultimate outcome is a thin plant cover that provides poor protection of the land and necessitates its eventual abandonment (Schickele et al., 1935:191-92).[3]

Despite widespread concern over productivity losses from soil erosion, the relationship between erosion and productivity has not been clearly determined. One must assume that the long-term productivity benefits acquired through conservation efforts outweigh the additional requirements of time, energy, and effort needed to institute and maintain conservation practices. Regardless of the exact nature of the productivity-erosion relationship, it should not be assumed that the two factors are, or must be, mutually exclusive. Production and conservation can be mutually reinforcing if appropriate technologies are developed and utilized (Office of Technology Assessment, 1982:21).

One of the reasons that the productivity-erosion relationship has not been clearly specified is the avail-

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[3]Although dated, this reference offers an excellent discussion of the general topic of erosion effects.

ability of commercial fertilizers. To date, fertilizers have masked the full effects of topsoil movement and have compensated for erosion-promoting treatment of the land. Extra fertilizer and improved corn varieties have kept crop yields high. But, there is some evidence that crop yields are peaking and that additional inputs of production technology will have diminishing effects on crop yields (U.S. Department of Agriculture, 1979). A "quick fix" technological solution to this situation cannot be presumed (Nowak and Korsching, 1981). Rather, what must be anticipated is an increased emphasis on topsoil preservation and management (U.S. Department of Agriculture, 1979).

The effects of erosion are many, although not always obvious. While the most important involve topsoil depletion, water quality degradation, and possible declines in productivity, there are also concerns about the increased energy requirements needed to farm poor soils, the squeeze on family farms resulting from more competition for fewer available acres, the ability to realize a favorable balance of trade through agricultural exports, and the likes. Given the growing recognition of the negative consequences of erosion (U.S. Department of Agriculture, 1981; National Summary, 1984; Clark et al., 1985) and the fact that technology exists for severely curtailing this erosion, it is important to consider how extensively conservation practices and structures are being applied today as a remedy for soil erosion problems.

Use of conservation practices

Many different types of conservation practices and structures are needed to effectively control erosion. Crop rotation, reduced tillage, contouring, and terracing are but a few. The use of some of these has greatly increased in recent years and will continue to play an important role in future conservation efforts. For example, the land area on which there is some form of conservation practices was 230 million acres in 1982, or more than 55 percent of all U.S. cropland acres. Yet, the percentage of all U.S. cropland still needing erosion treatment stood at approximately 50 percent in 1982 (National Summary, 1984). Obviously, much work remains before conservation practices are adequately utilized to preserve our endangered soil resources.

In Iowa, a survey of conservation tillage practices conducted in 1985 revealed that, of the 24 million acres of cropland in the state, 12 million acres (approximately 50 percent of Iowa cropland) had some form of conservation tillage applied (Conservation Tillage Information Center, 1985). The 1982 NRI estimates that approximately 19 million acres of Iowa cropland is still in need of some form of conservation treatment (National Summary, 1984).

Soil Erosion as a Sociological Problem

Public concern about soil erosion has been increasing in recent years. Soil erosion is currently seen as being a priority natural resource issue by both rural and urban residents. Furthermore, considerable attention is being paid to the question of the appropriate level of responsibility for, and involvement in, control of soil erosion. Rising public awareness and concern suffice in themselves to make soil erosion a topic of potential sociological interest. But, sociological study of soil erosion goes beyond concern with public opinion. Given the seriousness of erosion, from both a technical and social perspective, questions can be raised as to why farmers have failed to adopt needed conservation practices. Specifically, how do various social and institutional factors serve to facilitate, or impede, the adoption of soil conservation practices?

While the financial costs of implementing and maintaining conservation practices may be a major determinant for their adoption, costs are by no means the sole factor in these decisions. It is noted by Christensen and Miranowski (1982:3), that the problem goes "beyond economics" to encompass such things as the personal characteristics and orientations of potential adopters, landlord-tenant relationships, peer-group pressures, community characteristics, and local traditions. Consideration of these and other socioeconomic variables seems important in determining who is most likely to adopt needed conservation practices. Sociological research can identify the socioeconomic processes, institutional factors, and farm-firm characteristics which affect awareness, adoption, and maintenance of soil conservation practices (Nowak and Korsching, 1981:2; van Es, 1982).

Socioeconomic factors that have been analyzed in the study of innovative behavior include personal and farm-firm factors (e.g., tenure status, debt level, size and type of operation, employment of labor, and income), as well as social-system characteristics (e.g., innovativeness norms, social integration, patterns of communication, and the local availability of supporting infrastructures for innovation). In addition, sociologists recently have displayed interest in ecological constraints on the use of conservation practices.

Debate has arisen as to whether or not the variables and models used by sociologists to explain the adoption of commercial farm innovations, also apply to the adoption of conservation measures (Rural Sociological Society, 1982). While commercial and noncommercial innovations can be distinguished on some key points (Nowak and Korsching, 1979), these differences may not diminish the utility of standard socioeconomic variables in explaining the use of soil conservation practices. There is need, however, to move beyond the standard socioeconomic characteristics to include a wider breadth of variables in seeking understanding and explanation of soil conservation attitudes and behaviors.

In sum, it is clear that soil erosion remains a serious problem in the United States after 50 years of ameliorative efforts by farmers and the federal government. Topsoil continues to erode in large amounts and precious organic matter is being lost. While soil conservation receives widespread praise as a global concept, it is the actual use of conservation practices, not vague expressive support, that reduces soil losses. As the cost-price squeeze continues in the 1980s to impact farmers negatively, a firm commitment to soil and water conservation is crucial (Rasmussen, 1982:3-4, 14-15). Within an interdisciplinary approach to the study of soil erosion, there is need to better illuminate the socio-economic factors which promote, or impede the use of conservation practices.

Sample and Data

The data in this dissertation are from an inter-disciplinary study titled "Effect of Agricultural Land Use Practices on Stream Water Quality."[4] For the sociological component of this study, three watershed areas in east-central Iowa were selected for study. These areas were

[4]This project was funded through Environmental Protection Agency Grant R8 06 8110; Iowa Agriculture and Home Economics Experiment Station Project #2364.

the Four Mile Creek Watershed in Tama County, the Mud Creek Watershed in Benton County, and the Rock Creek Watershed in Cedar County. All three watersheds lie within the Iowa-Cedar River Basin.

Selected comparative statistics for the three watersheds are presented in Table 1. Maps of the relative locations of the watersheds within the state, as well as of the individual watersheds, are contained in Appendix A.

The original conceptualization of the study included a quasi-experimental design which allowed for the control of various factors impinging on the adoption of soil conservation practices. The Four Mile Creek area was selected because of an existing data base, previous cooperation from farm operators, and support from local agencies and organizations. It was to receive special conservation cost-share funds and educational programs. Selection of the two other study sites was based on the desire to achieve a high degree of similarity between all the study areas with regard to soil, topographic, and climatic conditions, as well as the socioeconomic characteristics of farmers. The Rock Creek Watershed was the primary control area. It was to receive only special educational and technical assistance programs. The other control area, the Mud Creek Watershed, was to receive neither special monetary incentives nor educational or technical assistance, except as part of the regular

Table 1. Selected comparative statistics for the Four Mile, Mud Creek and Rock Creek watersheds

Selected characteristic	Watershed: Four Mile Creek (Tama County)	Mud Creek (Benton County)	Rock Creek (Cedar County)
Total acres in watershed	12,000	19,000	11,500
Average annual rainfall (inches)[a]	32.4	32.3	26.0
Percent of land in row crops[a]	75	67	62
Average farm size (acres)[a]	262	279	260
Average dollar value of buildings and land per acre[a]	750	824	860
Average dollar market value of farm products sold[a]	84,356	94,438	87,607
Average age[b]	33.6	31.3	31.9
Average years of schooling completed[c]	12.4	12.4	12.4
Percent of total watershed acres operated by respondents	95	62	65

[a]These data are county-level summary items (U.S. Department of Commerce, 1978).

[b]These data are county-level summary items (U.S. Department of Commerce, 1980a).

[c]These data are county-level summary items (U.S. Department of Commerce, 1980b).

programs of federal, state, and county agencies. Due to the early termination of the project as a result of budgetary cutbacks, the original comparative design of the study could not be fully implemented. For the purposes of this study, the watersheds were treated as a single group.

A saturation sample was used. The intent was to cover all of the farmland in the three watersheds. A list of 303 rural households within the three study areas was obtained through a directory service[5] and was provided to interviewers before they entered the field. The interviewers were instructed to go to the designated households and to determine if an operator who farmed in the respective watersheds lived in the household. If so, they were to complete an interview. If the land surrounding the household was not operated by a member of the household, inquiry was made regarding the name and location of the operator. Interviewers were instructed to locate and interview these persons if they lived within 20 miles of their holdings. A total of 193 eligible respondents were included in the study. Table 2 contains information about the data collection procedures.

Four contacts were made with respondents over a two-year period, 1980-1981. In the first contact, personal interviews

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[5]The directory service used was the TAM Service, published by the R.C. Booth Co., Harlan, IA.

Table 2. Summary of data collection procedures

Type of contact	Date of Contact	N	Refusals	Other[a]
Personal interview	Feb.-March 1980	193	----[b]	----
Telephone interview	August 1980	176	8	9
Personal interview	March 1981	153[c]	0	23
Mail questionnaire	March 1981	141	12	0

[a]"Other" represents persons who could not be contacted. Most were no longer farming in the study area or had stopped farming altogether.

[b]The number of refusals from among those eligible to participate in the study was not available from records of the data collection procedure. It is known, however, that this number was small -- perhaps less than ten persons -- and that, overall, 71 percent of the land area in the three watersheds was operated by persons who participated in the study.

[c]The attrition of 23 persons between the second and third contacts was due, not only to the reasons noted in Footnote a, but also to the unavailability of information on the erosion factors for some of the farms. As with the first contact, data collection records do not permit a specification of the number of actual refusals.

with the farm operators were conducted by the Statistical Laboratory at Iowa State University. Information was obtained on the personal backgrounds of the respondents, their attitudinal orientations (e.g., agrarianism, environmentalism, risk preference, innovativeness, etc.), organizational affiliation, community orientation, and the perceptions and use of various soil, water, and energy conservation practices. A second contact, in the form of a telephone survey, was made in the summer of 1980. This survey focused on farm-firm characteristics, including size of the farm operation, legal organization (family farm, family corporation, etc.), ownership status, labor provision by family and/or others, farm decision making, and the personal acceptability of some conservation policies. Ten respondents were lost between the first and second wave of contacts because of refusals, residential mobility, and retirement from farming.

The third and fourth contacts were made with the respondents in March of 1981. These involved a personal interview and mail questionnaire, respectively. In an interview, the farmers were asked about: 1) their awareness, knowledge, and use of conservation practices, 2) the main causes of, and solutions for, their soil erosion problems, and 3) their contacts with soil conservation information sources. The third contact also served to provide information that made possible a calculation of the Universal Soil Loss Equation. A total of 153 farm operators were interviewed in the third contact. A mail questionnaire was left with the respondents at the time of the third interview. This instrument assessed attitudes about why soil erosion continues to be a problem, feelings about some general problems faced by farmers, and detailed information on general farm practices and machine use and ownership. A total of 141 persons returned the mail questionnaires.

Dissertation Format

The alternative dissertation format is used here. The dissertation consists of four interrelated papers, each of which explores an issue related to how socioeconomic or ecological factors affect the use of adoption of soil conservation practices.

Paper 1 examines the Cancian thesis as a challenge to the traditional findings of adoption-diffusion research on the relationship between socio-economic rank and innovation. Cancian argues that, while the overall relationship between rank and adoption is positive and linear, this relationship changes between early and later stages of adoption. This study tests for the overall relationship between socio-economic rank and farmers' adoption of soil conservation practices, as well as for the relationship at various adoption stages.

The second paper builds on the common indication of the literature that the relationship between socioeconomic rank and adoption is positive and linear. But, it notes that some studies have failed to confirm the positive linear relationship, and that those that have confirmed it have usually shown only moderate relationships. This study looks at how some alternative class measurements of socioeconomic rank may affect the predicted relationship between rank and adoption. In doing so, it evaluates the worth of rural class measures vis-a-vis traditional stratification measures in accounting for the adoption of soil conservation innovations.

Paper 3 identifies a diverse set of factors that are posited to influence farmers' adoption of agricultural innovations. Especially important among these have been the personal attributes of farmers, their attitudes, their use of information sources, and their farm-firm characteristics. It is further noted, however, that a prominent deficiency in the adoption-diffusion literature has been the failure to account for variations in physical and biological environments that affect farmers' decisions to adopt new technologies and farming practices. Using the perspective of environmental sociology, with its particular emphasis on the interactions of ecological and sociological factors, the relative explanatory power of ecological variables is assessed in respect to commonly studied socioeconomic variables for the adoption of soil conservation innovations.

The fourth, and final, paper identifies a fairly consistent amalgam of socioeconomic and social psychological variables that has been employed in the empirical literature on the adoption of soil conservation innovations. It is suggested that part of the reason for the poorly defined relationships utilizing these predictor variables has been the lack of background theory and model building. Adoption studies have generally been characterized by a purposive selection of potentially relevant variables, and the correlation analyses of these variables. In response to this deficiency, this paper uses a conceptually and statistically based causal model for explaining soil conservation innovations.

Overall, the four papers allow for a consideration of related topics and measures in the sociological study of soil erosion and conservation behavior. It is hoped that these studies will provide some answers, while perhaps raising a few more questions, as to how various social and institutional factors serve to facilitate, or impede, the adoption of soil conservation innovations.

SECTION I. CANCIAN'S UPPER-MIDDLE CLASS CONSERVATISM THESIS: APPLICATION TO A SOIL CONSERVATION INNOVATION[1]

Introduction

There is an extensive research literature on the role of social and psychological factors in the diffusion of new ideas, practices, and technologies (Rogers, 1982; Rogers and Shoemaker, 1971; Stofferahn and Korsching, 1980). One factor that is especially important in explaining the adoption of new farming practices is "socioeconomic rank." Such rank is commonly felt to be positively associated with innovative behavior. According to Rogers (1982:254): "It is assumed that individuals adopt innovations in direct proportion to their socioeconomic status; with each added unit of income, size, or other socioeconomic status dimension, an individual is expected to be more innovative."

However, there have been challenges to the assumption of a positive association of socioeconomic rank and adoption. Cancian (1967; 1972; 1979), for example, argues that, while the overall relationship between rank and adoption is

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[1]This study was part of a larger interdisciplinary study titled "Effect of Agricultural Land Use Practices on Stream Water Quality." The Project was funded through Environmental Protection Agency Grant R8 06 81 4110; Iowa Agricultural and Home Economics Experiment Station, Project #2364.

positive and linear, this relationship shifts between the early and later stages of adoption. Most notable, persons of "low-middle rank" are felt to be earlier adopters than those of "upper-middle rank." This is because those of the lower rank presumably gain more, or lose less, from early adoptions than do upper-middle rank persons (Cancian, 1967:913).

Theoretical Framework

The theoretical perspective in this study is drawn from Cancian (1967; 1972; 1979). His arguments direct a search for positive linear relationships, as well as alternative relationships, between rank and adoption. The key to this relationship is the time period, or stage, of adoption being considered.

The Cancian thesis

The "upper-middle class conservatism thesis" of Cancian has received much attention. It has been presented formally in three articles (Cancian, 1967; 1972; 1979), and has drawn thorough comment and criticism (Gartrell et al., 1973; Morrison, 1973; Morrison et al., 1976; Gartrell, 1977; Frey et al., 1979; Rogers, 1982; Gartrell and Gartrell, 1985). One result of the substantial airing of the Cancian thesis has been modifications of its original form. But, the core elements of the thesis have been retained and defended. It is these elements that are examined in this paper.

Cancian's upper-middle class conservatism thesis is drawn from a larger theoretical argument relating rank to risk-taking behavior (Cancian, 1967; Frey et al., 1979). Three assumptions are essential to this argument. First, is that persons prefer high rank over low rank in any stratification system. Derived from this is the second assumption that higher-ranked persons are more likely than lower-ranked persons to adopt innovations because they can better afford the financial costs, as well as survive uncertain outcomes. Third, and very important, it is assumed that the early adoption of new agricultural practices typically entails greater uncertainty about outcomes than does later adoption (Cancian, 1967; 1979).

A distinction is made in Cancian's theory between uncertainty and risk. Uncertainty obtains where probable outcomes are unspecifiable or random. Risk occurs where there is a measurable uncertainty, or where the probability of occurrence can be specified (Knight, 1971:20; Ashby, 1982). This distinction is critical in that early adoption is felt to be characterized by uncertainty because new innovations remain unproven in their payoff, compatibility, and/or adaptability. Later adoption, however, more often entails risk because of the availability of more information. As the number of farmers adopting an innovation increases over time, the conditions of uncertainty shift to conditions of calculable risk.

The inhibiting effect of rank A central argument in the Cancian thesis is that, under certain conditions, the higher the socioeconomic rank, the less one is likely to adopt an innovation. This is termed the inhibiting effect of rank, which works to produce a reversal of the otherwise linear relationship pattern of adoption with rank. In contrast to conventional arguments, for some innovations, persons of low-middle rank are predicted by Cancian to innovate at more rapid rates than persons of upper-middle rank, especially at the outset of the adoption process.

The idea of status-maintaining and status-striving behavior is helpful in understanding the inhibiting effects of rank. By rejecting innovations, persons can avoid changes in rank that may accrue from new adoptions. Such changes are presumed to be more disadvantageous to upper-middle, than to lower-middle, ranked persons. Due to the relative boundary impermeability between the upper-middle and upper ranks, vis-a-vis that between the lower-middle and upper-middle ranks, it is the lower-middle rank which, relatively speaking, is felt to have the most to gain through status-striving, innovative behavior. Conversely, the upper-middle rank has the least to lose through status-maintaining, noninnovative behavior. The result is a predicted "dip" in the adoption rate of middle-ranked persons during the initial stages of adoption.

<u>The curvilinear effect of rank</u> There are two reasons why Cancian is led to hypothesize a curvilinear, versus linear, relationship between rank and adoption. First, he sees a differential importance of facilitating and inhibiting effects of rank for various strata or classes. Second, he feels that these effects operate at different times, or stages, in the adoption process.

The argument of a curvilinear effect of rank on adoption is, as noted by Cancian, well addressed in Homan's chapter on "Status, Conformity, and Innovation" (Homans, 1961). Homans divides the rank continuum into several categories and stresses that the middle categories are different in behavior from those at polar ends of the continuum. Namely, there is a curvilinear relationship between rank and innovation, with the middle ranks reflecting the greatest degree of conservatism in their innovation behavior.

If the inclination to adopt innovations is viewed as a psychological weighting of what might be gained against what is to be lost, it is plausible that persons in the middle ranks won't operate from the same principles as those at the extremes of the rank continuum. This is because economic constraints have lesser significance in the middle ranks for innovation. They are neither so great that an innovation is impossible, nor so trivial that its adoption is irrelevant. It is, therefore, in these middle ranks that an inhibiting effect is most likely to occur (if it occurs), and it is these ranks that produce the predicted curvilinear pattern in the early stages of adoption.

A test of the curvilinear effect, as discussed by Cancian, requires that at least four social ranks be specified. The facilitating effect of rank is expected to be operative at the lowest and highest ranks, regardless of the time or period of adoption. The inhibiting effect is expected to be operative for the two middle ranks only in the initial stages of adoption.

Relationship of rank and adoption

Considerable study has tested for factors that affect innovativeness. From 869 studies reviewed by Rogers and Shoemaker (1971), three-fourths found generally positive associations of the status measures of education, social status, and farm-size with innovation (Gartrell, 1977:318). Studies conducted after Rogers and Shoemaker's extensive literature review largely support the conclusion of a positive relationship between social rank and adoption behavior, but there are important exceptions to this pattern.

Much of the substantiation of the conventional linearity thesis following Rogers and Shoemaker's (1971) summary assessment has been in the form of rebuttals to arguments by

Cancian. For example, Gartrell et al. (1973) replicated and extended Cancian's studies, but the results failed to support the curvilinear argument. On the contrary, the authors note that "...the relationship between income and innovation was explained more parsimoniously by a linear model" (Gartrell et al., 1973:408). In another test of Cancian theory, Gartrell (1977) found no evidence to support the contention of a nonlinear relationship between rank and adoption. In a recent and extensive reexamination of the functional form of the status-innovation relationship, the Gartrells (1985) found some support for a curvilinear relationship as predicted by Cancian, but their evidence led them to conclude that "....across studies and analyses, the status-innovation relationship appears to be linear, and Cancian's theory appears to have very small marginal utility in explaining innovation" (Gartrell and Gartrell, 1985:48).

Morrison et al. (1976), similarly, have replicated Cancian's studies, but found little support for his notion of an upper-middle rank conservatism. Analyzing data from a 1967 study of six Hindu Indian villages, their results showed, with few exceptions, monotonic, positive relationships between adoption and four indicators of social rank.

In a study that examined the effects of both social status and awareness of technology on the trial adoption of some new technologies, Gartrell and Gartrell (1979) found that both awareness and status were strongly related to these trial adoptions. Taken together, the independent variables explained over three-fifths of the variance in trial behavior.

Although most studies have found social rank to be related positively to the adoption of farm innovations, it is important to note that this literature generally has failed to comment on the strength of the revealed relationships. Even studies that have called the linearity argument into question (Cancian, 1967; 1972; 1976; 1979), have not typically addressed the level of relationships. Rather, studies have been cited as either supportive or nonsupportive of the linearity argument thesis without attention given to the magnitude of demonstrated relationships. When these relationships are noted, they usually are positive, but of modest strength.

For example, Gartrell et al. (1973) found moderate bivariate correlation coefficients (from .25 to .48) between four status indicators and the number of years having elapsed since adoption. Morrison et al. (1976) reported Pearsonian correlations of .23 between farm size and agricultural innovation, and .39 between income and innovation. Their highest correlation was .63 between a level of living index and agricultural innovation. Likewise, Gartrell (1977) obtained zero-order correlations between .28 and .55 for five status indicators and the trial adoption of innovations.

In sum, while most studies on the adoption and diffusion of innovations report positive relationships between measures of socioeconomic rank and the adoption of new technologies, some findings have failed to support this pattern (Cancian, 1972; 1976; 1979; Frey et al., 1979; Gartrell, 1977:318--footnote 2; Boyd, 1980). Given these exceptions, and the generally moderate strength of the rank-adoption relationships, it seems important that the generalization that "....earlier adopters have higher social status than later adopters" (Rogers, 1982:251) not be uncritically accepted. Rather, it seems appropriate to inquire into the factors, if any, that may modify or attenuate a positive linear relationship between social rank and adoption.

Problem

During the past decade, environmental problems have been recognized as having far-reaching social, economic, and political implications. One such problem is the loss of topsoil through erosion from cropland, and the concomitant pollution of streams and lakes with sediments, nutrients, and pesticides. Loss of soil is a cause for concern, but the loss of rich topsoil is of particular concern because of its fertility (Troeh, Hobbs, and Donahue, 1980:87).

Each year, over 2 billion tons of soil are eroded from nonfederal rural lands. Most of this loss is a result of water erosion (Bills and Heimlich, 1984). The estimated average annual sheet and rill erosion on all cropland in the coterminous United States is 4.7 tons/acre/year (t/a/y). The 1977 National Resource Inventory (NRI) found 94 million acres of cropland were losing in excess of the tolerance rate of 5 tons per acre annually (U.S. Department of Agriculture, 1981:2-3).[2] Given a continuation of these rates, it is projected that crop yields in the Corn Belt may be reduced 15 to 30 percent by the year 2030 (CAST, 1981). Furthermore, it has been projected that a failure to control soil erosion could result in a doubling of production costs for food and fiber in the next 50 years, even disregarding inflation and other factors. It is felt by some that the preservation of soil and water resources could well surpass energy as the major "crisis issue" before the end of this century (Orr, 1981).

A disturbing aspect of this problem is that soil erosion can be reduced to acceptable levels through the use of existing technologies and available knowledge (Nowak and

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[2]Tolerance rate, or T-value, refers to the maximum rate of soil erosion that will permit a high level of crop productivity to be maintained over an indefinite period of time. Although erosion rates in excess of 5 t/a/y are usually considered excessive, no single tolerance rate will apply to all soils.

Korsching, 1979). Conservation techniques, such as terracing, contouring, strip cropping, minimum tillage, and grass waterways, are but a few of the practices that are highly effective in reducing soil erosion. But, despite the availability of ameliorative programs at the national, state, and local levels, which often incorporate monetary incentives with technical assistance, many of the potentially effective conservation technologies have not been widely implemented.

The objective of this study is to test for the importance of socioeconomic rank in farmers' adoption of soil conservation practices. Given previous findings on this topic, a positive linear relationship is expected between social rank and adoption behavior. But, since a substantial number of studies have not confirmed this positive linear pattern, attention is also paid here, drawing upon Cancian, to some factors that may be modifying or attenuating the predicted relationship.

Hypotheses

Several hypotheses, as stated below, are tested in the study. The first is that of a positive relationship between rank and adoption. This is followed by a test of two of Cancian's hypotheses (Cancian, 1979:20).

> Hypothesis 1: There is an overall positive relationship between farmers' socioeconomic rank and their adoption of soil-conserving innovations.

Hypothesis 2: In the initial stage of farmers' adoptions of soil conserving innovations, low-middle ranked persons will have a higher adoption rate than higher-middle ranked persons (LM > HM).

Hypothesis 3: In a secondary stage of the adoption of soil-conserving innovations, the adoption rate of high-middle ranked persons will increase relative to the adoption rate of low-middle rank persons ($HM_2 - HM_1 > LM_2 - LM_1$).

Data and Procedures

Sample and data collection

This study was part of a larger interdisciplinary project that examined the effects of alternative agricultural land-use practices on stream water quality. In the sociological component of the study, three watersheds were selected in east-central Iowa on the basis of farmers having comparable socioeconomic characteristics and similar soil types, topographic patterns, climatic conditions, and crop production techniques.

The sample was a saturation sample. The intent was to cover all of the farmland in the three watersheds selected for inclusion in the study. A list of 303 households within the sample area was obtained through a directory service[3] and provided to interviewers before entering the field. Interviewers were instructed to go to the selected households and

[3]The directory service used was the TAM Service, published by the R. C. Booth Co., Harlan, Iowa.

to determine if a resident of the household farmed in the local watershed. If the operator of land adjacent to a farmstead did not live on the farmstead, inquiry was made regarding the name and location of this operator. Interviewers were instructed to locate and interview these operators if they lived within 20 miles. A total of 193 eligible respondents were identified and interviewed in the initial phase of the study (Table 1).

Four contacts were made with the respondents over a two-year period, 1980-1981. In the first contact, personal interviews with the farm operators were conducted by the Statistical Laboratory at Iowa State University. Information was obtained on the personal backgrounds of the respondents, their attitudinal orientations (e.g., agrarianism, environmentalism, risk preference, innovativeness, etc.), organizational affiliation, community orientation, and their perceptions and use of various soil, water, and energy conservation practices. A second contact, in the form of a telephone survey, occurred in the summer of 1980. This survey focused on farm-firm characteristics, including the size of the farm operation, legal organization (single family farm, family corporation, etc.), ownership status, labor provision by family or others, farm decision making, and the personal acceptability of some conservation policies. There was an attrition of ten respondents from the first to the second

Table 1. Summary of data collection procedures

Type of Contact	Date of Contact	N	Refusals	Other[a]
Personal interview	Feb.-Mar. 1980	193	---[b]	---
Telephone interview	August 1980	176	8	9
Personal interview	March 1981	153[c]	0	23
Mail interview	March 1981	141	12	0

[a]"Other" represents those who were not able to be contacted. They fall predominantly into the categories of persons who no longer farmed in the area or who had stopped farming altogether.

[b]The number of refusals from among those eligible to participate in the study was not available from records of the data collection procedure. It is known, however, that this number was small -- perhaps less than ten -- and that, overall, 71 percent of the land area in the three watersheds was operated by persons who participated in the study.

[c]The attrition of 23 persons between the second and third contacts was due, not only to the reasons noted in footnote a, but also to the unavailability of information on the erosion and quality of land factors for some of the farms. As with the first contact, data collection records do not allow for a specification of the number of actual refusals.

contact, attributable mainly to refusals, residential mobility, and retirement from farming.

The third and fourth contacts with respondents were made in March 1981. These involved a personal interview and a mail questionnaire. In the personal interview, the farmers were asked about: 1) their awareness, knowledge, and use of conservation practices, 2) the main causes of, and solutions for, their soil erosion problems, and 3) their contacts with soil conservation information sources. The third contact provided information necessary to calculate the Universal Soil Loss Equation (USLE) for their farms. A total of 153 farm operators were interviewed in the third contact. The mail questionnaire was left with the respondents at the time of this interview. This instrument solicited attitudes about why soil erosion continued to be a problem, feelings about some general problems faced by farmers, and detailed information on general farm practices. A total of 141 persons returned the mail questionnaires (Table 1).

Measures

The key variables in this study were socioeconomic rank and adoption. These were operationalized in accord with Cancian's argument (1967; 1972; 1979). Socioeconomic rank was measured by income, education, and size of farm. Adoption behavior was determined by the date of the first reported use of minimum tillage.

The three indicators of socioeconomic rank were measured as follows: First, average annual gross farm income was requested for the period 1977-1979. Categorized average annual gross farm incomes over the three-year period were used.[4] Second, educational attainment was measured by years of schooling completed. Third, the total acreage operated in 1979 was obtained by combining the acreage which respondents' owned and operated with that which they rented.

To meet Cancian's requirement that at least four socioeconomic ranks be considered, the status variables of income, education, and acres operated were each divided into quartiles, resulting in "low," "low-middle," "high-middle," and "high" status rankings. An additive index of socioeconomic rank was computed in which each of the three status variables was given a score of "1" for low rank, "2" for low-middle rank, "3" for high-middle rank, and "4" for high rank. This cumulative index had a range from 3-12. The reliability (Alpha coefficient) for the index was .58. The distributions and categorizations of the independent variables are presented in Table 2.

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[4]The categories for average gross farm income were: 1) none; 2) less than $5,000; 3) $5,000-9,999; 4) $10,000-19,999; 5) $20,000-29,999; 6) $30,000-39,999; 7) $40,000-49,999; 8) $50,000-99,999; 9) $100,000-149,000; 10) $150,000-199,999; 11) $200,000-299,999; 12) $300,000-399,999; and 13) over $400,000.

Table 2. Distributions and categorizations of the socio-economic status indicators

I Status Index				II Average Annual Farm Income			
Score	N[a]	Percent	Rank[b]	Dollars	N	Percent	Rank
3-5	47	28.8	L	Less than 49,999	51	27.8	L
6-7	52	31.9	LM	50,000-99,999	60	33.3	LM
8-9	36	22.1	HM	100,000-149,999	32	17.8	HM
10-12	28	17.2	H	More than 150,000	38	26.1	H
	163	100.0			181	100.0	

III Years of Education				IV Acres Operated			
Years	N	Percent	Rank	Acres	N	Percent	Rank
7-11	38	20.1	L	40-220	40	23.1	L
12	108	57.1	LM	221-350	45	26.0	LM
13-15	26	13.8	HM	351-550	45	26.0	HM
16-18	17	9.0	H	551-1740	43	24.9	H
	189	100.0			173	100.0	

[a]The total number of cases differs between variables due to a differing number of missing cases for the respective variable measures.

[b]The ranks are: L=low; LM=low-middle; HM=high-middle; and H=high.

The date of first reported use of minimum tillage was the dependent variable in the analysis. Minimum tillage was defined for respondents as a "form of tillage that retains protective amounts of residue mulch on the soil surface throughout the year." In order to guard against the reported use of minimum tillage that might not qualify as a conservation innovation by current standards, a constraint was introduced. In addition to identifying themselves as users of minimum tillage, the respondents also must have begun this use after 1964. The 1964 cut-off was selected since it represents the period in which minimum tillage was first promoted by soil conservation and extension personnel in the study area.

The distribution of the dependent variable, and its division into four stages according to the Cancian criteria (1979:63), is presented in Table 3. As shown in the table, the quartile of those first adopting this practice ranges from 9 to 15 years prior to the survey. This group is identified as the "Stage 1 adopters." "Stage 2 adopters" had been using minimum tillage from five to eight years. Of those remaining, one-fourth had adopted minimum tillage within the past four years and an additional one-fourth had not used minimum tillage by the time of the survey. In addition to examining the four stages of adoption, a

Table 3. Distribution and classification of the adoption of minimum tillage

Years Since Adoption	N	Percent	Stage Classification
9-15	41	22.2	I
5-8	49	26.4	II
1-4	53	28.7	Remainder of adopters
0	42	22.7	Nonadopters
	185	100.0	

Table 4. Bivariate correlations of the socioeconomic rank and adoption variables[a]

	x_1	x_2	x_3	x_4	y
Index of status (x_1)	1.00	.84	.46	.79	.30
Farm income (x_2)		1.00	.23	.64	.28
Education (x_3)			1.00	.07	.11
Acres operated (x_4)				1.00	.33
Adoption stage (y)					1.00

[a]These correlations were calculated for the quartiled rank and adoption scores.

dichotomy of adopters and nonadopters was used in some of the analysis.

Statistical analysis

Parsonian correlation coefficients are presented in testing the hypothesis of a positive relationship between status and adoption. Next, Cancian's two hypotheses are tested by replicating his procedures. This involves comparisons of the adoption rates of persons in the low-middle and upper-middle ranks for two stages of adoption. Finally, gamma is used as an ordinal level measure of association to test the relationship between adoption/nonadoption and socioeconomic rank, as well as between stages of adoption and socioeconomic rank.

Findings

The Pearsonian correlation coefficients for the variables included in the analysis are reported in Table 4. A moderately positive relationship (r=.30) is found between the status index and adoption stages. This result is consistent with the common finding of a positive association between rank and adoption. It should be noted that, of the variables comprising the status index, education is the least strongly associated with adoption (r=.11).

The two Cancian hypotheses were tested by comparing adoption rates of the four status groups (using the overall status index) at two stages in the adoption process. First, it was posited that in the initial stage of adoption (i.e., 1965-71) the adoption rate of low-middle ranked persons would exceed that of upper-middle ranked persons (LM > HM). This hypothesis (Hypothesis 2) was supported by the data (Figure 1). Twenty-two percent of the lower-middle rank persons had adopted minimum tillage in the first stage of adoption, as compared with 19 percent from the high-middle rank.

The second Cancian hypothesis (Hypothesis 3) is also supported. The difference in adoption rate between stages 1 and 2 for the high-middle rank exceeds the difference in the adoption rate between these same stages for the low-middle rank (50.0 > 24.5)[5] Thus, these data are consistent with the Cancian hypotheses.[6]

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[5]The second Cancian hypothesis was $HM_2 - HM_1 > LM_2 - LM_1$. From Figure 1, it may be seen that for the high-middle rank: 69.4 - 19.4 = 50; for the low-middle rank: 46.9 - 22.4 = 24.5.

[6]An additional criterion for consideration in the analysis was that all respondents had not been farming for the entire period in which minimum tillage was promoted. Consequently, a criticism could be raised regarding an unequal opportunity to adopt, based on years in farming. In order to guard against this, an analysis was performed that involved only those farmers who had been farming for at least 16 years -- the entire time period for which minimum tillage was promoted in the study area. Minor differences were found when comparing these results with those for the entire sample, and there were no changes in the conclusions. Because of this, and a substantially higher N, the test of the Cancian thesis reported here is based on the entire sample.

Figure 1. Levels of adoption of minimum tillage at two stages, by status rank

To further assess the rank-adoption relationship, while retaining the ordinal measurement of the status ranks and adoption stages, zero-order gammas[7] were calculated between stages of adoption and socioeconomic rank. This statistic was also calculated between a dichotomous adoption/non-adoption variable and socioeconomic rank. The adoption/non-adoption distinction is important in that most of the literature ignores the time, or degree, of adoption. The question is asked whether this omission affects the interpretation of results in light of the usual findings on the rank-adoption relationship.

As shown in Table 5, relationships between the status indicators and the dichotomous adoption/nonadoption variable are strong and positive, with the exception of education. When the stages of adoption are included, these gammas are reduced from the initial calculations, but the direction remains positive. A detailed presentation of the data used in calculating the gammas is reported in Tables 6 and 7. Comparison of the percentage figures in these tables reveals that nonadopters are disproportionately concentrated in the lower-status ranks, while adopters tend to be more concentrated in the middle and upper ranks. This is also true when adoption stages are examined, although some peculiarities

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[7]Gamma is an ordinal level of measure of association which indicates the probability of correctly guessing the order of a pair of cases on one variable given that their order on another variable is known (Nie et al., 1975:228).

Table 5. Zero-order gamma coefficients between socioeconomic rank and the adoption of minimum tillage

Socioeconomic Status Variable	Nonadoption/adoption	Four Adoption Stages[a]
Status index	.64	.34
Farm income	.63	.32
Education	.33	.14
Acres operated	.63	.37

[a]The adoption stages are described in Table 3.

Table 6. Adoption/nonadoption by status indicators

Socioeconomic Status Indicator	Adoption Classification	Status Rank (%)			
		L	LM	HM	H
Status index	Adoption	58.7	83.7	91.7	96.4
	Nonadoption	41.3	16.3	8.3	3.6
		100.0	100.0	100.0	100.0
Farm income	Adoption	53.0	82.2	93.8	92.1
	Nonadoption	47.0	17.8	6.2	7.9
		100.0	100.0	100.0	100.0
Education	Adoption	65.7	78.3	84.6	82.4
	Nonadoption	34.3	21.7	15.4	17.6
		100.0	100.0	100.0	100.0
Acres operated	Adoption	56.4	71.1	95.2	95.4
	Nonadoption	43.6	28.9	4.8	4.6
		100.0	100.0	100.0	100.0

Table 7. Stages of adoption by socioeconomic status indicators

Socioeconomic Status Indicator	Adoption Stage	Status Rank (%) L	LM	HM	H
Status index	I	19.5	22.4	19.4	25.0
	II	8.7	24.5	50.0	42.8
	III	30.4	36.7	22.2	28.5
	IV	41.3	16.3	8.3	3.6
		99.9	99.9	99.9	99.9
Farm income	I	16.3	26.8	31.2	18.4
	II	10.2	28.6	21.8	50.0
	III	26.5	26.8	40.6	23.7
	IV	46.9	17.8	6.2	7.9
		99.9	100.0	99.9	100.0
Education	I	25.7	20.7	11.5	35.3
	II	11.4	28.3	34.6	35.3
	III	28.6	29.2	38.5	11.7
	IV	34.3	21.7	15.4	17.6
		100.0	99.9	100.0	99.9
Acres operated	I	20.5	17.7	14.2	32.5
	II	12.8	20.0	40.5	39.5
	III	23.0	33.3	40.5	23.2
	IV	43.6	28.9	4.7	4.6
		99.9	99.9	99.9	99.9

emerge within and between the stages. The overall relationship is fairly stable for all the status indicators, and appears less pronounced only for the education variable.

Discussion

The often-reported finding that status and adoption are positively related is supported by these data. The bivariate relationships between the four status measures and time of adoption are all in the predicted direction, although they display correlations that are only moderate to weak in strength. The overall positive relationship between rank and adoption is more strongly supported when the dependent variable is divided into adoption and nonadoption categories. Adopters are most often found in the middle and upper status groups, whereas nonadopters tend to be concentrated in the lower status groups.

The Cancian thesis was examined here as representing a prominent challenge to the traditional findings of the adoption-diffusion literature on the relationship of rank and innovation. My testing of this thesis reveals several things. First, both of Cancian's hypotheses are technically supported by these data. This finding lends credence to the notion of a curvilinear relationship between socioeconomic rank and adoption when the time of adoption is introduced. Second, the substantive importance of the small percentage differences obtained in testing the Cancian thesis is called into question. Persons in the upper-middle ranks only slightly surpass those in the lower-middle ranks during the initial adoption period. Actually, there is a similar level of adoption at all four SES levels during the first adoption stage. Cancian, himself, did not test the statistical significance of any revealed differences. Rather, in applying his theory to a number of data sets, he indicated the binomial probability for finding the number of studies supporting, versus those not supporting, his theory. Third, the traditional linear relationship between status and adoption if found by the itme of the second adoption stage.

An important conclusion to be drawn from this present analysis is that, in failing to reject the Cancian thesis, the general theory relating rank to adoption is called into question. When taking into consideration the time factor, the general theory was not supported here for the earliest stage of adoption. Although evidence for an inhibiting effect in the form of a negative relationship between rank and adoption (as predicted by Cancian for the middle-rank groups) was not strong, the absence of a positive relationship (as predicted by the general theory) certainly is notable in the first stage of adoption. Only later, in the second stage, does the positive relationship emerge as predicted.

This study calls into question the idea that the facilitating effect of rank is the basis for a commonly reported positive linear relationship between socioeconomic rank and the adoption of agricultural innovations. Apparently the period of adoption can have a bearing on this relationship. Furthermore, the remarkably constant adoption rates for the different status ranks in the first adoption stage suggest a unique characteristic of early adopters relative to later adopters. The literature is replete with discussions of innovativeness factors that are believed to be important to adoption behavior. These factors, however, may be much more important at some periods of the adoption process than at others.

Further research is needed on the influence of various factors (e.g., personality factors, socioeconomic status characteristics, traits of the innovation, etc.) at distinct time periods in the adoption process. The Cancian thesis constitutes an important contribution to adoption-diffusion literature by suggesting that the relationship between socioeconomic status and adoption behavior need not necessarily be linear (Rogers, 1982:257).

SECTION II. A REEXAMINATION OF SOCIAL RANK IN THE ADOPTION OF SOIL CONSERVATION INNOVATIONS[1]

Introduction

A substantial amount of sociological research has been directed to identifying factors that explain the differential speed with which people adopt new ideas and technologies (Rogers and Shoemaker, 1971; Rogers, 1982; Stofferahn and Korsching, 1980; Basu et al., 1982; van Es, 1985). "Socioeconomic rank" has been a much-used variable in explaining these adoptions, and has usually been found to be positively associated with innovative behavior. According to Rogers (1982:254), "it is assumed that individuals adopt innovations in direct proportion to their socioeconomic status; with each added unit of income, size, or other socioeconomic status dimension, an individual is expected to be more innovative."

Socioeconomic rank usually is measured by income, farm size and amount of education. Analysis that uses these variables is referred to here as "stratification research."

A second tradition in the analysis of socioeconomic rank, but one that has found lesser application in

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[1]This study was part of a larger interdisciplinary study titled "Effect of Agricultural Land Use Practices on Stream Water Quality." The project was funded through Environmental Protection Agency Grant R9 06 81 4110; Iowa Agricultural and Home Economics Experiment Station, Project #2364.

explaining adoption behavior, is the Marxian concept of social class. A social class typically is seen as "an aggregate of individuals who occupy a broadly similar position in the scale of prestige..." (Kohn, 1969:10).[2] For Marx, the bases of class systems were people's relationships to the means of production. He saw social classes as "...aggregates of persons who perform the same function in the organization of production" (Coser, 1971:49). Research out of this tradition is referred to here as "class research."

A problem of practical importance in the study of adoption behavior involves the adoption of soil conservation innovations. Although soil erosion has long been recognized as having important ecological consequences, only recently has there been systematic inquiry into the social factors that affect erosion levels. A major reason is the growing concern both to farm and nonfarm populations (Harris, 1980; Clark et al., 1985) of the on-farm and off-farm impacts of excessive topsoil loss through erosion. In addition, there is growing recognition that solutions to erosion problems are not merely technological; social factors are also important to explaining both erosion and farmers' use of conservation practices. There is a need to better under-

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[2]This definition, cited by Kohn, is from Williams (1960:98).

stand why some farmers adopt, and others reject, needed soil conservation practices, and to apply this knowledge in the formulation of erosion-control programs.

Social class theory and analysis, with its emphasis on the form and degree of involvement with the means of production, seemingly has utility in explaining farmland soil erosion. While stratification variables have been widely used in the study of adoption of innovations (including soil conservation innovations), and have generally been found to be positively related to adoption, class variables have seldom been tested. Yet, it seems that indicators of the form of relationship to production (i.e., class variables) will relate differently to the use of conservation practices than will stratification measures.[3]

This study tests the importance for adoption of some infrequently used measures of socioeconomic rank; viz., class measures and planned change in operation size.[4] It

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[3]The term "class," as used here, has a social-psychological thrust which focuses on the individual as the unit of analysis, and seeks to understand how the relationship of persons to their social system is important to their behavior. This stands somewhat in contrast to most class analysis which is structural in nature; i.e., which is directed to the formation, characteristics, interactions, etc., of class groups as social collectives.

[4]Planned change in operation size holds seeming importance in explorations of the relative merit of class measures. Although it is not identified as a class variable, per se, its interaction effects with class measures are examined. Further discussion of this variable, and its relationship to class measures, is included in the variable description and measurement sections of the paper.

builds on the assumption that "social class" and "stratification" studies flow from very different perspectives. The primary objective is to compare the relative explanatory power of class measures versus stratification measures for explaining farmers' adoption behavior. The examination of class measures will hopefully allow for a better understanding of adoptive behavior by looking beyond the conventional stratification variables that have been used.

Theoretical Perspective

Relationship of socioeconomic rank and adoption

Three-fourths of the 869 studies cited by Rogers and Shoemaker (1971) that examined the association of education, social status, and operation size to innovation, produced positive relationships. More recent studies continue to demonstrate a positive relationship between these variables (Gartrell et al., 1973; Morrison, 1973; Gartrell, 1977; Gartrell and Gartrell, 1979; 1985). But some studies fail to confirm a positive linear association (Cancian, 1967; 1972; 1979). A key question concerns what effect alternative measurement of social rank has on understanding this relationship.

While both class and stratification analyses address many of the same issues, the two perspectives set forth distinct criteria as important to individual action. The stratification tradition emphasizes the degree to which certain status attributes are present, while the class tradition emphasizes actors' relationships to the means of production through control of the factors of production (i.e., land, labor and capital). It can be expected that the two perspectives, with their respective sets of indicators, will relate differently to adoption behavior.

<u>Social class and adoption</u>

Despite its past importance in sociological analysis, the concept of class has received little emphasis as a distinctive subject matter in the adoption literature. Although rural sociologists have analyzed social class at the conceptual level, there has been little attention paid to class factors that affect the actual behavior of farm operators. The result has been a paucity of research on the importance of social class in the rural sphere, especially in the use of neo-Marxist or similarly rooted class variables involving relationships to the means of production (Gillespie et al., 1979; Goss et al., 1979).

There are important exceptions to this pattern. A few studies have tested for social-rank correlates of innovation behavior (e.g., Harry et al., 1969; Devall, 1970; Buttel and Flinn, 1978). Additionally, several studies on the structure of agriculture have included variables similar to those commonly used in class studies (e.g., Rodefeld, 1978; Schertz, 1979). But, whereas this class-oriented research has frequently sought to describe farmer/farm-firm characteristics, or to document changes in size, organization, operation, and ownership of farming units, it has only infrequently addressed the effects of alternative class-based measures on farmers' behavior.

Neo-Marxist theory and class relations in agriculture

Mooney (1983) has summarized from Wright (1978) three basic neo-Marxian processes involved in the notion of human relationships to the means of production. These are: 1) control over the physical means of production; 2) control over labor power; and 3) control over investments and resource allocation. The capitalist class supplies the land and capital factors, but not its own labor. The proletariat, on the other hand, supplies the labor power, but not land or capital. The petty bourgeoisie falls into an intermediate position between these two classes. It is the most directly involved in the production process, in that it supplies all three production factors.

Mooney (1983) identifies five relationships in production that may be used to establish class membership. These are tenancy, indebtedness, off-farm work, contract production, and hired labor. These five class relations share certain traits, but they are not equivalent. Each represents a unique form of relationship to the means of production, and, consequently, its distinctiveness in sociological analysis should be retained.

The question arises as to how stratification measures are to be distinguished from class measures. Some commonly used variables (e.g., tenancy) could appear in either "theoretical camp," or in both. A key distinguishing point is that class measures, especially when used in concert, measure relationships to the means of production. The degree and type of total involvement in the production process is the key influence on behavior from a class perspective. The more directly and extensively one is involved in the production process, the more likely one could be expected to adopt conservation innovations. From a class perspective, this would be the petty bourgeoisie -- an interim class between the capitalists and proletariats.

Stratification measures, on the other hand, emphasize the degree to which status attributes are possessed. The stratification perspective stresses the linearity of the relationship between rank measures and adoption, based on the availability of economic resources for adoption. The absolute magnitude of the possession of certain resources is crucial for influencing behavior.[5]

Class variables in the present study

The class patterns in agriculture described by Mooney serve as a partial basis in this study for measurement of socioeconomic rank. Three of the factors mentioned by Mooney -- tenure, off-farm work, and hired labor -- are incorporated into the present analysis. Two factors -- contract production and indebtedness -- are not used because contract production was nonexistent in the study area and there was no satisfactory measure of indebtedness available from the survey instrument. In addition, three variables not specifically identified in neo-Marxist rural class analyses -- viz., acres owned, nonland capital ownership, and planned change in operation size -- are included.[6] A discussion of each of these class variables follows.

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[5]While the present study does not examine the form of the relationship between rank measures and adoption (stratification perspective vs. class), it does represent a preliminary attempt to employ variables that could be used in a class analysis that would be part of such a study. See Mooney (1983) for a development of a theoretical basis for a class analysis of agriculture. Note, however, the difficulty in such an analysis because of the contradictory combination of class locations in modern U.S. agriculture.

[6]Further explanation for the inclusion of these variables as class measures is given in the discussion of the separate class variables. Suffice it to say here that their inclusion is intended to supplement, rather than to supplant, the other class relationship measures.

Tenure The first indicator of class included in the study was tenure, or tenancy. Tenancy is the converse of land ownership; it refers to a relationship in which an exchange occurs between a direct producer and a landlord for the use of land. This exchange may be in the form of a crop share or cash rent arrangement. In either case, part of the earned income from the renter's agricultural product is lost in the form of a rent payment. The rent constitutes, in Marxian terms, a surplus value for the landlord. It is unearned income over and above what is necessary to produce a subsistence for the producer (Mandel, 1973).

A tenancy relationship places the renter outside the realm of simple commodity production. The tenant becomes subject to processes that reflect proletarianization. Major investment decisions involving land and buildings ordinarily continue to reside with the land owner, although most of the day-to-day decisions are made by the operator. A situation of contradictory class location for tenants exists, therefore, between simple commodity production and proletarian production.

Owner-operated acres This measures takes on special importance in assessing land resource control as an indicator of class where a relatively large proportion of land ownership involves a small number of total acres, or where a large number of owner-operated acres represents a small proportion of one's total operation. The question is asked, "In which case is greater control over the land resource evidenced?" For this reason, examining both tenure and total owner-operated acres is necessary for an accurate measurement of land resource control. Inasmuch as ownership represents greater control over land as a means of production, a larger number of owner-operated acres indicates a movement toward the petty bourgeoisie or capitalist classes, while a lesser number of owner-operated acres is identified with the proletariat class.

Off-farm work Interest in off-farm work as an indicator of class resides primarily in work that is engaged in for the purpose of maintaining a simple commodity production. This variable is identified by Steeves (1972) as the primary factor in proletarianization. To the extent that off-farm work is wage or salary labor, it indicates movement in the direction of proletarianization. By concluding that off-farm work involves proletarianization, it is assumed that there is an appropriation of surplus value in the sale of labor power, and that the farmer does not control the means of production in his off-farm work.

Off-farm work may, however, be entered into for a variety of reasons. It may be used to embellish income in order to assist in an expansionary phase of the farm operation; it may be engaged in as a result of special needs resulting from the family's life cycle position; or it may be used for bolstering the financial position of farmers who are experiencing declining returns. Off-farm work may be the means by which debt and tenancy are avoided, but only at the cost of selling labor elsewhere. In such a situation, off-farm work moves the farmer into a contradictory class location between petty bourgeoisie and proletariat (Mooney, 1983:573-75).

Hired labor For most Marxian analysis, hired labor is taken as the best single indicator of capitalist penetration into agriculture. The extraction of surplus value from producers who are hired laborers constitutes the transformation of simple commodity production into capitalist production. The hiring of labor most likely places one in a capitalist class position, but there is also the possibility of being placed into contradictory class positions. These may be in the form of a contradictory location between petty bourgeoisie and capitalist (e.g., the small employer), or a contradictory combination of contradictory class locations (termed "the new petty bourgeoisie" by Mooney, 1983:577). The latter are most likely to be persons engaged in an expansionary process who are debtors and tenants, but who also hire some labor.

Nonland capital ownership Another indicator of class is an index of machinery ownership. This variable has not previously been identified in neo-Marxist rural class analyses, but it measures an important capital factor of production. A higher proportion of machinery ownership suggests a location among the petty bourgeoisie or capitalist classes, while a low proportion of ownership points to proletarianization.

Planned change in operation size A variable that holds seeming importance in explorations of the relative merit of the class measures is planned change in operation size. It is to be expected, for example, that decisions about the use of hired labor or off-farm employment might be related to plans for expansion, constriction, or maintenance of extant acreage levels.[7] This is central to the situation experienced by the "new petty bourgeoisie," as described by Mooney (1983). In an expansionary phase, there is often engagement in debt or rent, as well as the possible hiring of additional labor. The farmer, in such a situation, fits none of the pure class locations. He moves nearer to capitalist production on the basis of land resource control and hired labor, but at the same time approaches proletarinization on the basis of rent and debt. Although planned change in operation size is not articulated in this analysis as a class variable, per se, because of its potential

[7] I am indebted to a member of my thesis review committee for bringing this possibility to my attention.

bearing on class, the interaction effects between the class measures and planned change are examined along with the main effects.

Hypotheses

In examining the explanatory utility of class versus stratification indicators of rank in adoption research, several general hypotheses are examined. It is hypothesized that: 1) stratification and class measures will each be related to farmers' adoption of soil conservation innovations, 2) inclusion of class measures contributes significantly to the overall explanation of conservation behavior, even after controlling for stratification measures, and 3) planned change in operation size, and its interaction with class measures, affects adoption behavior.

Procedures and Data

Sample and data collection[8]

To test the hypotheses, data were obtained from farmers in three watersheds in east-central Iowa. A saturation sample was used. A list of 303 rural households within the three watersheds was obtained through a directory service[9]

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[8]A more complete description of the sampling and data collection procedures is found in Nowak et al. (1983).

[9]The directory service used was the TAM Service, published by the R. C. Booth Co., Harlan, Iowa.

and was provided to interviewers before they entered the field. The interviewers were instructed to go to the households and to determine if they had a resident who farmed in the local watershed. If so, they were to complete an interview. If the operator of land adjacent to the farmstead did not live on the farmstead, inquiry was made as to the name and location of the operator. Interviewers were instructed to locate and interview all eligible persons if they lived within 20 miles of the study site. A total of 193 respondents were included in the first wave of the study. Table 1 summarizes information on the data collection.

Four contacts were made with these respondents over a two-year period, 1980-81. In the first contact, personal interviews with the farm operators were conducted by the Statistical Laboratory at Iowa State University. Information was obtained on the personal backgrounds of the respondents, their attitudinal orientations, and their perceptions and use of selected soil, water, and energy conservation practices. A second contact, by telephone, was made in the summer of 1980. It focused on farm-firm characteristics, including size of the farm operation, legal organization (single family farm, family corporation, etc.), ownership status, labor provision by family or others, farm decision making, and the personal acceptability of some

Table 1. Summary of data collection procedures

Type of contact	Date of contact	No.	Refusals	Others[a]
Personal interview	Feb.-Mar. 1980	193	----[b]	----
Telephone interview	August 1980	176	8	9
Personal interview	March 1981	153[c]	0	23
Mail questionnaire	March 1981	141	12	0

[a]"Other" represents those who were not able to be contacted. They fall predominantly into the categories of persons who no longer farmed in the area, or who had stopped farming altogether.

[b]The number of refusals from among those eligible to participate in the study was not available from records of the data collection procedure. It is known, however, that this number was small -- perhaps less than ten -- and that, overall, 71 percent of the land area in the three watersheds was operated by persons who participated in the study.

[c]The attrition of 23 persons between the second and third contacts was due not only to the reasons in footnote a, but also to the unavailability of information on the erosion factors for some of the farms. As with the first contact, data collection records do not allow for a specification of the number of actual refusals.

conservation policies. There was an attrition of 17 respondents from the first to the second contacts, due largely to refusals, residential mobility, and retirement from farming.

The third and fourth contacts with the respondents were made in March of 1981. These involved a personal interview and a mail questionnaire, respectively. In the personal interviews, the farmers were asked about: 1) their awareness, knowledge, and use of conservation practices, 2) the main causes of, and solutions to, their soil erosion problems, and 3) their contracts with soil conservation information sources. The third contact also provided information that made possible a calculation of the Universal Soil Loss Equation (USLE). A total of 153 farm operators were interviewed in the third contact.

A mail questionnaire was left with the respondents at the time of the third interview. This instrument assessed selected attitudes about why soil erosion continued to be a problem, feelings about some general problems faced by farmers, and detailed information on general farm practices. A total of 141 persons returned the questionnaire.

Measures

Dependent variables Three dependent variables were used in the analysis as indicators of conservation practice use. First, the number of years, if any, that the respondents had been using minimum tillage was ascertained. Minimum tillage is a widely recognized conservation practice today and may be used under a variety of physical resource conditions. It was defined for the respondents as "a form of tillage that retains protective amounts of residue mulch on the soil surface throughout the year."

A second adoption measure involved assigning respondents a score (from 0-5) that reflected their use, or nonuse, of five conservation practices. These practices were contour planting, strip cropping, minimum tillage, sod waterways, and filter strips.

A third dependent variable was the amount of mulch, expressed in pounds per acre, left on the soil surface at spring planting. The measure was calculated from crop and tillage information obtained for another purpose -- the calculation of the universal soil loss equation. This information included the type of crop, the tillage implements used, the number of passes made over the fields, and the application of conservation practices.

The three measures assess conservation behavior, but are not equivalent. The number of years since adoption of minimum tillage measures the earliness of adoption. The index of conservation practices looks at the number of conservation practices adopted from among a range of alternative practices. Finally, pounds of crop residue is a measure of intensity, or degree, of adoption. Relationships between the three dependent variables were small, but positive. The Pearsonian correlation coefficients of minimum tillage adoption with the conservation practice index and pounds of crop residue were .15 and .09, respectively. The correlation between the conservation practice index and pounds of crop residue was .22.

Independent variables Five variables were used to measure class, and three variables measured stratification dimensions. Also, the interaction of the class variables with planned change in operation size was ascertained.

The first class-based measure was tenure status, which is the proportion of owned land that comprises all the land being farmed. This was calculated by determining the number of owner-operated acres in 1980, combining this figure with the number of acres rented out, and dividing by the total number of operated acres. Scores ranged between zero and 100 percent, with a mean of 45 percent, and median of 40 percent. One-third of the respondents owned 90 percent or more of the land they operated.

Second, respondents were asked to provide the total number of owner-operated acres farmed in 1980. Responses ranged between 0 and 1500 acres, with a mean of 195 and a median of 160 acres. The total number of owner-operated acres was moderately correlated with tenure (r = .58).

Third, off-farm work was measured by asking respondents how many days, if any, they had worked off the farm for pay in the previous year. Seventy-five percent were not employed off the farm. The mean number of off-farm work days was 26, with a median of 17 days. Due to the skewed distribution, the natural log of the off-farm work variable was used in the analysis.[10]

Fourth, hired labor was the number of days of full-time, part-time, and occasional labor used in the farming operation in the year preceding the survey. Forty-four percent of the respondents had not used hired labor. The mean number of days of hired labor was 52, and the median was 1.9 days. As with the off-farm work variable, the skewedness of the distribution required a natural log transformation.

Fifth, nonland capital ownership was measured as the proportion of machinery owned from an index of machinery that was used in the farming operation. Twenty-nine percent of the respondents owned none of their machinery, while 55 percent owned all of it. The mean percent of capital ownership was 66, and the median was 99.

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[10]Before taking the natural log, the value of "1" was added to each of the values for off-farm work in order to avoid the problem of there being no natural log of zero.

Planned change in acres operated was measured by asking respondents if, during the three years following the survey, they planned to increase, decrease, or keep the same amount of land in their farming operations. Persons intending to maintain or decrease their operation size were assigned a score of -1. Those planning an increase were given a score of 1. The interaction of class measures with planned change was computed through multiplication of the class measures by the planned change score.

In addition to these class measures, the conventional stratification indicators of income, education, and acres operated were included in the analysis. Income was the average annual gross farm income for the period 1977-79. Formal educational attainment was the years of schooling completed. Total acreage was the sum of owner-operated and rented acres.

Specific hypotheses

The hypotheses being tested, organized into independent variables sets, are as follows:

Stratification variables

H_1a: The stratification measures of income, education, and total acres operated explain a significant proportion of the variance in the number of years since adoption of minimum tillage.

H_1b: The stratification measures explain a significant proportion of the variance in the number of conservation practices used.

H_1b: The stratification measures explain a significant proportion of the variance in the pounds of crop residue.

<u>Class variables</u>

H_2a: The class measures of tenure, owner-operated acres, off-farm work, hired labor, and non-land capital ownership explain a significant proportion of the variance in the number of years since adoption of minimum tillage.

H_2b: The class measures explain a significant proportion of the variance in the number of conservation practices used.

H_2c: The class measures explain a significant proportion of the variance in the pounds of crop residue.

<u>Class variables, controlling for stratification variables</u>

H_3a: The class measures explain a significant proportion of the variance in the number of years since adoption of minimum tillage, after controlling for the stratification measures.

H_3b: The class measures explain a significant proportion of the variance in the number of conservation practices used, after controlling for the stratification measures.

H_3c: The class measures explain a significant proportion of the variance in pounds of crop residue, after controlling for the stratification measures.

<u>Planned change, controlling for stratification and class variables</u>

H_4a: Planned change in operation size explains a significant proportion of the variance in the years since adoption of minimum tillage, after controlling for the stratification and class measures.

H_4b: Planned change in operation size explains a significant proportion of the variance in the number of conservation practices used, after controlling for the stratification and class measures.

H_4c: Planned change in operation size explains a significant proportion of the variance in the pounds of crop residue, after controlling for the stratification and class measures.

Interaction of planned change with class variables, controlling for stratification, class and planned change variables

H_5a: The interaction of planned change in operation size with class measures explains a significant proportion of the variance in the years since adoption of minimum tillage, after controlling for the stratification, class, and planned change measures.

H_3b: The interaction of planned change in operation size with class measures explains a significant proportion of the variance in the number of conservation practices used, after controlling for the stratification, class, and planned change measures.

H_5c: The interaction of planned change in operation size with class measures explains a significant proportion of the variance in pounds of crop residue, after controlling for the stratification, class, and planned change measures.

Statistical analysis and models

Analysis   Parsonian correlations are used to measure the relationships of the class and stratification variables to adoption behavior. Multiple regression is used to assess the collective relationships of the independent variable sets with each of three dependent variables. A test for the significance of change in R^2 is used to compare the effects of introducing control procedures as suggested by the third, fourth, and fifth sets of hypotheses. Finally, in cases where there is a significant change in R^2 between models, multiple regression is used to examine which indicators of socioeconomic rank are contributing to the explanation of variance in the dependent variables.

<u>Models</u> There are five statistical models utilized in the analysis. These models are presented in Table 2. Model 1 states that conservation behavior (Y) is a function of the stratification measures plus an error term. Similarly, Model 2 presents the conservation measures as a function of class variables plus an error term. These models correspond with Hypotheses 1 and 2, respectively. Model 3 states that conservation behavior is a function of stratification and class measures, in addition to the error term. By comparing Models 3 and 1, the effect of class is examined after controlling for the stratification measures. This is a test of Hypothesis 3. Model 4 introduces planned change in operation size as a covariate with stratification and class measures. Model 5 incorporates the interaction of planned change with class measures, after controlling for the unique contributions of stratification, class, and planned change. Comparisons involving Models 4 and 5 allow for a testing of Hypotheses 4 and 5, respectively.

Table 2. Statistical models relating the adoption of conservation practices with stratification measures, class measures, planned change in operation size, and the interaction effects of planned change with class measures

Model	Functional expression
1	Y = f(STRAT, E)
2	Y = f(CLASS, E)
3	Y = f(STRAT, CLASS, E)
4	Y = f(STRAT, CLASS, PLANCHANG, E)
5	Y = f(STRAT, CLASS, PLANCHANG, CLASSINT, E)

Where:

Y = dependent variable of years since first use of minimum tillage, number of conservation practices used, or pounds of crop residue;

f( ) = Y as a function of the independent variable set(s);

STRAT = stratification variables of annual gross farm income, years of education, and total acreage operated;

CLASS = class measures of tenure, total owner-operated acres, off-farm work, hired labor, and nonland capital ownership index;

PLANCHANG = plans to increase, decrease, or remain the same in acres operated;

CLASSINT = interaction of PLANCHANG and CLASS measures; and,

E = error term.

Findings

As a preliminary step in analyzing the data, bivariate correlations were calculated for the indicators of socio-economic rank and planned change variables with the adoption measures. These correlations are reported in Table 3. Relatively few of these correlations were statistically significant.

No correlations were significant when the number of years since adoption of minimum tillage use was examined. But four relationships were significant for the conservation practice index -- gross farm income, total owner-operated acres, total acres owned, and days of hired labor. With pounds of crop residue as the adoption measure, significant relationships were obtained for four variables -- viz., gross farm income, years of education, total acres operated, and tenure.

The second step in the analysis involved testing Hypotheses 1 and 2 with regression analysis. These results are shown in the F-values for Models 1 and 2 (Tables 4 through 6). Unexpectedly, a significant proportion of the variance in the dependent variables was not explained by either the stratification variables (Model 1) or the class variables (Model 2). At best, 6 percent of the variance in pounds of crop residue was accounted for by the class variables. Summary data for the other models are also

Table 3. Bivariate correlations between indicators of socioeconomic rank and adoption measures

Socioeconomic rank indicators	Adoption measures: Years since first use of minimum tillage	Conservation practice index	Pounds of residue
Stratification measures			
Gross farm income	-.005	.155*[a]	.150*
Years of education	.067	.025	.168*
Total acres operated	.038	.179**	.178**
Class measures			
Tenure	.068	.073	.193**
Total owner-operated acres	-.023	.180**	.066
Days of off-farm work[b]	.069	-.044	-.124
Days of hired labor[b]	-.141	.181**	.087
Proportion of machinery owned	.029	.053	-.049
Planned change in operation size[c]	.058	.073	.084
Interaction of planned change in operation size with class measure[c]			
Tenure	-.007	.051	.027
Total owner-operated acres	.003	-.006	-.094
Days of off-farm work	-.072	.006	.031
Days of hired labor	.112	-.005	-.046
Proportion of machinery owned	-.021	.033	.088

[a]Probability levels: $*p \leq .05$, $**p \leq .01$, $***p \leq .001$.

[b]Due to the skewed distribution of these variables, a natural log transformation was used in calculating the correlation coefficients.

[c]Although these are not socioeconomic rank indicators, per se, their potential influence on class measures was considered important. Consequently, they are included in the table.

presented in Tables 4 through 6. Only in the case of pounds of crop residue, for Model 5, was there a significant overall F-value.

Hypothesis 3 was tested by comparing Model 3 with Model 1. It was predicted that the class variables would contribute significantly to the explained variance in the adoption measures after controlling for the stratification measures. This argument was not supported. As shown in Tables 7 through 9, a test for change in R^2 between models 3 and 1 failed to reveal a significant R^2 change for any of the dependent variables.

While the findings for the effects of stratification and class variables were not encouraging, the possibility that change in operation size, and its interaction with the class variables, would have a bearing on the adoption measures was examined. The results of the model comparisons for testing Hypotheses 4 and 5 are summarized in Tables 7 through 9. There was a significant change in R^2 between models for only one case. With pounds of crop residue as the dependent variable, the interaction of planned change in operation size with class measures was significant after controlling for the stratification, class, and planned change measures (comparison of Models 5 and 4). But, even for the full model in this case (Model 5), only 20 percent

Table 4. ANOVA table for years since adoption of minimum tillage regressed on stratification measures, class measures, planned change in operation size, and the interaction effects of class measures with planned change

Model	Source	df	SS	MS	F	Signif. of F	R^2
1[a]	Regression	3	15.37	5.12	.20	.89	.005
	Residual	116	2874.80	24.78			
2[b]	Regression	5	124.60	24.92	1.02	.40	.043
	Residual	114	2765.56	24.25			
3	Regression	8	139.62	17.45	.70	.68	.048
	Residual	111	2750.55	24.77			
4	Regression	9	149.14	16.57	.66	.73	.051
	Residual	110	2741.02	24.91			
5	Regression	14	218.20	15.58	.61	.84	.075
	Residual	105	2671.97	25.44			

[a]This is a test of Hypothesis 1a.

[b]This is a test of Hypothesis 2a.

Table 5. ANOVA table for number of conservation practices regressed on stratification measures, class measures, planned change in operation size, and the interaction effects of class measures with planned change

Model	Source	df	SS	MS	F	Signif. of F	R^2
1[a]	Regression	3	7.59	2.53	1.72	.16	.034
	Residual	143	210.22	1.47			
2[b]	Regression	5	10.27	2.05	1.39	.22	.047
	Residual	141	207.55	1.47			
3	Regression	8	10.75	1.34	.89	.52	.049
	Residual	138	207.06	1.50			
4	Regression	9	11.50	1.27	.84	.57	.052
	Residual	137	206.32	1.50			
5	Regression	14	15.01	1.07	.69	.77	.068
	Residual	132	202.81	1.53			

[a]This is a test of Hypothesis 1b.

[b]This is a test of Hypothesis 2b.

Table 6. ANOVA table for pounds of crop residue regressed on stratification measures, class measures, planned change in operation size, and the interaction effects of class measures with planned change

Model	Source	df	SS	MS	F	Signif. of F	R^2
1[a]	Regression	3	2635023.42	878341.14	1.89	.13	.046
	Residual	118	54611511.68	462809.42			
2[b]	Regression	5	3310567.22	662113.44	1.42	.22	.057
	Residual	116	53935967.87	464965.24			
3	Regression	8	5264854.09	658106.76	1.43	.19	.091
	Residual	113	51981681.01	460014.87			
4	Regression	9	5528794.89	614310.54	1.33	.22	.096
	Residual	112	51717740.20	461765.53			
5	Regression	14	11371903.66	812278.83	1.89	.03	.148
	Residual	107	45874631.44	428734.87			

[a]This is a test of Hypothesis 1c.

[b]This is a test of Hypothesis 2c.

Table 7. Summary of model comparisons and testing of Hypotheses 3-5, with years since adoption of minimum tillage as the dependent variable

Models compared	Hypotheses tested	R^2 change	F	Significance of F
3-1	H_3	.042	1.002	.419
4-3	H_4	.003	.382	.537
5-4	H_5	.006	.542	.743

Table 8. Summary of model comparisons and testing of Hypotheses 3-5, with the number of conservation practices used as the dependent variable

Models compared	Hypotheses tested	R^2 change	F	Significance of F
3-1	H_3	.014	.421	.833
4-3	H_4	.003	.494	.482
5-4	H_5	.016	.457	.807

Table 9. Summary of model comparisons and testing of Hypotheses 3-5, with pounds of crop residue as the dependent variable

Models compared	Hypotheses tested	R^2 change	F	Significance of F
3-1	H_3	.045	1.143	.341
4-3	H_4	.004	.571	.451
5-4	H_5	.102	2.725	.023

of the variance was explained by the 14 independent variables.

As a final step in the data analysis, the significant relationship between pounds of crop residue and the interaction of planned change in operation size with class measures was examined to see which of the class indicators, if any, was contributing significantly to the overall relationships. Only one class indicator -- tenure, and its interaction effect with planned change -- proved to be contributing significantly. A plot of the interaction effect of tenure with planned change is displayed in Figure 1. The figure shows a positive relationship between tenure and crop residue when there is a planned increase in operation size. When there are plans to decrease or to remain the same in operation size, however, the relationship is slightly negative.

Summary and Conclusions

There are several items of interest among these findings. First, from the correlational analysis, the number of years since adoption of minimum tillage was not found to be related to any of the indicators of socio-economic rank. This was unexpected in light of the substantial emphasis that adoption and diffusion studies have placed on speed of adoption as a dependent variable (Rogers

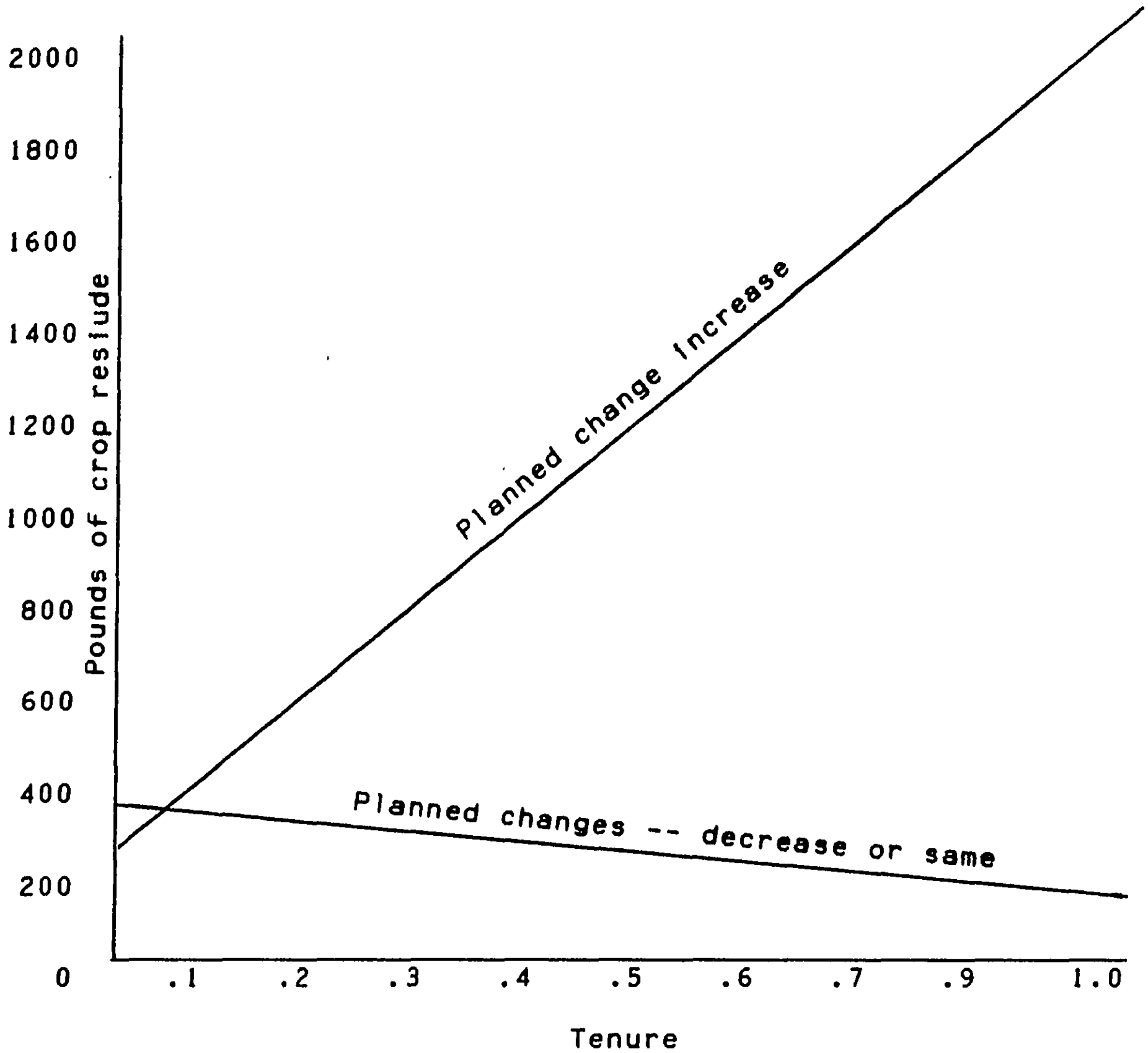

Figure 1. Plot of significant interaction effect between tenure, pounds of crop residue, and planned change in operation size

and Shoemaker, 1971:128-31; Rogers, 1982:251ff.). The reason for this finding is not entirely clear, but minimum tillage is a broadly defined conservation practice. As such, the variability of minimum tillage is small. Seventy-eight percent of the respondents said they used some form of minimum tillage. This large number of adopters might have contributed to the lack of observed relationships involving the minimum tillage variable. In addition, conservation innovations have been described (van Es, 1982; Lovejoy and Parent, 1982) as having qualities which distinguish them from traditional commercial innovations. This difference could result in the lack of consistency of these findings with relationships previously identified for commercial adoptions.

Second, the statistically significant correlations were evenly distributed between these class and stratification measures. This shows some distinctiveness for class measures, and would suggest merit in investigating the class measures' relationships to adoption of conservation practices beyond the level of correlation analysis.

The results from the hypothesis testing utilizing regression analysis were surprising, too, in that, with one exception, no relationships were demonstrated between rank and adoption measures. Reiterating several possible reasons for this from the discussion of the findings for the correlational analysis, the uniqueness of conservation innovations vis-a-vis traditional commercial innovations, and their moderate relationships previously identified in the literature, suggest that conservation innovations might not be expected to be related to socioeconomic rank in the same manner as commercial innovations, or might not be related to any appreciable degree.

A second possible reason for a lack of significant findings from the hypothesis testing could be attributable to the measures themselves. While both the dependent and independent variables were rigorously operationalized, there is always the possibility that this measurement was masking relationships that might have been discerned with alternative operationalization of the variables.

A third possible explanation for the lack of significant relationships between rank and adoption, which could not be explored here, was that environmental variables may render socioeconomic variables relatively unimportant in explaining adoption of soil conservation practices. This is essentially the conclusion of a recent SCS report that singles out physical factors as being of primary importance in explaining conservation practice use (Bills and Heimlich, 1984).

Finally, it is noteworthy that when pounds of crop residue is the dependent variable, the interaction effect of planned change in operational size with class variables is significant after controlling for stratification, class, and the planned change variables. This suggests that it is not solely class variables, and relationships to the means of production, that influence adoption behavior. It is also important to consider the interrelationship of class variables with other factors (such as planned change in operation size). Social class measures may take on different meanings when they are interpreted in light of planning goals. Especially, as shown here, owners leave more residue than renters when there are plans to increase operation size. When there are no such plans, few distinctions occur between owners and renters with regard to crop residue.

Interpretation of this latter finding is not immediately obvious. One explanation is that farmers owning larger proportions of their land, and who are planning expansion, are likely to leave more residue because of concern with the quality of land over which they have a direct ownership investment. The need for land resource preservation may be sensitized by plans for expanding that resource. When there are no plans for expansion, the idea of reducing soil loss through increased residue cover may not be prominent in decision making because of the notion that current levels of residue cover are serving adequately. In the absence of an outside stimulus for change in the pattern of operation, there may not be a stimulus for change in conservation behavior.

Another explanation of the finding may involve time, money, and labor savings often thought to be associated with leaving more residue on the fields. As a means of recognizing savings, plans for enlarged operation size could make an increased residue cover especially attractive to persons having a large ownership investment. This explanation, as well as the former one, are speculative and further research is needed on the role of tenure, conservation behavior, social rank, and plans for expansion.

Overall, the findings suggest that, for the respondents studied here, neither traditional stratification measures or class-based measures are important explanators of soil conservation behavior. Perhaps other types of variables better account for the adoption of conservation innovations than do these socioeconomic variables, for example, physical environmental factors and perceptions of the innovations. Or perhaps, as suggested in the analysis, rank variables are acting in concert with other sets of variables rather than uniquely.

SECTION III. THE ROLE OF ECOLOGICAL FACTORS IN FARMERS' ADOPTIONS OF SOIL-CONSERVING INNOVATIONS

Introduction

A diverse set of factors that are posited to influence farmers' adoption of agricultural innovations have received substantial study (Rogers and Shoemaker, 1971; Rogers, 1982). Especially prominent as explanatory variables for adoption have been the personal attributes of farmers, their attitudes, their uses of information sources, and their farm-firm characteristics. But, the role of environmental or ecological factors, in farmers' adoption, has received little attention -- much to the lament of some writers (Dunlap and Martin, 1983; Ashby, 1983; Hooks et al., 1983).

Because of the often close linkage of ecological and sociological complexes[1] in rural settings, agriculturally-related topics are especially appropriate for examining the potential interactions of ecological and sociological factors in affecting adoption behavior. This is precisely the thrust of environmental sociology literature, which serves as the

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[1]The ecological complex is a conceptual device developed by Duncan (1959:683) for viewing the interaction of human populations with their environments. Its four constituent elements are population, organization, technology, and environment. The first three of these are essentially social variables, and have been viewed as comprising a social complex that is analytically distinct from environment. It is therefore appropriate to think of environmental sociology as looking at the relationship between the social complex and the physical environment (Dunlap and Catton, 1979:66).

perspective for this study (Dunlap and Martin, 1983; Perez, 1979; Wohlwill, 1983).

Theoretical Framework

The perspective of environmental sociology

A core argument in environmental sociology addresses the interactions of environment and society (Catton and Dunlap, 1978; Dunlap, 1982). Environmental sociology recognizes that natural physical environments influence and, in turn, are influenced by social environments. Environmental sociology focuses on relationships between the physical environment and other elements of the ecological complex. The physical environment is seen as being both a cause and a consequence of human behavior (Dunlap and Catton, 1979:14; O'Riordan and d'Arge, 1979:65-66).

From a sociological perspective, ecological variables are not perceived as singular determinants of behavior, but rather as initiating or interacting with other, more conventional, sociological variables (Lewthwaithe, 1966). Ecological variables supplement, but do not supplant, these social variables (Dunlap and Martin, 1983:216). Physical factors may motivate and affect decisions to adopt or not adopt by setting the objective conditions against which specific practices or behaviors are evaluated. As such, they help to establish the objective need for adoption, but they obviously do not dictate whether or not adoption takes place. The adoption decision is a complicated process, with decision-making being mediated by many social and psychological factors.

Limitations of traditional adoption-diffusion studies

An identified deficiency in the adoption-diffusion literature has been the failure to account for variations in physical and biological environments that affect farmers' decisions to adopt new technologies and farming practices. These variations have typically been ignored in adoption research[2] (Ashby, 1982:232-35; Saint and Coward, 1977: 733-34).

Support for the inclusion of ecological variables in adoption studies comes from numerous sources (Perez, 1979; Gilles, 1980; Ashby and Coward, 1980; Ashby, 1983; Dunlap and Martin, 1983; Albrecht et al., 1983; Nofz, 1983; Padgitt et al., 1984). Common to these studies is an "agro-ecosystem perspective" which links the physical environment, the crop, the crop producer, and the crop-producing community. From an agro-ecosystem perspective, natural processes and social

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[2]The predominant assumption here has been that technologies are equally adoptable among farming units; that is, they are equally needed. This notion fails to address the question of ecological suitability. The ecological suitability of an innovation takes into account not only the consistency of the innovation with the norms, values, experiences, and needs of the adopting unit, but also its consistency with the ecological environment into which it is adopted.

processes are intertwined (Saint and Coward, 1977:735). The adoption of innovations is to be examined, not only in the context of social system variables, such as norms, values, and cultural beliefs, but also considering such physical variables as climate, topography, and soil conditions (Dunlap and Martin, 1983:215; Padgitt et al., 1984). Both physical and social aspects of agricultural production are viewed as comprising a common singular system (Saint and Coward, 1977:735).

The agro-ecosystem perspective suggests that the natural features of agriculture may prove as influential as the personal attributes of farmers and farm-firm characteristics in explaining the adoption of conservation practices. Ashby (1982), for example, found very different rates of adoption for high yielding varieties of rice and maize across three different climatic zones in Nepal. These differences were not explained by regional differences in awareness of new varieties (there was high awareness, even in low adoption areas), but rather were attributable to the expected performance of the varieties under the temperature, rainfall, and soil moisture conditions of the respective "micro-climates" of the three elevation levels.

Similarly, Albrecht et al. (1983) examined the interdependence of location-specific environmental factors with personal and farm-firm characteristics in studying the adoption of a new irrigation technology in the Texas High Plains. The conclusion was reached that ecological factors were of importance in explaining adoption. One attribute of the physical environment in particular -- the reported depth of aquifers under respondents' farms -- held more importance than many of the social variables that were used to explain adoption behavior (e.g., age, education, years in farming, and gross farm income).

In the same vein, Oldenstadt et al. (1982:904) have noted that the value of conservation tillage varies between geographic areas, depending upon the environmental characteristics of these areas. Tillage practices which worked well in one area were not necessarily suitable for other areas because of differences in weeds, insects, precipitation, and the like.

Padgitt et al. (1984) have studied the relative contribution of operator characteristics, farm-firm characteristics, attitudes toward erosion and conservation, and soil erosion potential in explaining the adoption of conservation tillage. They conclude that soil-erosion potential is an important dimension of the ecological suitability of a planned innovation. It was demonstrated that erosion potential held a positive, and moderately strong, relationship to adoption of conservation tillage. Farm-firm and operator characteristics, on the other hand, showed almost no relationship to this adoption.

The role of socioeconomic variable sets

Interest by social scientists in the adoption of agricultural innovations has served to dramatize the fact that adoption behavior is more than a technological issue, and that the use of innovative farm practices is more than a direct response to environmental conditions. The predominant variables still being examined by social scientists in adoption studies include the personal factor backgrounds of potential adopters, their attitudes, their use of information sources, institutional factors, farm-firm characteristics, and the like (Rogers, 1982). But, examination of the role of socioeconomic factors in the adoption process need not, and indeed should not, lead to an exclusion of ecological factors. Neither should the study of ecological factors ignore the effects of socioeconomic variables. While the emphasis of this study is on the role of ecological factors in farmers' adoption behavior, standard nonecological variable sets are also included for the purpose of examining the relative explanatory power of the ecological variables versus commonly studied socioeconomic factors.

Problem

The perspective of environmental sociology, with a particular emphasis on the interactions of ecological and sociological factors, may be applied very practically to the problem of soil erosion in rural settings. Soil erosion is recognized today as having far-reaching ecological, political, and social implications. The excessive loss of topsoil through erosion, and the resulting nonpoint source pollution, are of growing concern, both to farm and nonfarm populations, as well as to national policy makers (Harris, 1980; Reicheld-erfer, 1985).

Each year, over two billion tons of soil erode from U.S. cropland (Bills and Heimlich, 1984). Most of this loss is the result of water erosion. Given this high rate of erosion, and the importance of preserving soil resources, there is a need to better understand why farmers are adopting or rejecting needed soil conservation practices, and to utilize this knowledge in developing and promoting implementation strategies for soil conservation programs. The objective of this study is to examine the contribution of some ecological variables, vis-a-vis socioeconomic variables, in explaining farmers' adoption of some soil conserving practices.

Hypotheses

Two general hypotheses were tested in examining the importance of ecological factors, vis-a-vis other variables, in explaining farmers' adoptions of soil conservation practices. First, it was hypothesized that two indicators of conservation adoption -- the number of conservation practices used and the amount of crop residue retained -- would be positively associated with ecological factors. The second hypothesis was that the ecological factors would contribute significantly to the explanation of conservation adoption, after controlling for the contribution of other, more conventional, socioeconomic variables.

Procedures and Data

Sample and data collection[3]

To test the hypotheses, data were obtained from farmers in three watersheds in east-central Iowa. A saturation sample was used. A list of 303 rural households within the three watersheds was obtained through a directory service,[4] and was provided to interviewers before they entered the field. Interviewers were instructed to go to the indicated households and to determine if they had a resident who farmed

[3]A more complete description of the sampling and data collection procedures is found in Nowak et al. (1983).

[4]The directory service used was the TAM Service, published by the R.C. Booth Co., Harlan, Iowa.

in the local watershed. If so, they were to complete an interview. If the operator of land adjacent to the farmstead did not live on the farmstead, inquiry was made regarding the name and location of the operator. Interviewers were instructed to locate and interview all eligible persons if they lived within 20 miles of the study site. A total of 193 respondents were included in the first wave of the study. Table 1 summarizes information on the data collection.

Four contacts were made with these respondents over a two-year period, 1980-81. In the first contact, personal interviews with the farm operators were conducted by the Statistical Laboratory at Iowa State University. Information was obtained on the personal backgrounds of the respondents, their attitudinal orientations, and their perceptions and use of selected soil, water, and energy conservation practices. A second contact, by telephone, was made in the summer of 1980. This survey focused on farm-firm characteristics, including size of the farm operation, legal organization (single family farm, family corporation, etc.), ownership status, labor provision by family or others, farm decision making, and the personal acceptability of some conservation policies. There was an attrition of ten respondents from the first to the second contacts, due mainly to refusals, residential mobility, and retirement from farming.

Table 1. Summary of data collection procedures

Type of contact	Date of contact	No.	Refusals	Other[a]
Personal interview	Feb.-Mar. 1980	193	-----[b]	----
Telephone interview	August 1980	176	8	9
Personal interview	March 1981	153[c]	0	23
Mail questionnaire	March 1981	141	12	0

[a]"Other" represents those who were not able to be contacted. They fall predominantly into the categories of persons who no longer farmed in the area or who had stopped farming altogether.

[b]The number of refusals from among those eligible to participate in the study was not available from records of the data collection procedure. It is known, however, that this number was small -- perhaps less than ten -- and that, overall, 71 percent of the land area in the three watersheds was operated by persons who participated in the study.

[c]The attrition of 23 persons between the second and third contacts was due not only to the reasons in Footnote a, but also to the unavailability of information on the erosion factors for some of the farms. As with the first contact, data collection records do not allow for a specification of the number of actual refusals.

The third and fourth contacts were made with the respondents in March of 1981. These involved a personal interview and a mail questionnaire, respectively. In the personal interview, the farmers were asked about: 1) their awareness, knowledge, and use of conservation practices, 2) the main causes of, and solutions to, their soil erosion problems, and 3) their contacts with soil conservation information sources. The third contact also provided information that made possible a calculation of the Universal Soil Loss Equation (USLE). A total of 153 farm operators were interviewed in the third contact. A mail questionnaire was left with the respondents at the time of the third interview. This instrument assessed selected attitudes about why soil erosion continued to be a problem, feelings about some general problems faced by farmers, and detailed information on general farm practices. A total of 141 persons returned the questionnaires.

Measures

Two dependent variables and five independent variable sets were measured in the study. The dependent variables measured were the number of conservation practices used and the amount of residue mulch retained. The five sets of independent variables identified as having importance for the conservation adoptions of the residents were: 1) ecological factors, 2) personal attributes of farmers, 3) farm-firm characteristics, 4) institutional factors, and 5) attitudinal-perceptual factors.

Dependent variables

First, respondents were assigned a score (from 0-5) that reflected their use of five conservation practices. These practices were contour planting, strip cropping, minimum tillage, sod waterways, and filter strips. These were the practices most widely available to farmers in the study area. The second adoption measure was the average amount of residue mulch left on the soil surface at the time of spring planting, expressed in pounds per acre. The amount of mulch was estimated from crop and tillage information obtained for another purpose -- the calculation of the USLE. This information included the type of crop, the tillage implements used, the number of passes made over fields, and the application of conservation practices.

Both the "index of conservation practice use" and the "crop residue measures" tapped conservation behavior, but were not equivalent measures. The index assessed the number of conservation practices adopted, whereas crop residue was a measure of the outcome of conservation practice use. The correlation in this study between the two variables was positive, but small (r = .28). Frequency distributions for the two adoption measures are given in Appendix B. Other summary statistics for the dependent variables, as well as for the independent variables, are also contained in the Appendix.

Independent variables

Ecological factors   The first set of independent variables tapped ecological features of the farmland. Those variables constitute the focal point of the analysis, in that their incorporation in explanatory models is felt to significantly contribute to an explanation of adoption behavior.

Two ecological measures were incorporated in the analysis. These were "average erosion potential" and "average erosion rate." Both were calculated using the USLE. The primary purpose of the USLE is to identify the key ecological variables that influence soil erosion and to predict average soil loss. In obtaining information for calculating the USLE, the farmers were asked to identify their individual fields from ASCS crop year photos. Information was then obtained for each field on crop rotation, crop yield, conservation practice use, and fall and spring implement use. Technicians used this information, in conjunction with soil surveys and USLE factor tables, to estimate the erosion potential and the annual soil erosion rate on each field, for each farm. The USLE equation is:

$$A = R \times K \times L \times S \times C \times P$$

where A = the predicted soil loss in tons per acre;
R = the rainfall erosivity factor;
K = the soil type factor;
L = the length of slope factor;
S = the slope gradient factor;
C = the crop management factor; and
P = the conservation practice factor.

When multiplied together, the R, K, L, S, C, and P factors provide a predicted annual amount of soil erosion for a given field.

It is important to recognize that while the USLE is a sophisticated procedure for erosion estimation, and is based on a great deal of research collected over 50 years, it is also limited in scope. The USLE does not give soil losses for a particular storm or a particular year. Neither does it predict how much soil ends up in a waterway. Rather, it predicts average annual erosion rates by means of comparing the R, K, L, S, C, and P factors for a given slope of field with those known to occur under standardized field conditions. A more detailed discussion of the USLE is presented in Wischmeier and Smith (1978) or Hudson (1981, Chapter 10).

Average erosion potential The "average erosion potential" measure indicates the erosivity of the land in the absence of conservation practices. It incorporates rainfall (R), soil type (K), slope length (L), and slope gradient (S). The erosion potential for each farm was calculated by weighting the RKLS factor for each field by the number of acres in the field, summing over all the fields, and then dividing by the total number of acres in the farm operation. The coefficient for RKLS increases in size with an increase in the erosion potential of the land.

Average erosion rate Average erosion rate was calculated on a field-by-field basis for each farm in the sample, again using the USLE. Each farm's overall average soil erosion rate was computed by weighting each field's erosion rate by the number of acres in the field, summing over all the fields, and dividing by the total number of acres in the farm operation.

The average erosion rate differs from potential erosion rate by incorporating crop management and conservation practices. Consequently, it shares some variance with the dependent variables, although the latter -- especially crop residue -- are not isomorphic with the measures of conservation use contained in the average erosion rate.

Personal factors Two personal factors were included in the analysis. Age was the operator's present age, and education was the highest grade of schooling completed.

Farm-firm characteristics Four farm-firm characteristics (acres, tenure, income, and credit) were measured. Total acres included both operator-owned and rented land. Tenure was the ratio of acres owned to the total acres in the operation. Income was average categorized gross farm income over a three-year period, 1977-79.[5] Reliance on credit for acquisition of land, machinery, farm buildings, and livestock was assessed through a four-point

[5]The categories for average gross farm income were: 1) none; 2) less than $5,000; 3) $5,000-9,999; 4) $10,000-19,999; 5) $20,000-29,999; 6) $30,000-39,999; 7) $40,000-49,999; 8) $50,000-99,999; 9) $100,000-149,000; 10) $150,000-199,999; 11) $200,000-299,999; 12) $300,000-399,999; and 13) over $400,000.

response format ranging from not relying on credit at all to relying on credit to a large degree.

Institutional factors Contacts with formal information sources, importance of cost-shared practices, and the presence of a Soil Conservation Service conservation plan were the three institutional factors tested. To measure contacts with information sources, the respondents were asked how many times they had visited, or talked with, a member of the Soil Conservation Service (SCS), the Agricultural Stabilization and Conservation Service (ASCS), a member of the Soil Conservation District Commission (SCDC), or the County Extension Service (CES) in the year prior to the survey. The total number of these contacts, if any, was the "agency contact score." Importance of cost-shared practices was measured by the proportion of currently-used conservation practices for which cost-share funds had been obtained. The presence of an SCS conservation plan was measured dichotomously as to whether one had such a plan or did not have a plan.

Attitudinal and perceptual factors Several attitudinal and perception measures were used. "Stewardship" implies a moral obligation to preserve resources for other persons' use and for future generations. To measure this concept, respondents were asked which of five statements best represented their views. At the extremes, the statements reflected no moral obligation to maintain soil and water resources, or an obligation, regardless of costs. A tradeoff was introduced in the remaining statements. Farmers were asked if there was a moral obligation to maintain soil and water resources, even if costs to an individual exceeded the annual amounts of $500, $2,500, or $4,500, successively.

The second attitudinal measure tapped risk orientation. The risk scale was constructed from responses to four statements:

1. I must be willing to take a number of risks to get ahead;
2. I regard myself as the kind of person who is willing to take a few more risks than others;
3. I am generally cautious about accepting new ideas;
4. I am reluctant about adopting new ways of doing things until I see them working for people around me.

The respondents expressed agreement or disagreement with the statements on a five-point scale ranging from "strongly disagree" to "strongly agree." The items were coded so that the higher numbers reflected greater risk proneness. Response scores were summed and divided by the number of items in the scale.

The final measure entailed identification of the perceived seriousness of erosion on each farm. A four-point response format for erosion perception ranged from no problem (1) to a major problem (4).[6]

Statistical analysis

The strength of the bivariate relationships between the independent variables and the two measures of conservation practice adoption was measured with Pearsonian correlations. Block multiple regression analysis was used to test the amount of variance explained in the dependent variables by each of the five variable sets. Finally, block multiple regression was again used to test the importance of the ecological variables after having controlled for the effects of the other independent variables.

Findings

Bivariate relationships between all of the variables in the analysis are reported in Table 2. Focusing first on the

[6]In a review of this article, it was suggested that the perception of erosion could be treated as distinct from the other perceptual variables. Namely, erosion perception could be examined as a subjective ecological variable vis-a-vis the objective ecological variables of soil erosion potential and predicted erosion rate. While the comparison of subjective and objective measures of erosion has very interesting potential for analysis, it was not pursued in this study. The primary reason for this was due to the low correlations between perception of the erosion problem and the dependent variables. Consequently, it was anticipated that erosion perception would not add to the overall analysis as a distinct explanatory factor. The low correlations may stem from the measure of perceived erosion in this study, and not from the analytical relationship between erosion perception and conservation practice use. Presumably, one acts on one's perceptions. The possibility of comparison between objective and subjective measures of erosion problems in future studies remains strong.

Table 2. Zero-order correlations for all variables in the analysis

	1	2	3	4	5	6
Ecological factors						
1 Erosion potential	---					
2 Erosion rate	.49***[a]					
Personal factors						
3 Age	.04	-.07	---			
4 Education	-.08	-.09	-.43***	---		
Farm-firm characteristics						
5 Acres operated	.29***	.07	-.18**	.06	---	
6 Tenure	-.06	-.23**	.43***	.03	-.06	---
7 Income	.06	.02	-.28**	.16*	.67***	-.07
8 Credit reliance	.01	-.06	-.44***	.36***	.36***	-.08
Institutional factors						
9 Contacts	.09	-.11	-.11	.12	.02	.11
10 Cost-sharing	.20**	.04	.02	.01	.22**	.04
11 SCS plan	.05	-.21**	-.12	.18**	.22***	.24***
Attitudes-perceptions						
12 Stewardship	-.02	-.14	-.05	.09	.15*	.15*
13 Risk	.12	.01	-.15*	.29***	.29***	.02
14 Perceived problem	.01	.04	-.13*	.21***	.13	.02
Conservation practices						
15 Pounds of residue	-.03	-.13	-.15*	.19*	.13	.07
16 Index of practices	.26***	.06	-.08	.06	.21*	.04

[a] In this, and all following tables: * = $p < .05$, ** = $p < .01$, and *** = $p < .001$.

7	8	9	10	11	12	13	14	15	16

.44***	---								
.13**	.24***	---							
.16**	.13*	.06	---						
.20**	.20***	.13*	.37***	---					
.24**	.15*	.16*	.08	.13	---				
.32***	.40***	.16*	.21**	.28***	.17	---			
.11	.14*	.15*	.16**	.13*	.04	.08	---		
.21*	.32***	.27***	.16*	.15*	.24**	.22**	.15*	---	
.16*	.29***	.30***	.32***	.32***	.23**	.22***	.10	.23**	---

relationships between the ecological variables and the conservation-adoption measures, only one relationship was significant. That was between erosion potential and the conservation practice index ($r = .26$, $p < .001$). As erosion potential increased, so also did the number of conservation practices adopted. But, overall, the ecological variables were not related to the adoption measures. Pounds of crop residue were not related to either erosion potential or erosion rate, and the index of practices was not related to erosion rate. Thus the first hypothesis received only partial support.

With respect to the other independent variable sets, there were a number of significant relationships with conservation practice use. All of the nonecological variables were related significantly to the pounds of crop residue variable, with the exception of acres operated and tenure. Furthermore, all of these significant relationships were in the positive direction, as would be anticipated from the literature,[7] with the exception of age, which was negatively related. Regarding the index of conservation practices, acres, income, credit, the institutional factors,

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[7]A caveat should be mentioned for the hypothesized influence of tenure. Although much of the literature has suggested that land ownership is associated with conservation practice use, recent literature has suggested no relationship. At best, the relationship between tenure and conservation use is not clearly defined (Bills, 1985; Crosson and Stout, 1983; Lee, 1983).

stewardship and risk were related positively and significantly to it. Consequently, standard socioeconomic variables fared much better in the correlational analysis than did the ecological variables.

It should be noted in the findings that there was a potentially confounding effect between the average erosion rate measure and the dependent variables, in that the use of conservation practices is taken into account when calculating the erosion rate. But, the measures of conservation use contained in the average erosion rate were not isomorphic with the dependent variables. In analyzing the data, the correlation of erosion rate with erosion potential was .49. The correlations of erosion rate with the conservation practice index and with residue cover, respectively, were .03 and -.13. Erosion potential also was correlated with the dependent variables (.25 and .03, respectively). This indicates that, while the two ecological measures were moderately associated, neither was highly correlated with the dependent variables, and the problem of a confounding effect between the independent and dependent variables was minimal.

Turning to an analysis of the amount of variance explained in the two dependent variables, there were several noteworthy findings. These are summarized in Table 3. First when each variable set was entered separately into a regression equation, the ecological variables accounted for a

Table 3. Variance explained in the dependent variable by ecological, farm-firm, institutional, personal, and attitudinal-perceptual variables

Variance explained by variable sets	Percent variance explained (R^2) Amount of crop residue	Index of conservation practices
Ecological factors[a]	1.8	7.4**
Farm-firm factors[a]	11.7**	10.4***
Institutional factors[a]	9.8**	21.5***
Attitudinal-perceptual factors[a]	10.6**	9.5**
Personal factors[a]	4.1*	0.7
Variance explained uniquely by ecological variable set[b]	0.6	3.1
Variance explained by all the variables	20.0*	30.0***

[a]This is the variance explained when the variable set was entered separately.

[b]This is the additional variance explained by the ecological factors when all other variables have been entered.

significant proportion of the explained variance only for the conservation practices index. Slightly more than 7 percent of the variance ($p < .01$) of the conservation practice index was explained by the ecological variable set. Second, the amount of variance explained by the ecological factors was surpassed by the explained variance of all other variable sets, with the exception of personal factors. Third, the unique variance explained by the ecological variables in the case of the conservation practice index was not significant after having controlled for the other variable sets. Finally, the variance explained (R^2) by all 14 independent variables was a modest 20 percent for the crop residue variable, and a somewhat higher 30 percent for the index of conservation practices.

In sum, the findings from the regression analysis failed to support the hypotheses of the study. The finding that the ecological variable set explained a significant proportion of the variance in the case of the conservation practice index, lent only partial support to the first hypothesis that the ecological variables would be significantly related to the use of conservation practices. In light of the lack of support for the second hypothesis, that the ecological variables would contribute significantly to the explanation of conservation adoption after controlling for the contribution of more conventional socioeconomic variables, the impact of even partial support for the first hypothesis was reduced.

Discussion

Recent studies into the adoption of agricultural innovations have stressed the importance of including measures from the physical environment as potentially important explanators of adoption behavior. The present study included two ecological variables in seeking to explain Iowa farmers' adoption of some soil conserving practices. Contrary to expectations, presumed importance of ecological factors in adoption behavior was not well supported.[8] Among the variable sets used as independent variables, ecological factors, along with personal factors, explained the least amount of variance in crop residue and the number of conservation practices used.

The relative unimportance of the ecological factors in the regression analyses suggests that other factors were exerting a greater influence on conservation use than was expected. Institutional factors were found to be fairly important for adoption. Farm-firm characteristics were also of importance, and to a somewhat lesser extent, so were

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[8]It should be mentioned that the original design of the study selected respondents from watersheds that were similar on the basis of topographic and agronomic characteristics. This had the effect of reducing the overall variance for the study population on the ecological factors of erosion potential and erosion rate. Consequently, the study design may have contributed to the lack of demonstrated importance for the ecological variables. However, the potential for wider variance on these factors for a given farm operation remained high, and therefore a mitigating effect was registered against the lack of overall variance for the ecological variables.

Ideally, when examining the effect of ecological variables on conservation adoption, one would hope to maximize the variance so as to examine its effect as an independent variable. The possibility of pursuing this intent in future study designs is recommended.

attitudes and perceptions. Given the recent emphasis on the need for including ecological variables in adoption studies, and the traditional emphasis placed on personal characteristics of potential adopters, it is noteworthy that these factors were of minimal value in explaining the adoption of the conservation innovations included in this study. There are several possible reasons for this.

First is the nature of the innovation. It has been suggested that conservation innovations are distinct in their characteristics from typical commercially-oriented innovations,[9] and therefore, one could expect that a unique set of explanatory factors might be in operation. This would hold for the poor showing of the personal factors, but would not account for the relative unimportance of the ecological variables. If anything, one would expect the ecological variables to be particularly influential in the case of conservation innovations because of their close relationship to the physical environment. This was the suggestion given in the theoretical framework of the paper from the perspective of environmental sociology.

Second, the measurement of the innovation is an important consideration in assessing the relationship between the

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[9]The debate on this issue has been discussed by a number of sources, including Pampel and van Es, 1977; van Es, 1982; Lovejoy and Parent, 1981; 1982; Fast, 1983:443; Taylor and Miller, 1978; Korsching et al., 1983; Heffernan and Green, 1982; and Nowak, 1982.

independent and dependent variables. Although the overall relationship between the ecological variables and conservation use was relatively unimportant, there was a significant R^2 value between the ecological factors and the index of conservation practices. Likewise, there was a significant R^2 value between the personal factors and the amount of crop residue. There was some difference, then, when the number of conservation practices was used as a measure of conservation behavior versus an intensity of use measure. This may have bearing on the explanatory factors that have emerged as important in previous studies. Clearly, it is important to specify one's indicators, even when working with the same general analytical concept (e.g., conservation innovation).

Third, while the intensity measure (i.e., crop residue) may be the better indicator of conservation practice use -- in that it measures the result of any number and variety of conservation practices in terms of pounds of crop residue left on the soil surface -- there was not a wide range of variance for this variable. Perhaps a measure which incorporates intensity of conservation practice use, while at the same time displaying a wider range of variance, would demonstrate a clearer relationship between ecological variables and intensity of adoption of conservation.

Despite the weak relationship between the ecological variables and the two measures of conservation innovation --

the relationship that was the focus of this study -- a number of the relationships involving sociological variable sets did prove significant. These were not necessarily the variables that have commonly received the greatest attention in sociological literature on the adoption of innovations. The importance of institutional factors,[10] and to a lesser extent, farm-firm characteristics and attitudes-perceptions, proved to be noteworthy in this respect. Furthermore, within these sets of variables, certain individual variables accounted for the greatest proportion of variance in the dependent variables. There is a need for further study of these significant variable sets, and the individual variables within them, that account for the greatest amount of explained variance in the dependent variables.

In addition to further study of the more important variable sets, it should be recognized that certain of these sets are more modifiable than others. It is more feasible, for example, to effect change in institutional and attitudinal/perceptual factors that impede or facilitate conservation programs than it is to change personal,

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[10]In regard to the institutional factor of agency contact score, no distinction was made between self-initiated and agent-initiated contacts. Neither was there an identification of the content of the contacts. These points could take on importance in program development and implementation designed to educate farmers on conservation matters via enhanced contacts with agency personnel. Caution is therefore urged in the interpretation of findings on this variable.

ecological, or farm-firm characteristics. Promoting greater awareness of conservation problems and disseminating information about available solutions through extant social and political institutions, and directing this information toward farmers' attitude and perceptions about erosion and conservation, has very real potential for changing conservation behavior. To a lesser extent, educational programs which promote conservation can also make use of knowledge about personal and farm-firm characteristics. But, here the problem is more one of working within given constrictions than of changing these constrictions.

Although having an important potential for affecting the educational programs are not a panacea for soil erosion problems. So long as the factors remain in place (viz., social-structural and economic factors) which impede conservation practice use, education will not suffice to translate awareness and information into action. Programs which address these constraints must also be implemented.

Finally, while it would have been best to have no confounding effect present between the dependent and independent variables in this study, as was discussed in the findings, the average erosion rate is a variable of considerable theoretical and practical importance -- one that is being used more frequently in the study of soil conservation behavior -- and it was, therefore, included in addition to the erosion potential variable. One must be aware of the limitations of this potentially confounding effect, however, and exercise caution in interpreting the influence of erosion rate on conservation behavior.

Acquiring a better understanding of the factors affecting conservation behavior is important for sustained and improved food and fiber production. The mere discussion of factors commonly thought to be related to adoption of conservation measures is helpful, but it remains to be determined if these factors are actually important for the adoption of effective conservation practices. Certainly, the specifications of these factors are important for the formation of policy and programs to promote awareness and practice of soil conservation.

SECTION IV. MODELING THE ANTECEDENTS OF SOIL CONSERVATION ADOPTIONS BY IOWA FARM OPERATORS[1]

Introduction

Farmers' innovativeness, as reflected in their adoptions of new agricultural practices and technologies, has received substantial study in recent years. Many socioeconomic factors have been tested as likely determinants of such innovativeness, including: 1) personal characteristics (e.g., age, education, ethnicity); 2) characteristics of the farm firm (e.g., tenure status, debt level, size and type of operation, employment of labor, and income); 3) orientational variables (e.g., recognition of a need for innovation, risk-proneness, innovativeness; and 4) social system characteristics (e.g., community norms, communication patterns, and infrastructure support of innovations).

In the investigation of innovativeness, much attention has focused upon the speed of farmers' adoption of soil conserving practices, reflecting a recognition that soil erosion has far-reaching ecological, political and

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[1]This study was part of a larger interdisciplinary study titled "Effect of Agricultural Land Use Practices on Stream Water Quality." The project was funded through Environmental Protection Agency Grant R8 06 81 4110; Iowa Agricultural and Home Economics Experiment Station, Project #2364.

social implications. The excessive loss of topsoil through erosion, and its off-farm impacts, are of concern both to farm and nonfarm populations (Clark et al., 1985). Clearly, soil erosion is more than a "technological issue," and requires more than a "technical fix." Social factors seem vital to explaining both erosion levels and farmers' use of conservation practices. Although some of the socioeconomic variables identified in the adoption/diffusion literature have been shown to be associated with farmers' adoption of soil conserving practices and technologies, these relationships are, for the most part, modest to weak (Lovejoy and Parent, 1981; Basu et al., 1982). Also, the analyses often have been superficial, using only bivariate tests of relationships. With a few exceptions (e.g., Napier et al., 1986; Pope et al., 1982; McConnell, 1983; Lovejoy and Parent, 1981), there has been little application of the newer modeling procedures and statistical techniques in testing for posited influences of various socioeconomic factors on the use of soil conservation practices.

The present study tests a causal model for explaining farmers' adoptions of soil conservation practices. It incorporates many of the variables examined in previous studies, but these are cast here in a causal framework so as to better capture some of the dynamics of adoption behavior. In addition, several of the variables, while given attention in adoption/diffusion research, generally have not previously been used in the study of conservation behavior. Most notable are farmers' perceptions of the various facets of innovations themselves. Whereas considerable attention has been directed to how perceptions of erosion problems influence adoption behavior, virtually no attention has been paid to the extent to which the perceived characteristics of remedial conservation practices influence this behavior.

Conceptual Framework

The adoption model[2]

The adoption model used here, following Rogers and Shoemaker (1971) and Rogers (1982), provides a conceptual framework that seems well-suited for predicting farmers innovativeness in applying erosion control practices. As presented in the model (see Figure 1), the adoption process has a temporal dimension that begins with awareness of new, potentially useful practices. Following awareness, there is an evaluation phase in which new practices are scrutinized from the perspectives of their costs/benefits and their compatibility with the current farming operations of potential adopters. Out of this

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[2]This section, on the adoption model, is based on the conceptual models presented in Nowak et al. (1983).

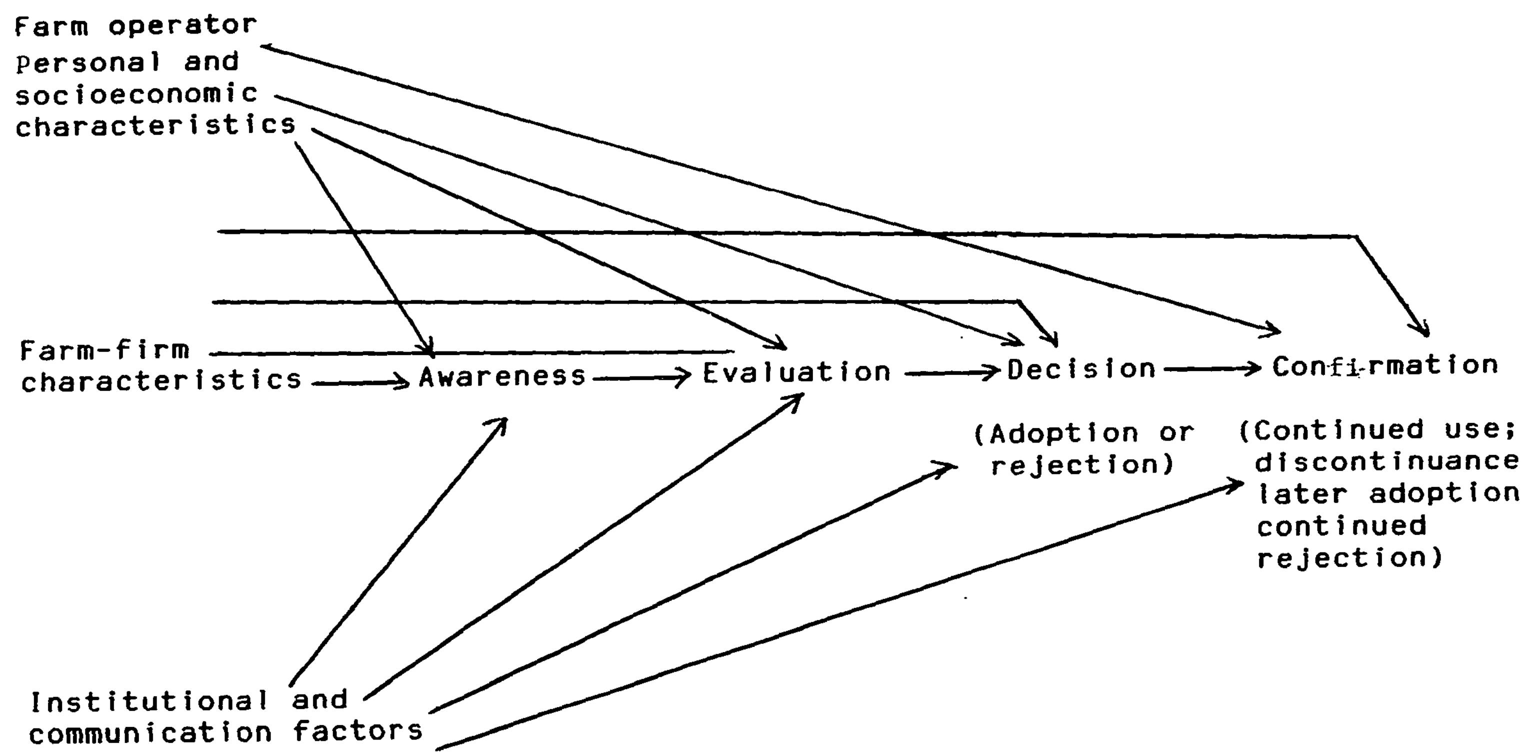

Figure 1. General adoption model

evaluation, decisions are made to adopt or reject the innovations. With the passage of time and the result of practical experience, there is either a confirmation or refutation of the adoption decision. Personal and socioeconomic characteristics of the farm operator, farm-firm characteristics, institutional and communication factors, and perception factors are all seen as significantly affecting the dynamics and outcome of this adoption process.

A modified version of the adoption model is presented in Figure 2. This model incorporates a suggested causal ordering of several variable sets thought to influence the adoption process. It is posited that farm operators' personal and socioeconomic characteristics, as well as their farm-firm characteristics, influence institutional and communication factors, which, in turn, affect the awareness, evaluation, and adoption decision stages. No attention is given to the confirmation stage in the present study. This does not imply that a confirmation stage is not an important element of an overall adoption model. Continued adoption, however (i.e., confirmation), is not the focus of this analysis. The awareness and evaluation stages are combined herein because of the nature of the measures used in their operationalization.

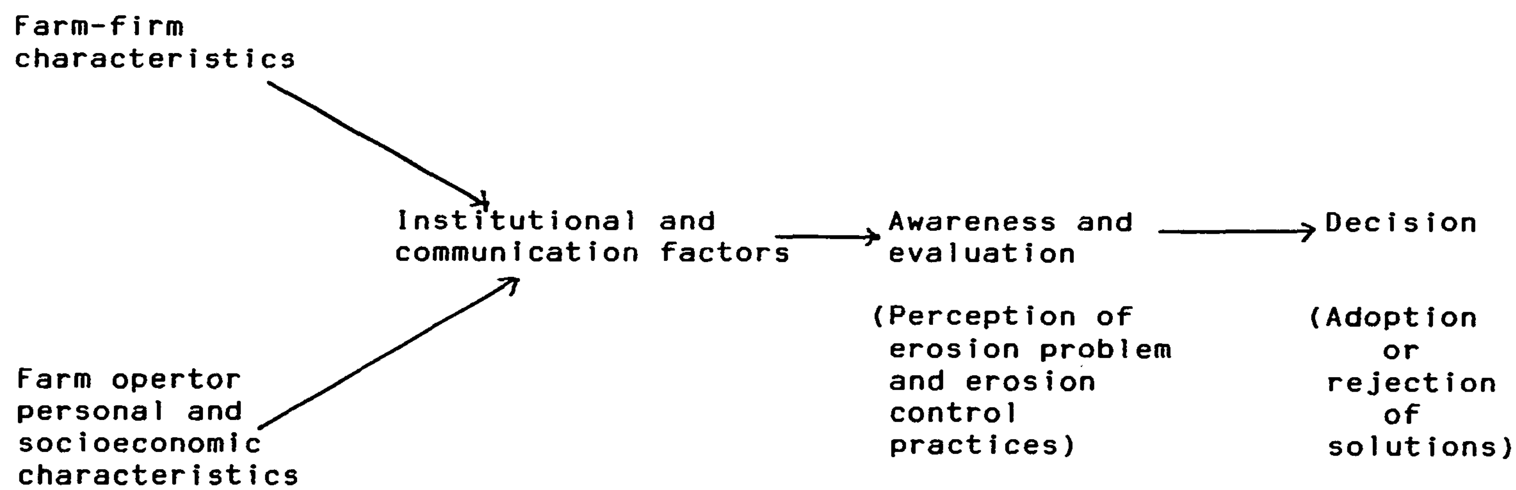

Figure 2. Simplified version of the adoption model, including causal ordering of variables, used in this study

Variables in the adoption model for soil conservation innovations

Figure 3 presents the variables used to operationalize the adoption model in Figure 2. Two distinct sets of exogenous variables are incorporated into the model. First are farm-firm characteristics; second are personal factors. While these two variable sets do not exhaust the potentially relevant exogenous variables in explaining agricultural innovation, they constitute the most commonly used explanators of such innovations.[3]

The farm-firm characteristics incorporated in the model are: income, acres operated, tenure, and reliance on credit. All of these variables have previously been shown to be important for the diffusion of agricultural innovations (Rogers, 1982). Three personal factors -- age, education, and occupation -- are frequently cited "determinants" of adoption (Rogers, 1982). Two of these -- viz., age and education -- are tested here. Occupation is not included as an explanatory variable because of the

[3]Social system variables such as community innovativeness norms, relative social standing, etc., have not been included in the present study, although they may have bearing on adoption behavior. The primary reason for their absence is the lack of available information on such concepts from the survey instrument. It may be noted that few studies have actually included social system variables in their analytical and empirical considerations. Those which have, often times have been forced to rely on less than desirable indicators, i.e., variables which, in fact, are questionable surrogates for social system variables.

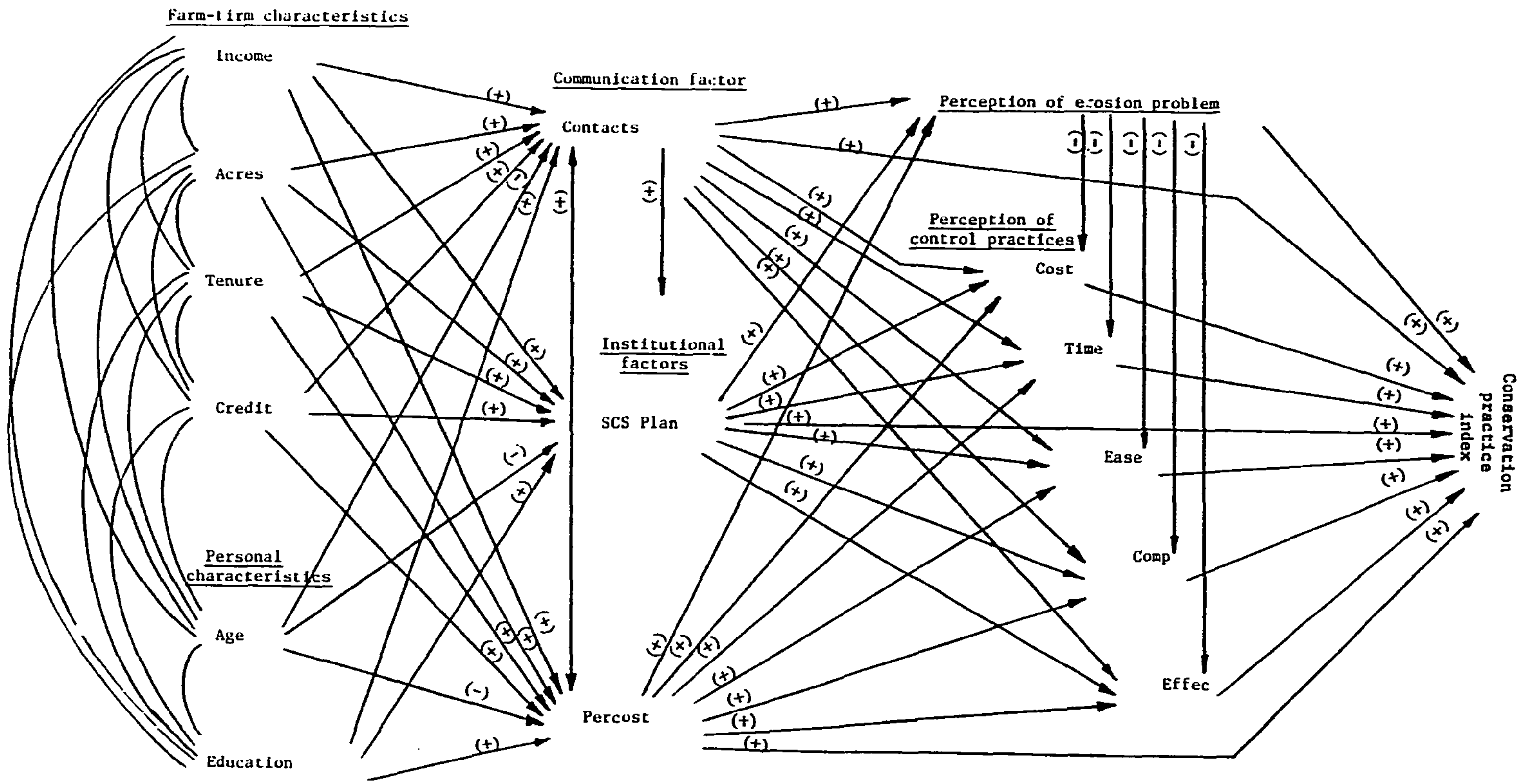

Figure 3. Full theoretical model and hypothesized relationships

homogeneity of the study population on this characteristic.

Four sets of variables are included in the model as endogenous variables (Figure 3). It is assumed that two of these sets are directly affected by farm-firm and personal characteristics: information-seeking contacts with public conservation agencies and institutional factors[4] (viz., degree of implementation of an SCS farm plan and percent of practices used for which cost-share funds are received). Both contacts and the institutional factors have been shown in past literature to be important correlates of adoption behavior (Rogers, 1982).

Perceptions of a soil erosion problem and perceptions of remedial conservation practices are the third and fourth sets of endogenous variables in the model. While problem perceptions often have been posited as useful in predicting adoption of soil conservation technologies (Nowak and Korsching, 1983; Lovejoy and Parent, 1982; Ervin and Ervin, 1982), perceptions of the practices themselves have been largely ignored. Yet, it seems likely that the perception of alternative, innovative solutions to a problem will affect adoption of those solutions.

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[4]The term "institutional" is used here to refer to formal involvement in government programs.

Both the farmers' problem and practice perceptions are assumed to be affected indirectly by personal factors and farm-firm characteristics, and directly by informational and institutional variables (Figure 3). It is also suggested that perception of the problem, in turn, affects the perceptions of each of the conservation practices. Seemingly, the more persons perceive an erosion problem the greater their acknowledgment that recommended conservation practices have relevance for their farming operation. This argument is elaborated in the hypothesis section.

Hypotheses

Hypothesized relationships between the endogenous variables in the conceptual model and their predictors are designated by parenthetically enclosed signs in Figure 3. Consistent with past research, most of these relationships are felt to be positive,[5] with several exceptions.

Age is predicted to be negatively related to the informational and institutional variables. Likewise, perception of an erosion problem should be negatively

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[5]The direction of the relationship is, of course, a function of how the variables are coded. This is most notable in the case of the perception variables, which do not have an inherent numerical ordering. All of the perception variables were coded such that a higher score reflected a perception more favorable to the adoption of conservation innovations.

related to favorable perceptions of individual conservation practices. As a serious erosion problem is identified, it is less likely that perceptions of additional cost and time requirements, as well as perceptions of the ease of use, compatibility and effectiveness of the conservation practices will be perceived favorably. This is so because there is increased need for commitment to conservation practices that may require substantial financial and other resource inputs on the part of the farmer. Practices tend to be perceived less positively than when no such commitment, or only minimal commitment, is required.[6]

A caveat should be introduced in regard to the hypothesized relationship of tenure to the informational and institutional factors. Because a positive relationship of tenure and innovative behavior is predicted by most pre-1980 research, and because more informational and institutional contacts with agencies have been positively associated with innovative behavior, one would anticipate a positive relationship of tenure with the institutional and informational variables. But current literature has called into serious question the positive relationship of tenure to conservation innovation (Bills, 1985; Crosson

[6]The colloquialism, "putting one's money where one's mouth is," summarizes this tendency well.

and Stout, 1983; Lee, 1983). Because a clear trend is not well established in the literature, a positive relationship was assumed between tenure and the informational and institutional variables in Figure 3. But, it is possible that a positive relationship may no longer exist, if it ever did.

Procedures and Data

Sample and data collection[7]

To test the hypotheses, farmers in three watersheds in east-central Iowa were interviewed. A saturation sample was used. A list of 303 rural households within the three watersheds was obtained through a directory service,[8] and was provided to interviewers before they entered the field. Interviewers were instructed to go to the designated households and to determine if they had a resident who farmed in the local watershed. If so, an interview was to be taken. If the operator of land adjacent to the farmstead did not live on the farmstead, inquiry was made as to the name and location of the operator. Interviewers were instructed to locate and interview all eligible persons if they lived within 20

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[7]A more complete description of the sampling and data collection procedures is found in Nowak et al. (1983).

[8]The directory service used was TAM Service, published by the R. C. Booth Co., Harlan, Iowa.

miles of the study site. A total of 193 respondents were included in the first wave of the study. Table 1 summarizes information on the data collection.

Three contracts were made with these respondents over a two-year period, 1980-81. In the first contact, personal interviews were conducted by the Statistical Laboratory at Iowa State University. Information was obtained on the personal backgrounds of the respondents, their attitudes, and their perceptions and use of selected soil, water, and energy conservation practices. A second contact, by telephone, was made in the summer of 1980. This survey focused on farm-firm characteristics, including size of the farm operation, legal organization (single family farm, family corporation, etc.), ownership status, labor provision by family or others, farm decision making, and the personal acceptability of several conservation policies. There was an attrition of 17 respondents from the first to the second contacts, due mainly to refusals, residential mobility, and retirement from farming.

The third contact was made with the respondents in March of 1981. It involved a personal interview in which farmers were asked about: 1) their awareness, knowledge, and use of soil conservation practices, 2) the main causes of, and solutions to, their erosion problems, and 3) their contacts with soil conservation information sources. A

Table 1. Summary of data collection procedures

Type of contact	Date of contact	Number contacted	Refusals	Others[a]
Personal interview	Feb.-Mar. 1980	193	----[b]	---
Telephone interview	August 1980	176	8	9
Personal interview	March 1981	153[c]	0	23

[a]"Other" respresents those who were not able to be contacted. They fall predominantly into the categories of persons who no longer farmed in the area or who had stopped farming altogether.

[b]The number of refusals from among those eligible to participate in the study was not available from records of the data collection procedure. It is known, however, that this number was small -- perhaps less than ten -- and that overall, 71 percent of the land area in the three watersheds was operated by persons who participated in the study.

[c]The attrition of 23 persons between the second and third contacts was due not only to the reasons in Footnote a, but also to the unavailability of information on the erosion factors for some of the farms. As with the first contact, data collection records do not allow for a specification of the number of actual refusals.

total of 153 farm operators were interviewed in the third contact.

Measures

Several sets of variables are included in the model that is tested in this study: personal factors and farm-firm characteristics are entered as exogenous variables, and communication, institutional, and perceptual factors are used as endogenous variables. The principal dependent variable is a conservation practice index, which measures the extent of the respondents' use of five soil conservation practices.

Exogenous variables

Farm-firm characteristics   Four farm-firm characteristics (income, acres, tenure, and credit) were included in the model. Total acres was the sum of operator-owned and rented land. Tenure was the ratio of acres owned to the total acres in the operation. Reliance on credit was measured by the question: "In the past, to what degree have you relied on credit to acquire such items as land, machinery, farm buildings, and livestock?" A four-point response format ranged from not relying on credit at all to relying on credit to a large degree.

Personal characteristics Two personal factors were included: age was the respondent's reported age in years; education was the number of years of formal schooling completed.

Endogenous variables

Communication factor To measure information-seeking contacts, the respondents were asked how many times they had visited, or talked with (in the year prior to the survey) a member of the Soil Conservation Service (SCS), the Agricultural Stabilization and Conservation Service (ASCS), Soil Conservation District Commission (SCDC), or County Extension Service (CES). The total number of such contacts, if any, was the "agency contact score."

Institutional factors Two institutional factors were examined. First was the importance of cost-shared practices. It was measured by the proportion of extant conservation practices for which cost-share funds had been received. Second was the degree of implementation of an SCS conservation plan. It was measured on a four-point scale ranging from no plan at all (assigned 1 point) to a fully implemented plan (4 points).

Perception of the erosion problem Perception of an erosion problem was measured by response to the question: "Is soil erosion a problem on your farm?" A four-point response format ranged from no problem (1 point) to a major problem (4 points).

<u>Perception of the practices</u> The respondents' perceptions of each of five conservation practices (contour planting, strip cropping, minimum tillage, sod waterways, and filter strips) were assessed by asking them to rate the practices on five dimensions: cost, time and labor requirements, ease of use, compatibility with existing practices, and effectiveness for erosion control. An 11-point response format was used for each dimension, ranging from 1 (not favorable for adoption) to 11 (very favorable for adoption). A single perception score was derived for each dimension by summing the scores for that dimension across all practices. These scores potentially ranged from 5 to 55.[9]

<u>Conservation practice index</u> The principal dependent variable was adoption of conservation practices. The respondents were assigned a score of "1" for each of five practices they were using at the time of the survey.

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[9]One necessarily reduces the specificity with which the individual adoption practice perceptions can be described and understood when a composite measure of practice perceptions is employed. However, the use of a composite allows for the desideratum of greater generalizability to a broader range of soil conservation perceptions.

These practices were contour planting, strip cropping, minimum tillage, sod waterways, and filter strips. The practices were selected for analysis because of their prominence in the study area and their applicability to the reduction of erosion problems on cropland. Summary statistics for all of the study variables are reported in Table 2.

Statistical analysis

Pearsonian correlation was used to test for bivariate relationships between the endogenous variables in the conceptual model. No causal connections were posited between the exogenous variables, with these correlations representing unanalyzed causes. However, the exogenous variables were predicted to be causally related to the endogenous variables.

To test for causal links in the conceptual model, a series of multiple regressions were run in which the endogenous variables were regressed on all of their designated antecedent causes. This produced both path coefficients for a "full model" and permitted a testing of the individual hypotheses. After the paths for the full model had been estimated, a series of additional "path trimming" regressions were run to obtain a parsimonious, reduced form of the full model.

Table 2. Summary statistics for the exogenous and endogenous variables

	Range	$\overline{X}$	SD	N
Exogenous variables				
Farm-firm characteristics				
Acres operated	40-1740	451.3	329.4	176
Tenure	0-1	.45	.40	176
Income	2-13	8.1	2.2	183
Credit reliance	1-4	2.9	1.0	193
Personal factors				
Age	23-76	45.4	12.5	193
Education	7-18	12.0	2.2	192
Endogenous variables				
Information contacts	0-83	11.6	13.6	147
SCS plan	1-4	2.3	.08	193
Proportion of cost shared practices	0-1	.17	.27	188
Perception of problem	1-4	2.3	.85	193
Perception of the conservation practices				
Cost	10-54	34.2	8.2	193
Time and labor	5-45	25.3	6.3	193
Ease of use	11-53	32.4	8.8	193
Compatibility	5-55	32.8	9.6	193
Effectiveness	7-55	42.1	8.3	193
Ultimate dependent variable				
Conservation practice index score	0-5	2.7	1.3	193

The "path trimming" procedures are those described by Pedhazur (1982). After all of the paths for the full model had been estimated, those not contributing significantly to the explanatory power of the model were eliminated. This process was pursued through a series of regressions in which one path (the least significant) to each of the y's was eliminated in a step-by-step process until all of the paths were statistically significant, or theoretically satisfactory.[10] The trimming process was carried out through a one-at-a-time deletion process because removal of any one variable from the regression could affect relationships of the remaining variables.

Findings

The full model

Correlations for the exogenous variables, shown in Figure 4, reveal several patterns. Most prominent is the .67 relationship between income and acres operated. Whereas this relationship suggests the needed elimination of one of these variables from the overall model, the decision was made not to drop any exogenous variables

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[10]As one proceeds with the process of successive regression runs to remove the least significant paths, the probabilities indicated by significance levels are no longer actual probabilities. For this reason, the term "theoretically satisfactory" has been used to describe path coefficients of at least moderate magnitude which makes them desirable for retention in the model.

based upon the correlational analysis, but rather to base this decision on the significance of paths emanating from these variables.

The path coefficients for the full model are also presented in Figure 4. The large number of nonsignificant paths indicates the need for model reduction. Only four paths from the exogenous to the endogenous variables were significant: acres and tenure to SCS plan (.29 and .31, respectively), and acres and credit to the percentage of practices for which cost share funds were received (.23 and .20, respectively). All of these relationships were in the hypothesized (positive) direction.

For the endogenous variables, the findings were more supportive of predictions. Statistically significant paths were obtained between: 1) agency contacts and cost (.20), time (.22,) and the conservation practice index (.16); 2) percost and perception of problem (.21), ease (.20), compatibility (.27), and the conservation index (.25); 3) cost and the conservation practice index (.32); and 4) compatibility and the conservation practice index (.33).

To obtain a reduced parsimonious model, a series of additional regressions were run which permitted the removal of nonsignificant paths in a step-by-step process. These path trimming procedures are described in Appendix

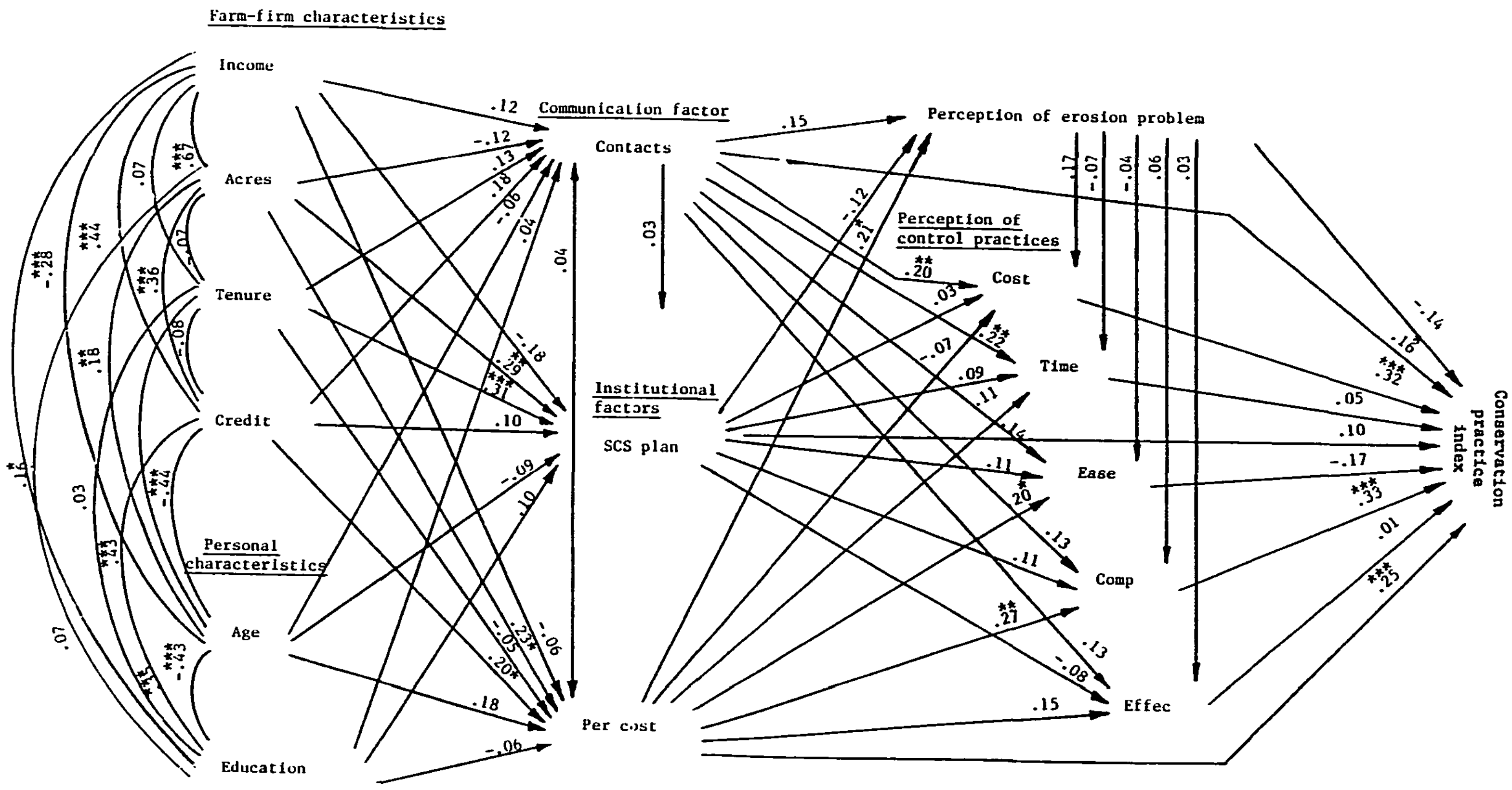

Figure 4. Full model with path coefficients

C. The reduced model, along with the path coefficients, are presented in Figure 5.

It can be seen from the reduced model that the exogenous variable of credit has a positive impact of .22 on contacts. The number of acres operated and tenure have positive paths (.22 and .27, respectively) to securement of a SCS plan. Acres, credit, and age have positive paths of .21, .17, and .18, respectively, to percent of cost-shared practices. As regards the relationships among endogenous variables, there are significant paths from (1) contacts to: cost (.23), time (.22), compatibility (.14), and the conservation practice index (.17); (2) percentage of cost-shared practices to perception of the erosion problem (.18), ease (.24), compatibility (.32), and the conservation practice index (.27); (3) perception of the erosion problem to the conservation practice index (-.14); (4) cost to the conservation practice index (.26); and (5) from compatibility to the conservation practice index (.28).

Most of the effects in the model are direct. Small indirect effects were found for the exogenous variables of acres, credit, and age on perception of an erosion problem, ease of use, compatibility, and the conservation practice index. Credit has an indirect effect on all of the perception variables in the reduced model and on the

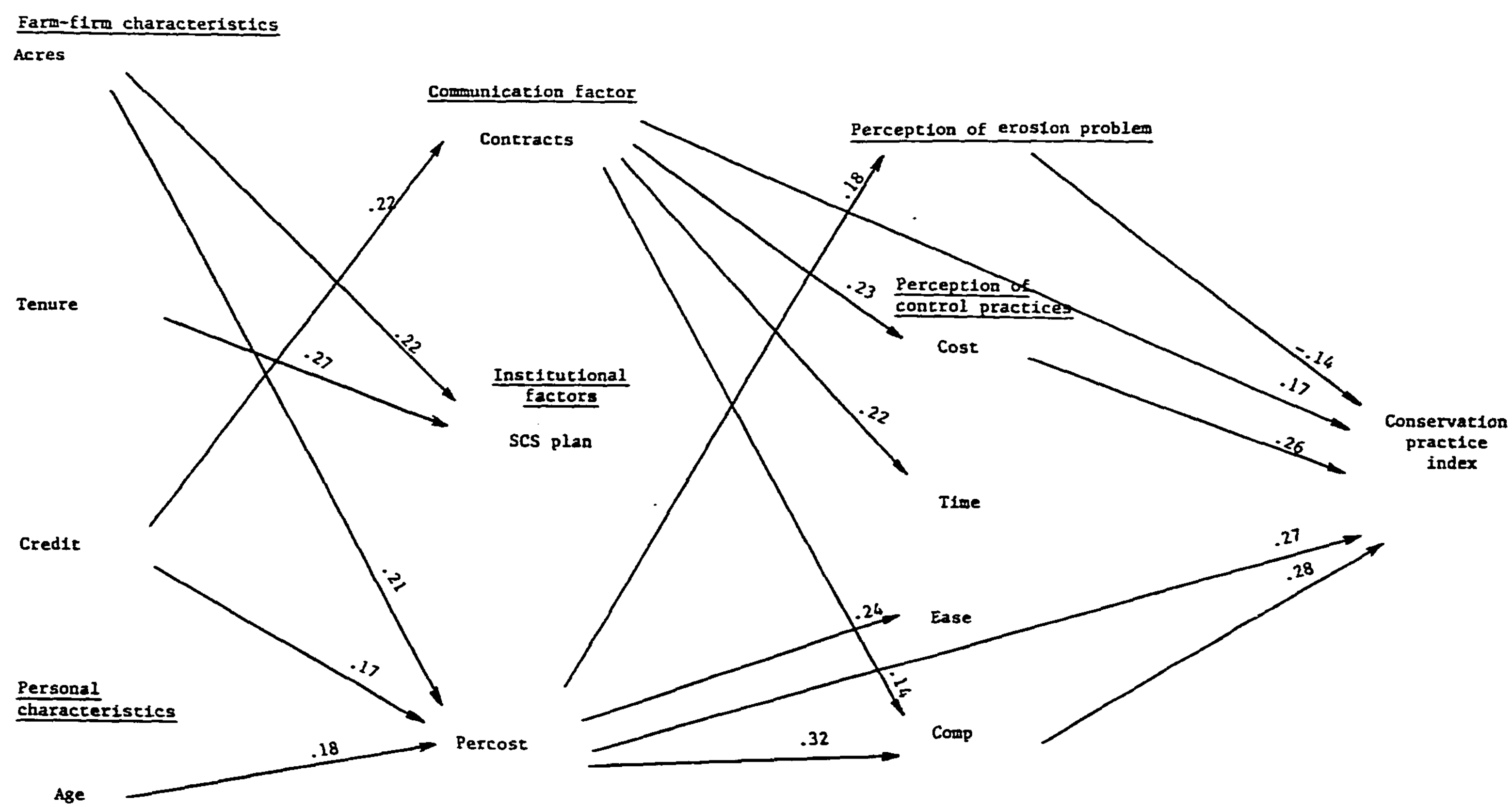

Figure 5. Reduced model with path coefficients

conservation practice index. In regard to the endogenous variables, "contacts" and "per cost" have indirect effects on the conservation practice index. The direct and indirect effects for the reduced model are presented in Table 3.

In sum, the principal dependent variable of conservation practice adoption has some important direct predictors. From among the communication and institutional factors, the number of contacts with conservation-related agencies and the number of practices for which cost share funds are received both have moderately strong path coefficients to the conservation practice index. This is consistent with the general adoption literature and with the hypotheses of this study. From among the perception of practice variables, the favorable perception of the costs of practices and their compatibility with extant farm practices also have moderately strong path coefficients to the conservation practice index. While literature is scarce on the perception of practice variables, it does suggest that a positive perception of practices has a positive effect on their adoption. This is as hypothesized in this study. Finally, perception of the problem has a moderate-to-weak path coefficient to the conservation practice index. However, it is in the opposite direction to that predicted by the literature and by the

Table 3. Reduced model direct and indirect effects

Independent variables used in the reduced model	Endogenous variables in the reduced model: Contacts D	Contacts I	SCS plan D	SCS plan I	Per cost D	Per cost I	Perception of problem D	Perception of problem I
Acres	0	0	.22	0	.21	0	0	.04
Tenure	0	0	.27	0	0	0	0	0
Credit	.22	0	0	0	.17	0	0	.03
Age	0	0	0	0	.18	0	0	.03
Contacts	---------		0	0	0	0	0	0
SCS plan	0	0	--------		0	0	0	0
Per cost	0	0	0	0	--------		.18	0
Perception of problem	0	0	0	0	0	0	----------	
Cost	0	0	0	0	0	0	0	0
Time	0	0	0	0	0	0	0	0
Ease	0	0	0	0	0	0	0	0
Compatibility	0	0	0	0	0	0	0	0

Cost		Time		Ease		Compati-bility		Conservation practice index	
D	I	D	I	D	I	D	I	D	I
0	0	0	0	0	.05	0	.07	0	.07
0	0	0	0	0	0	0	0	0	0
0	.05	0	.05	0	.04	0	.09	0	.12
0	0	0	0	0	.04	0	.06	0	.06
.23	0	.22	0	0	0	.14	0	.17	.09
0	0	0	0	0	0	0	0	0	0
0	0	0	0	.24	0	.32	0	.27	.06
0	0	0	0	0	0	0	0	-.14	0
------		0	0	0	0	0	0	.26	0
0	0	------		0	0	0	0	0	0
0	0	0	0	------		0	0	0	0
0	0	0	0	0	0	------		.28	0

hypothesis of this study. Further treatment of these findings is handled in the discussion section of the paper.

<u>Comparison of models</u>

Comparison of the reduced model with the full model permits an assessment of the relative explanatory power of these models. The full model used in this comparison was not the full model discussed in Figures 3 and 4, but rather the model shown in Figure 6, which is a fully recursive model for all of the endogenous variables incorporated in Figure 5. The reason for this is that a comparison can only be made between models which include the same variables. In the process of model trimming, some variables had been completely eliminated, making it impossible to compare the original full model (Figure 4) with the final reduced model (Figure 5).

In comparing the reduced model (Figure 5) with the full model (Figure 6), an examination of the differences in R^2 for each equation revealed that there were no differences greater than 5 percent. Table 4 contains a comparison of the R^2 values for the full and reduced model equations.

A further comparison of the full and reduced models can be made through a chi-square goodness-of-fit test. The method used here is that described Pedhauzer (1982:619

Table 4. Comparison of R^2 values for exogenous variables between full and reduced models

Dependent variable	R^2 value		
	Fully recursive model	Reduced model	R^2 difference
Contacts	.079	.048	.031
SCS plan	.158	.108	.050
Per cost	.101	.092	.009
Perception of erosion problem	.062	.030	.032
Cost	.078	.051	.027
Time	.079	.049	.030
Ease	.091	.057	.034
Compatibility	.140	.128	.012
Conservation practice index	.400	.381	.019

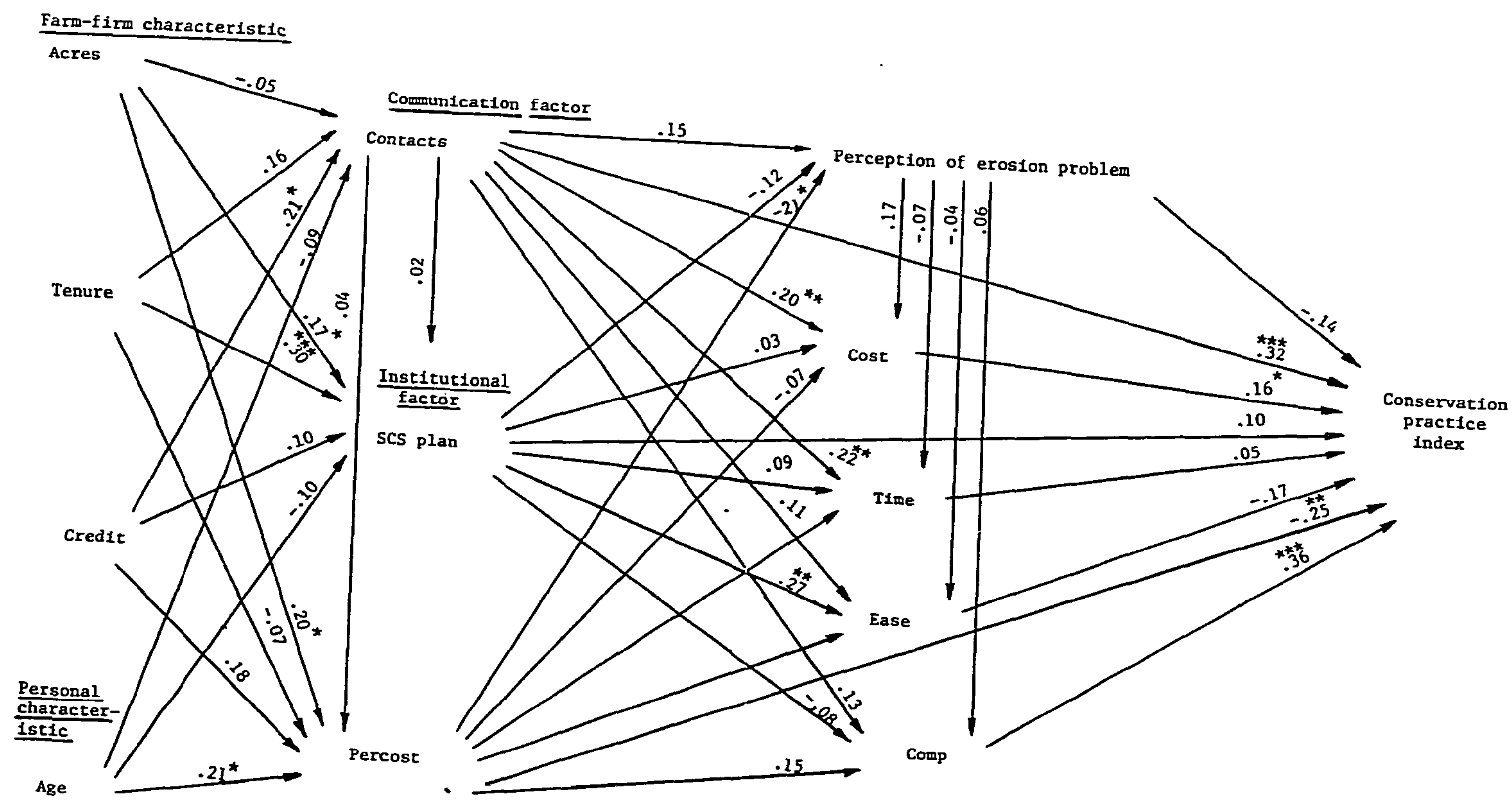

Figure 6. Fully recursive model for the reduced form variables

ff.). The result of this test is a chi-square value which, if not statistically significant, indicates the relative goodness-of-fit of the reduced model to the full model. For the present case, the calculated measure of goodness-of-fit (13.56) failed to exceed the critical value of chi-square (36.41) at the .05 level of significance, with 24 degrees of freedom. Therefore, the reduced parsimonious model (Figure 5) fits relative to the fully recursive model (Figure 6), for this reduced form case.

Discussion

This analysis has examined the relationships between several predictor variables and the soil conserving practices of some Iowa farmers. A second function of the analysis has been to identify a relatively small number of causal factors from a larger number of variables that have been used by social scientists to explain conservation adoptions.

There are several noteworthy findings that merit discussion. A greater number of contacts with farm-related government agencies led to a more positive perception of some conservation practices (for the dimensions of cost, time, and compatibility). There is apparently an educational process that occurs in such contacts which helps farmers to identify positive aspects of the conservation practices. The personnel of these agencies, all of which have conservation-related programs, are likely to convey, both formally and informally, these positive aspects of conservation practices to their clientele. The percent of cost-shared practices also improved the perception of conservation practices by farmers (for the dimensions of ease and compatibility). Financial assistance for practices, in the form of available cost-share funds, and the reception of these funds, apparently made the practices more attractive to use.

In addition to having a positive effect for perception of practices, informational contacts and percent of cost-shared practices also had a direct positive effect for the number of conservation practices used. The reasons for this positive effect could be expected to be very similar to those relating to the positive effects of information contacts and the percent of cost-shared practices for the perceptions of conservation practices.

Overall, the communication (number of contacts) and institutional (SCS plan and percent of cost-shared practices) variables in this study, while acknowledged in the literature, have not frequently been tested as important determinants of adoption. The present analysis shows their likely importance for conservation behavior, and suggests that they merit greater attention in future research. Likewise, the personal perceptions of the characteristics of the practices seem to be of greater importance than indicated in the empirical literature. Factors such as perceived cost, time requirements, ease of use and compatibility with existing practices seemingly merit more research, vis-a-vis perception of the erosion problem, than they have received in past studies. There were also some indirect effects of the institutional factors on adoption, via the perception of the erosion problem and perception of erosion control practices, but these were small.

Percent of cost-shared practices also had a positive impact on perception of the erosion problem. The availability of cost-share funds for erosion control practices, and the reception of these funds, appears to make farmers more attuned to the need for applying conservation practices by identifying the potential need for these practices (i.e., an erosion problem) on their own farms. But, perception of an erosion problem, which has often been seen in the literature as a central determinant of soil conservation adoption, was shown here to be negatively related to the conservation practice index. The reason for a negative relationship between perception of the erosion problem and the conservation practice index is not entirely clear. This may be partially an artifact of the dependent variable. A farmer who uses fewer conservation practices does not necessarily conserve the soil less. The practices which he uses may be more appropriate to his operation, or they may be used more efficiently. Additionally, the perception of a more serious erosion problem may have the effect of impeding conservation practice use because of perceived increases in commitments of time, labor, money, etc., in order to effectively implement practices to reduce erosion.

Finally, there is the question of tradeoffs in explanatory models between those which use a large number of prediction variables versus those having fewer predictor variables. It is desirable, of course, to have a model with the greatest explanatory power from the least number of variables. In the present case, the fully recursive model for the reduced form case (Figure 6) failed to explain significantly greater variance in the conservation practice index than did the reduced model (Figure 5). Consequently, the reduced model is the preferable explanation of conservation adoption since it contains fewer variables.

Although the comparison of models in this study has limitations in that the original full model could not be directly compared with the reduced model, credence is nevertheless lent to the model trimming procedures that reduced the large number of variables often used as explanators of conservation adoptions. Models that permit a parsimonious explanation of conservation behavior would seemingly enhance the application of modeling to "real world" situations and would reduce the somewhat arbitrary and indiscriminate use of predictors now commonly cited in the research literature. This study suggests need for further refinement of models in this regard.

SUMMARY AND DISCUSSION

Public concern about soil erosion has mushroomed in recent years. It is now a high-priority issue among rural and urban residents alike. Excessive erosion rates (i.e., rates exceeding an amount that permits the long-term maintenance of a high level of crop productivity) occur on more than 185 million acres, or 44 percent, of U.S. cropland (National Summary, 1984). After 50 years of ameliorative efforts by farmers and the federal government, soil erosion remains a serious problem in the United States; one that, ironically, seems to be worsening.

Soil erosion is of particular concern in Iowa, where agriculture and agribusiness-related occupations are major sources of economic wealth. While producing roughly 10 percent of the nation's food supply, Iowa tops all states in the amount of highly erosive cropland. Iowa's future production capabilities are being seriously jeopardized by this high erosion rate. Approximately 75 percent of the state's cropland is felt to be in need of some form of conservation treatment (National Summary, 1984).

Given the seriousness of soil erosion, both nationally and in Iowa, the question can be posed as to why many farmers have failed to adopt needed soil conservation measures. This question has only recently been systematically investigated by social scientists. It is now well recognized that controlling erosion is more than a technological exercise. Social and psychological factors are also important to securing effective erosion control.

Drawing upon a rich tradition of research on the adoption/diffusion of innovations, the present study examines some sociological factors that are of presumed importance for the speed with which farmers adopt needed soil conservation practices. Among the factors tested as being important for adoption are personal attributes of farm operators, farm-firm characteristics, communication and institutional factors, and "system" characteristics. Examination is also made of the role of ecological (i.e., environmental) constraints in adoption behavior.

The study findings are presented in four papers. The first paper examined the "Cancian thesis," which poses a challenge to previous findings on the relationship between socioeconomic rank and innovation. Socioeconomic rank has been commonly felt to be an important factor in innovative behavior, one that is usually positively associated with innovation. Whereas, the Cancian argument predicts a positive overall relationship between rank and adoption, it is felt that the nature of this relationship changes between early and later stages in the adoption process.

Findings of the first study suggest that the general theory (i.e., the predicted positive-linear relationship between rank and adoption) is not supported at the earliest stage of conservation adoptions. Although the Cancian predictions of a curvilinear relationship were not confirmed, absence of a positive relation (as predicted by the general theory) was evident in the first stage of adoption. Only later, in the second stage, did the predicted positive relationship emerge with clarity.

It was concluded from the test of the Cancian theory that the relationship between socioeconomic status and adoption behavior may not necessarily be linear. For the soil conservation innovation examined in this study, the earliness of adoption seemingly has a bearing on the rank-adoption relationship. The comparable adoption rates found for persons of different status in the early adoption stages suggests that there may be factors other than socioeconomic status that distinguish the earliest adopters from nonadopters. The literature is replete with discussions of innovativeness-related factors that are believed to be important to adoption behavior (e.g., personality characteristics). These factors, however, may emerge as more important at some phases of the process than at others.

The second paper examined the effects of different measures of socioeconomic rank on the speed of adoption behavior. The relative merits of rural "class measures" vis-a-vis traditional "stratification measures" were assessed as to their explanatory value in accounting for adoption of needed soil conservation innovations. Contrary to expectations, a significant proportion of the variance in three types of conservation adoptions were unexplained by either the stratification or class variables. The full model (14 independent variables), which included both stratification and class variables, explained only 20 percent of the variance in adoption. In sum, the study failed to support the argument that socioeconomic variables are important to farmers' adoptions of conservation practices.

The third paper tested the importance of a diverse set of sociological factors that seemingly should influence adoption of agricultural innovations. Among these were farmers' personal attributes, attitudinal orientations, use of information sources, and farm-firm characteristics. Given the past inattention to physical and biological variables, in adoption-diffusion studies, some ecological factors were explored as to their importance for the conservation adoptions.

The posited importance of the ecological factors was not supported. Among the several variable sets considered, the ecological factors, along with personal factors, explained the least amount of variance in the conservation adoption measures. Institutional factors, farm-firm characteristics, and farmers' attitudes/perceptions were the best explanators of this adoption. Given the appeal in the literature for more attention being directed to ecological variables in adoption studies, and the traditional emphasis given to personal characteristics of potential adopters, it is noteworthy that these two types of factors were found here to be of nominal value in explaining farmers' behavior with regards to implementing needed conservation practices.

The fourth, and final, paper identified several sets of socioeconomic and social-psychological variables that have been repeatedly used in adoption studies, including studies of soil conservation. It was suggested that part of the reason for the generally low explanatory value of these predictor variables has been the lack of adequate model building. In response to this deficiency, a causal model for explaining soil conservation innovations was developed and tested.

A parsimonious model of conservation behavior was evolved from a large number of predictor variables. Although receiving little attention in the literature, information contacts and use of cost-shared practices were found to be of considerable explanatory importance in this model. Furthermore, farmers' perceptions of some characteristics of conservation practices, such as their perceived cost, time requirements, ease of use, and compatibility with existing practices, were found to merit more attention than they have been given in the empirical literature on conservation adoptions. Although comparison here of a "full" and "reduced" model was constrained by technical considerations, the findings lent support to model-trimming procedures that reduce the large number of frequently-used explanators of innovation to a smaller number of causal factors.

In conclusion, several questions about sociological facets of farmland soil erosion were examined in this investigation. One question concerned the differential levels of farmers' awareness and concern about soil erosion, and the potential remedies they were applying. But, the analysis went beyond merely the awareness issue, and examined factors that were posited as influencing the actual adoptions of needed conservation practices. Several conclusions of the research are important to future sociological study of conservation behavior, as well as to policy making and program decisions for combating excessive soil erosion.

First, chronological time has seeming importance for adoption patterns. While the evidence was not overwhelming on this issue, the findings of this study give reason to suggest that further inquiry be directed to how factors may differentially affect behavior at different "stages" in the adoption process.

Second, the use of some alternative measures of socioeconomic rank, reflecting different theoretical perspectives, failed to prove important for adoption behavior. But, social rank may be acting in concert with, rather than independently of, other variables. There is need for more study of how social rank may be interacting with other variables as a possible synergistic mechanism in producing conservation-oriented actions.

Third, the value of some comparatively new variable sets for explaining conservation adoptions proved enlightening vis-a-vis variables that have been previously identified in the literature as important. Namely, as shown in the third paper, institutional factors (agency contacts and cost-shared practices), farm-firm characteristics (size, tenure, income, and credit), and attitudes/perceptions (stewardship, risk preference, perception of the erosion problem, and perception of erosion control practices) were all found to be better explanators of adoption than were social rank, personal factors, or ecological factors. There is a need for more detailed testing of these variable sets.

Finally, analysis showed that model trimming procedures have utility in producing parsimonious explanations of adoption behavior. Previous research has been characterized by a profusion of possible factors affecting adoption behavior, but these studies have generally failed to sort out factors in terms of a theoretical framework or dynamic model. Expanded use of some contemporary causal modeling procedures (e.g., path and LISREL analysis) is recommended for future research in identifying key variables in the adoption of soil conservation practices.

There are several points that stand out when considering the implications of these findings for policy makers and change agents. First, the finding that ecological variables did not fare well vis-a-vis sociological variables in explaining the adoption of selected conservation practices lends added support to the much argued need for incorporation of sociological considerations in soil conservation policies and programs. It is obviously insufficient to identify an objective need for utilizing conservation practices as the sole determinant of adoption behavior. And, yet, programs and research related to soil conservation have predominantly favored technical approaches to the erosion problem. Knowledge of an erosion problem and of technical solutions to its alleviation are only initial steps in getting conservation practices in place. These findings indicate that socio-economic aspects of soil erosion require attention in the formulation and implementation of conservation-related policy.

Second, beyond better incorporating socioeconomic factors into considerations of conservation policy, another implication of the findings is that heavy emphasis on the economic, as opposed to socioeconomic, factors has led to a neglect of other potentially important social factors. In fact, the papers demonstrated that income alone is not an important predictor of conservation practice use. Programs and policies that have relied on the "trickle down" method of promotion, whether intentionally or inadvertently, are not recommended as the most effective means of getting conservation innovations "in place" at the earliest time.

Third, programs and policies that fail to account for the differential operation of social factors at different stages in the adoption process will not get maximum benefit from promotion strategies. Being aware of where the adoption process is, along a time dimension, allows for implementation of the most effective strategies at the most beneficial times.

Fourth, among factors that influence the adoption of conservation practices, some are more amenable to modification for purposes of conservation promotion than others. Most notably among the variable sets that proved important here in accounting for conservation practice use, communication, institutional, and attitudinal/perception factors are those most likely to be affected by policy strategies.

Agency contacts and the attitudinal/perceptual factors could be effectively influenced through increased and improved educational strategies and programs. Information on conservation programs, and the key persons and agencies to contact in this regard, as well as educational materials to highlight the recognition of erosion problems and the beneficial aspects of conservation practices, may prove to be important policy-related strategies that can be used to effectively promote the adoption of conservation practices. In addition, educational programs to highlight cost-share arrangements, as well as programs to provide the actual funding, could also prove effective in this regard. Together, increased awareness of the problem and available solutions to it, along with financial incentives to put the solutions into practice, would increase farmers' motivations to adopt conservation practices.

Finally, acquiring a better understanding of the factors that affect adoption behavior is important for sustained and improved food and fiber production. Whereas, the continued identification of factors presumed to be important for adoption behavior is helpful, it remains to be determined if these factors have much demonstrated explanatory utility. The four analyses reported here represent but a first step in sorting out the complex and multifaceted factors that determine how farmers can effectively combat what has become a national issue -- the preservation of our endangered topsoil.

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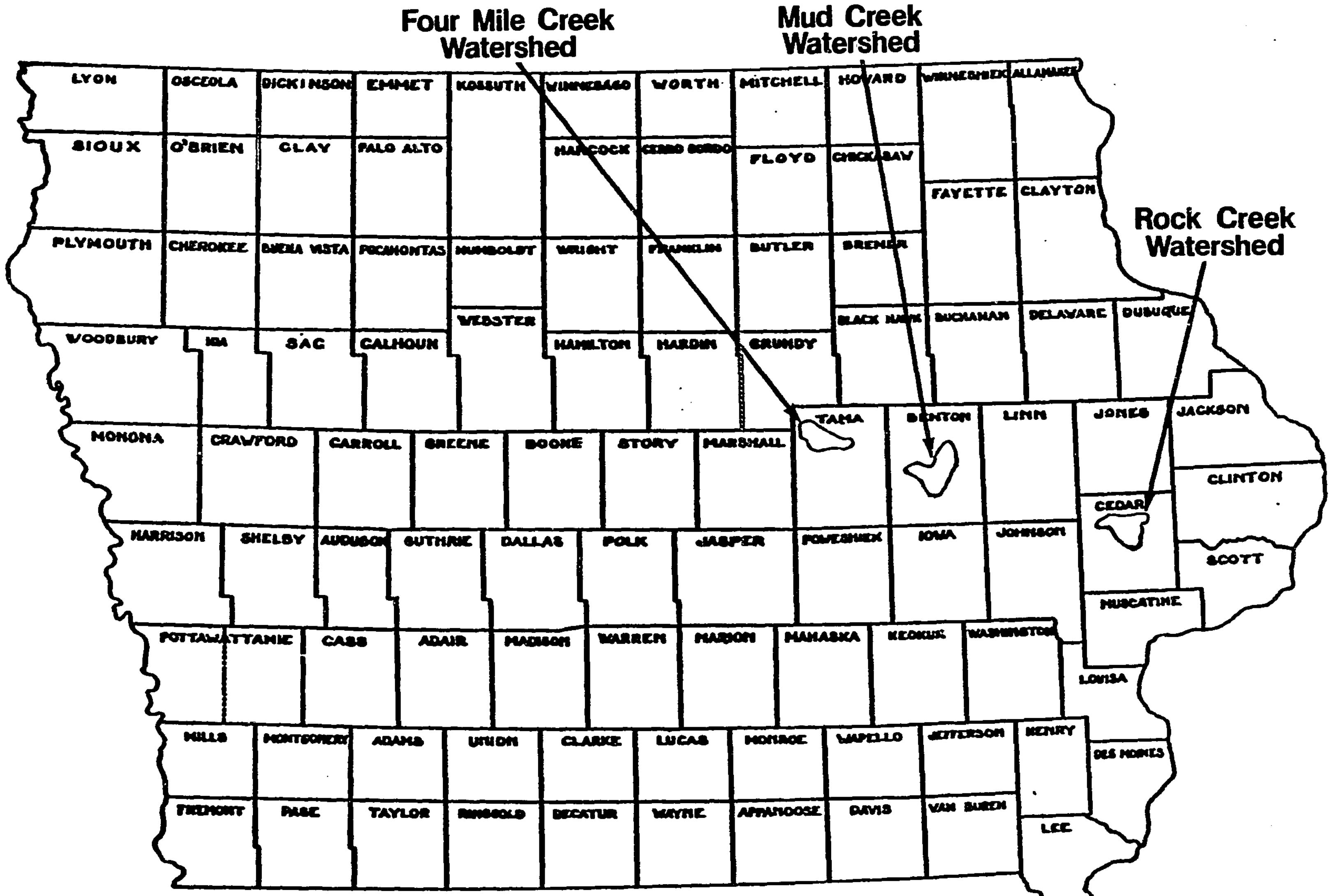
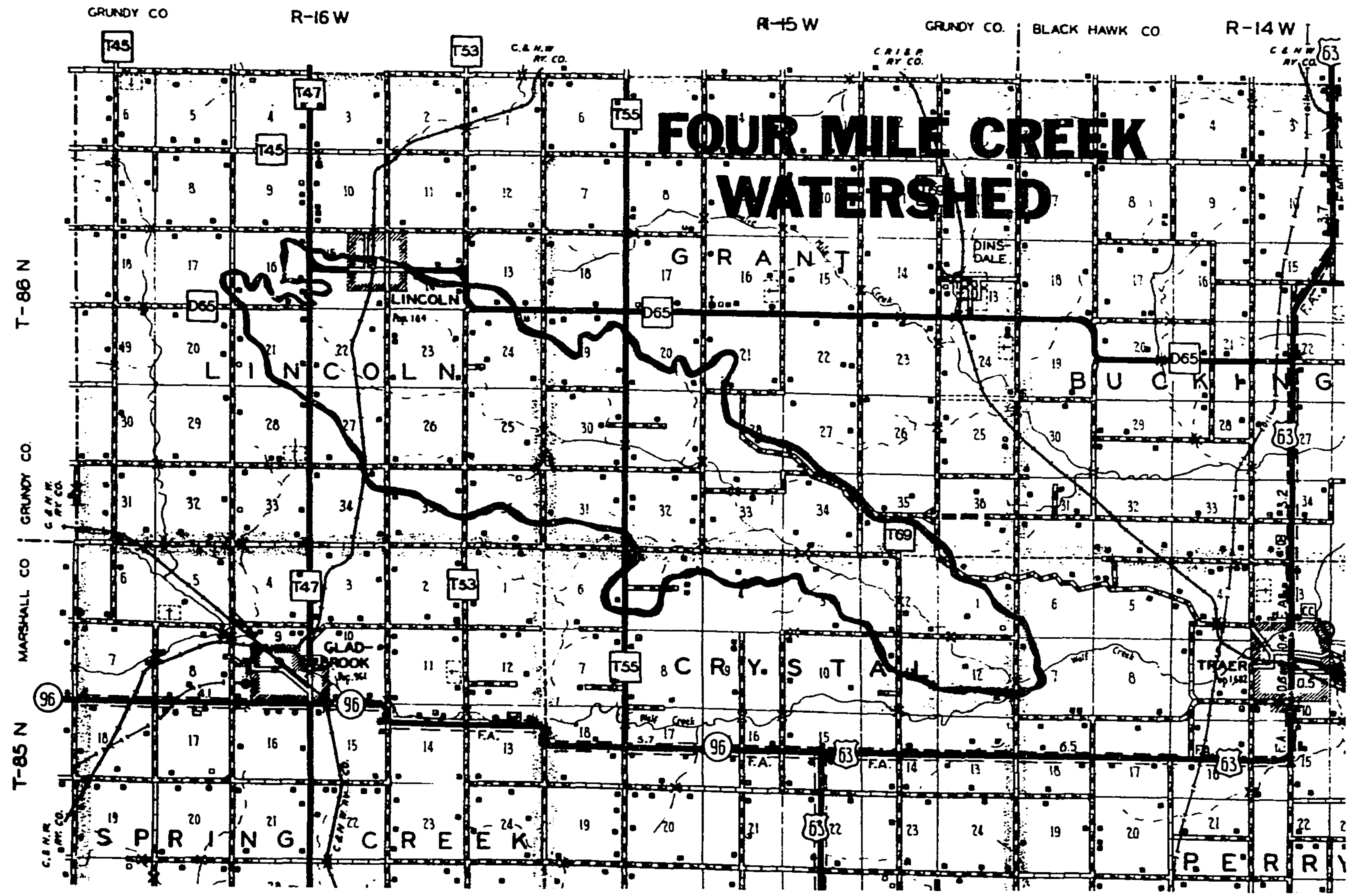
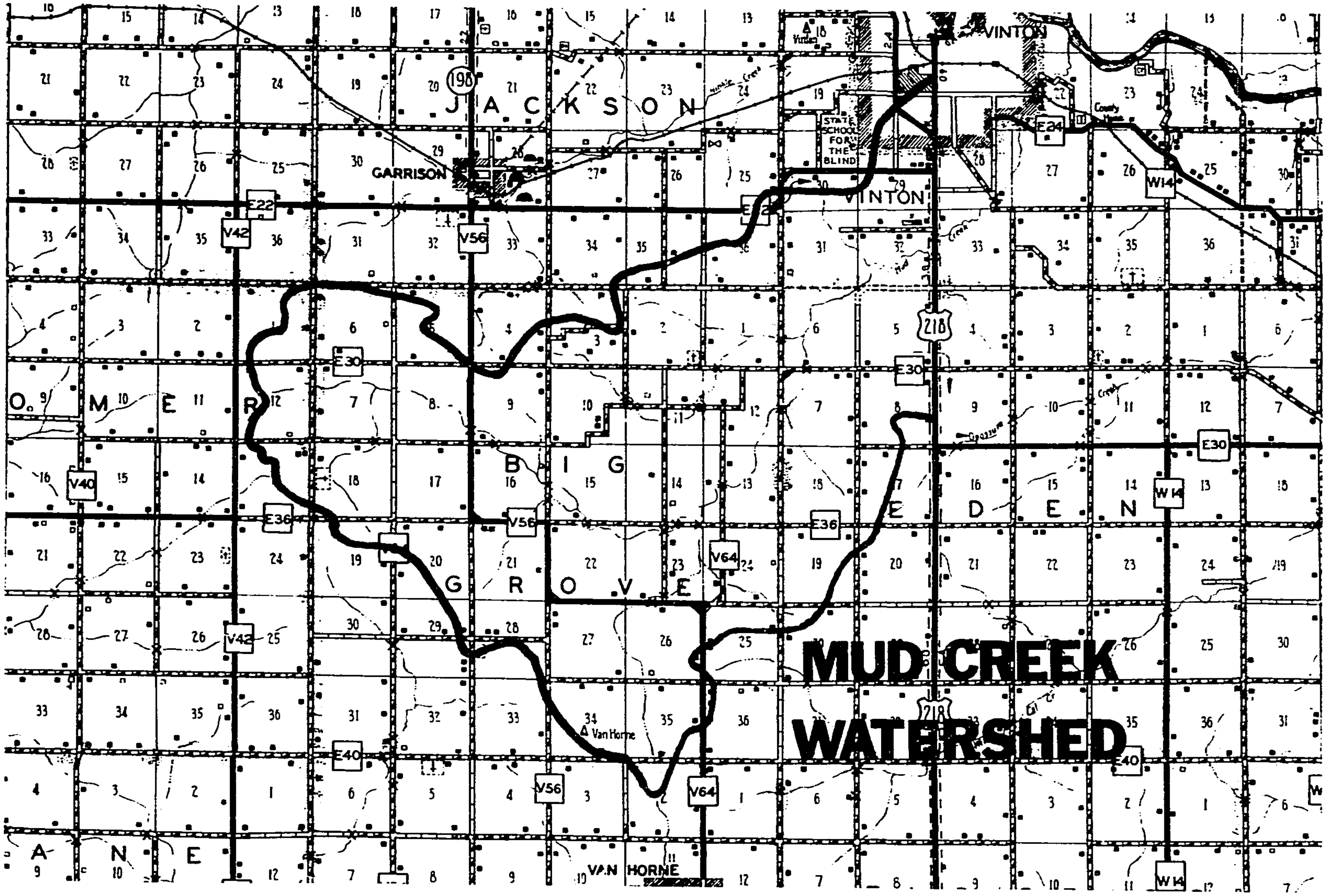
APPENDIX A: MAPS



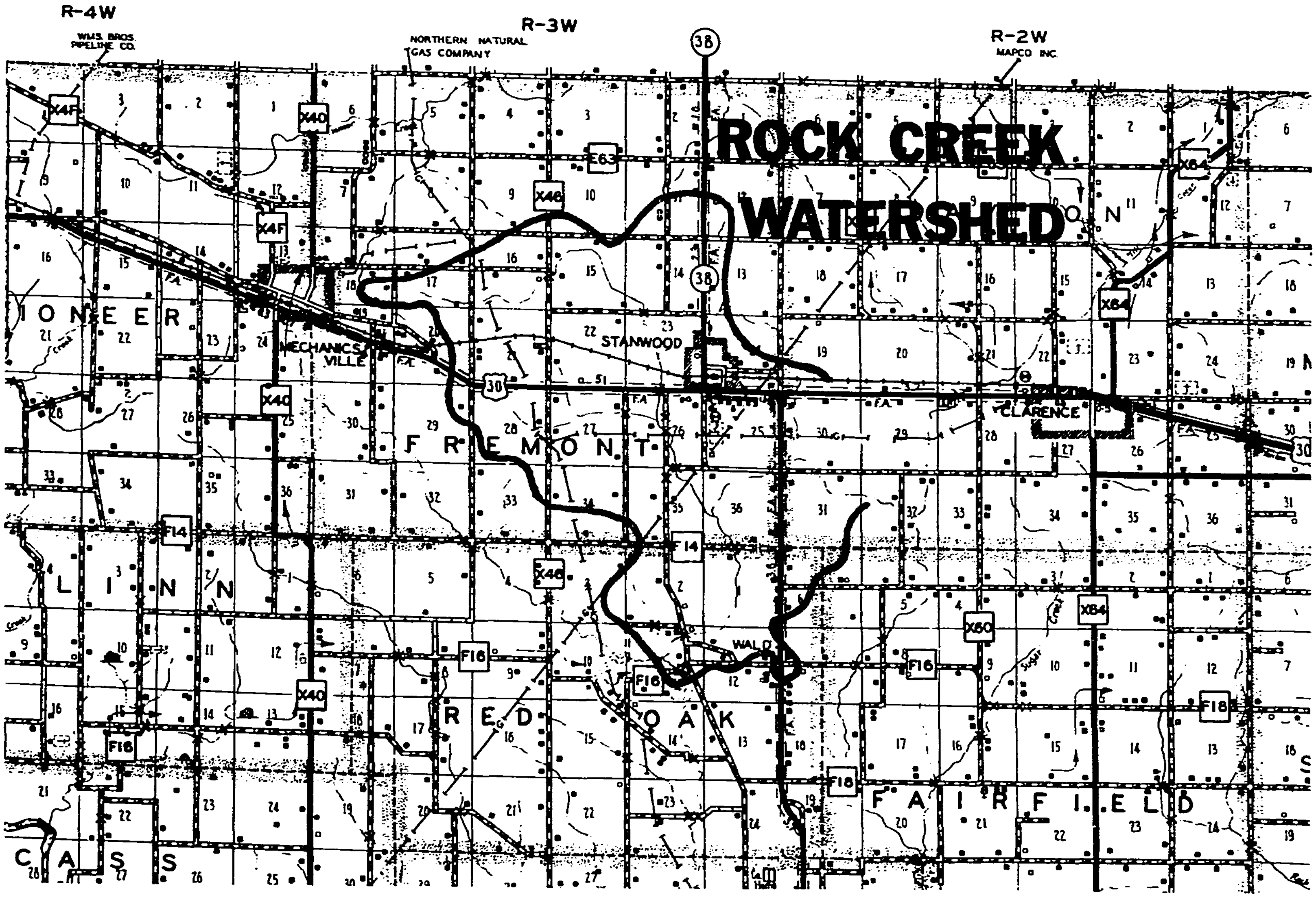
Location of Four Mile, Mud, and Rock Creek Watersheds in Iowa



Tama County, Iowa



Benton County, Iowa



Cedar County, Iowa

APPENDIX B: SUMMARY INFORMATION AND STATISTICS FOR THE INDEPENDENT AND DEPENDENT VARIABLES IN SECTION III

Table B-1. Frequencies for the dependent variables

Distribution on index score	Conservation practice index Score	N	Percent adopting
	0	5	2.6
	1	32	16.6
	2	53	27.5
	3	52	26.9
	4	28	14.5
	5	23	11.9
		193	100.0

Number and percent adopting the practices comprising the index	Practice	N	Percent adopting
	Contour planting	118	61.1
	Strip cropping	43	22.2
	Minimum tillage	151	78.2
	Sod waterways	172	89.1
	Filter strips	57	29.5

Table B-1 (continued)

Natural log of pounds of crop residue[a]	Value	N	Percent
	0-3.99	4	2.8
	4-4.99	3	2.0
	5-5.99	28	19.3
	6-6.99	74	51.0
	7-7.99	33	22.8
	8-8.99	3	2.0
		145	99.9

Pounds of crop residue	Value	N	Percent
	0-499	50	34.5
	500-999	52	35.8
	1000-1999	34	23.4
	2000-4999	9	6.2
		145	99.9

[a]Due to the skewed distribution of pounds of crop residue, the natural log of this variable was used as the actual dependent variable. A frequency distribution for categories of the untransformed variable has also been included for summary purposes.

Table B-2. Summary statistics for dependent and independent variables

	Range	$\bar{X}$	SD	N
Dependent variables				
Conservation practice index scores (0-5)	0-5	2.7	1.3	193
Natural log of pounds of crop residue	8.28	6.3	1.28	145
Independent variables				
Ecological factors				
Average predicted erosion rate	1-27	8.4	5.3	147
Average erosion potential	7-156	39.5	25.0	147
Personal factors				
Age	23-76	45.4	12.5	193
Education	7-18	12.0	2.2	192
Farm-firm characteristics				
Acres operated	40-1740	451.3	329.4	176
Tenure	0-1	.45	.40	176
Income	2-13	8.1	2.2	183
Credit reliance	1-4	2.9	1.0	193

Table B-2 (continued)

	Range	$\bar{X}$	SD	N
Institutional factors				
Contacts	0-83	11.6	13.6	147
Cost share percent	0-1	.17	.27	188
SCS plan	0-1	.59	.49	193
Independent variables				
Attitudinal and perceptual factors	1-5	3.4	1.5	132
Stewardship	1-5	3.4	1.5	132
Risk[a]	2-5	3.3	.64	192
Perception of problem	1-4	2.3	.85	193

[a]Cronbach's alpha reliability coefficient was 0.61. This is an acceptable level of reliability, by convention, for general attitudinal measures (Nunally, 1967).

Table B-3. Correlation coefficients for items forming indices

	(1)	(2)	(3)	(4)
Risk scale				
(1) Willingness to take risks to get ahead	1.0			
(2) Willingness to take more risk than others	.41	1.0		
(3) Cautious about accepting new ideas	.10	.28	1.0	
(4) Reluctant about adopting new ways	.21	.41	.46	1.0
Number of cases = 190 Alpha reliability coefficient = .65				
Agency contacts				
(1) Number of annual contacts with County Extension Service (CES)	1.0			
(2) Number of annual contacts with Soil Conservation Service (SCS)	** .30	1.0		
(3) Number of annual contacts with Agricultural Stabilization and Conservation Service (ASCS)	* .21	** .56	1.0	
(4) Number of annual contacts with Soil Conservation District Commissioners (SCDC)	** .30	* .25	.11	1.0

Table B-3 (continued)

	(1)	(2)	(3)	(4)	(5)
Cost sharing					
(1) Receive cost sharing for contouring	1.0				
(2) Receive cost sharing for strip cropping	.50***	1.0			
(3) Receive cost sharing for minimum tillage	.24**	.04	1.0		
(4) Receive cost sharing for sod waterways	.31***	.30*	.02	1.0	
(5) Receive cost sharing for filter strips	.25	.43*	.24*	.42	1.0
Conservation practices					
(1) Currently using contouring	1.0				
(2) Currently using strip cropping	.28***	1.0			
(3) Currently using minimum tillage	.29***	.26***	1.0		
(4) Currently using sod waterways	.12*	.15*	.01	1.0	
(5) Currently using filter strips	.18**	.41***	.26***	.13*	1.0

APPENDIX C: SUMMARY OF PATH TRIMMING PROCEDURES IN SECTION IV

In order to eliminate nonsignificant paths from the full model, a series of regressions were run which removed the least significant paths to each of the endogenous variables in a step-by-step process. After this procedure, only paths having at least moderately strong coefficients[1] were retained.

Table C.1 summarizes each step at which paths were removed. Each "x" in the table indicates the step at which a variable was removed from the model. For example, with the principal dependent variable (the conservation practice index) a single "x" indicates that effectiveness was removed from the second run, and so on. Five iterations of this process were conducted in total. Not all endogenous variables show five "x's." In some cases, fewer runs were necessary to remove nonsignificant paths (See footnote 10, p. 137) for a discussion of the term "significant"). In other cases, additional runs did not remove additional paths. The resulting model, along with the path coefficients, is presented in Figure 5 of the text.

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[1]No firm cut-off was established since the only intent was to develop an explanatory model based, not only on statistical, but also on theoretical criteria.

Table C.1. Summary table for paths removed at each stage of the path trimming procedure

Independent variables in the model	Exogenous variables in the model Contacts	SCS plan	Per cost	Problem perception	Cost
Income	xxxx[a]	xxxx	xxx		
Acres	xxxxx	.22	.21		
Tenure	xxx	.27	xx		
Credit	.22	xxxxx	.17		
Age	xx	xx	.18		
Education	x	xxx	xxxx		
Contacts		x	x	xx	.23
SCS plan x x					
Per cost				.18	xx
Perception					xxx
Cost					
Time					
Ease					
Compatibility					
Effectiveness					

[a]A single "x" indicates removal of a variable at the first stage of path reduction, a double "x" at the second stage, and so on.

Time	Ease	Compatibility	Effectiveness	Conservation Index
.22	.xx	.14	xxxx	.17
xxx	xx	xx	xx	xxx
xx	.24	.32	xxx	-.27
x	x	x	x	-.14
				.26
				xx
				xxxx
				.28
				x