Tillage Patterns of Iowa Farm Operators

A Study of the Adoption of Reduced Tillage Systems

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Sociological Studies of Environmental Issues
Department of Sociology and Anthropology
Iowa State University, Ames, Iowa
Sociology Report 152
January 1983

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This research was supported by the Iowa Agriculture and Home Economics Experiment Station (Project #2542) and Creswell, Munsell, Fultz and Zirbel Inc. The conclusions herein are solely those of the authors and do not necessarily reflect positions or policies of the sponsors.

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January, 1983

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ACKNOWLEDGEMENTS

We are appreciative of the cooperation of 425 farm operators in Iowa who responded, during a busy planting season, to questions about their tillage practices. We are indebted to Professor Joe Bohlen (Department of Sociology and Anthropology, Iowa State University), who provided us many insights into the applicability of the classical adoption/diffusion model to farmers' experimentation with new tillage systems. We also are grateful to Professor Min Amemiya (Department of Agronomy, Iowa State University), who helped us to identify the advantages and disadvantages of several types of reduced tillage. Mr. Dan Wiese (Director of Research Services at Creswell, Munsell, Fultz and Zirbel Inc.) provided us information about the role of agrimarketing firms in tillage decisions. Much thanks is due the staff of the survey section of the ISU Statistical Laboratory, who were responsible for the sample selection and the telephone interviews. Mr. Fouad Salama gave us able assistance in the coding and computerization of the data. Mrs. Georgia Parham was invaluable to the study in her typing of the survey instruments and this study report.

SUMMARY

There is ample evidence that farmers are increasingly turning away from the use of the moldboard plow and are instead embracing the basic philosophy and practice of reduced tillage. Drawing upon the adoption/diffusion perspective in sociology, this study examined the social and psychological factors underlying this shift from conventional to reduced tillage on Iowa farms.

The tillage practices of 425 farm operators, residing in 23 counties in Iowa, were studied. The information was collected in 1982 with telephone interviews and mail questionnaires.

Two-thirds of the farmers were found to be using reduced tillage on all or some of their corn and/or soybean acreage. Reduced tillage was more common in the rotation from soybeans to corn, which produces less crop residue, than in the corn to corn/soybean rotations.

The respondents were placed into one of three categories depending upon their tillage practices:

* adopters (67%), who presently were using reduced tillage on all or part of their corn and/or soybean acreage;
* potential adopters (20%), who, although not using reduced tillage, expressed the intent to try it in the near future;
* nonadopters (13%), who were neither using reduced tillage nor had any immediate plans to try it.

The three adoption categories differed in several respects, including the fact that those persons who had adopted reduced tillage were, on the average, younger, better educated, farming larger units, and receiving larger gross farm incomes than either potential adopters or nonadopters.

Not surprisingly, persons in the nonadopter category displayed the greatest reticence of the three groups in trying new things and in risk taking. They also were the least inclined to define soil erosion as a problem on their farms.

The recency with which farmers have discarded conventional tillage practices is seen in the finding that half of those using reduced tillage had adopted it within the past five years. A common pattern was for farmers to first experiment with reduced tillage on part of their cropland and then later expand its use.

Persons using reduced tillage often perceived that they were in accord with the feelings and practices of other farmers in their communities. Interestingly, adopters perceived a more receptive attitude toward, and greater use of, reduced tillage among local farmers than did nonadopters.

Most persons didn't favor public action that would prohibit the moldboard plow or penalize farmers who have excessive soil erosion. Those who were using reduced tillage, however, tended to be more supportive than other farmers of governmental intervention in tillage decisions.

Examination was made of the information sources being used by the farmers in their tillage decisions. At the awareness stage, in which one first learns about a new practice, the mass media were the most important source of tillage information. Neighbors, friends, and relatives were the second most important information source.

At the information-evaluation stage, when persons actively seek more detailed information about a new practice and mentally evaluate its relevance for their operations, neighbors and friends emerged as the

primary information source, followed by on-farm trials and mass media. In neither of these two stages were government agencies and commercial dealers listed by the respondents as prominent sources of information about reduced tillage.

There seem to be a set of interlocking motives for the adoption of reduced tillage, with prevention of soil erosion, reduced fuel expense, and lessened need for labor being the most important for these respondents. Recent increases in the cost of production inputs, especially tractor fuel, seem to be a galvanizing force in motivating farmers to experiment with reduced tillage. When coupled with a growing public sentiment for tillage systems which aid in the preservation of valuable topsoil, the shift to reduced tillage seems assured.

INTRODUCTION

This report is the first in a series of publications presenting findings from a study conducted by the Department of Sociology and Anthropology at Iowa State University titled: "Adoption/Diffusion of New Agricultural Ideas and Technology." The study was funded by the Iowa Agriculture and Home Economics Experiment Station (Project #2542) and by Creswell, Munsell, Fultz and Zirbel Inc., an advertising and public relations agency in Cedar Rapids and Des Moines, Iowa.

A total of 425 farm operators participated in the study. Their names were obtained from a random sample of farmers in 23 counties in Iowa. Information was solicited using telephone interviews and mailed questionnaires.

This report focuses on the respondents' adoption of reduced tillage. Future reports will discuss other topics examined in the study, including farmers' adoption of integrated pest management practices, their feelings toward selected world food issues and food policies of the United States government, and their assessments of future prospects for American agriculture.

Reduced Tillage

There is widespread interest and experimentation today among Iowa farmers with "reduced tillage" (also called "conservation tillage," "minimum tillage," "mulch tillage," and "residue farming"). Reduced tillage stands in contrast to conventional tillage in its rejection of the indiscriminate use of the moldboard plow and in the larger amount of crop residue retained on the soil surface.

Recent estimates by the U.S. Soil Conservation Service show that a large majority of Iowa's farmers use some form of reduced tillage on all or part of their cropland,[1] and that a small, but burgeoning, number of farmers are adopting the most extreme form of reduced tillage -- "no-till" -- in which the seedbed isn't disturbed prior to planting.[2] The trade-offs between conventional tillage, which relies on the moldboard plow, and various types of reduced tillage systems have received considerable scientific study.[3]

The popularity of reduced tillage is of recent origin. Relatively few Iowa farmers were using reduced tillage at the start of the 1970 decade. By mid decade, however, it was becoming increasingly popular, a trend that has continued unabated to the present day.

There is a great deal of confusion surrounding the term "reduced tillage." The source of this confusion is that, as a general term, it subsumes several distinct tillage types:[4]

1. Chisel, Disk, or Rotary Tillage

   These systems of seedbed preparation loosen the soil over the entire surface and partially incorporate the residue into the soil. Seedbed preparation and planting may be accomplished in one operation or in separate operations.

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[1] Approximately 88,000 Iowa farms used reduced tillage practices in 1981 on an estimated 13,351,000 acres. Soil Conservation Service. Iowa Summary: Conservation Tillage Survey, 1981. Des Moines, Iowa.

[2] Although the number of farmers using "no-till" remains small (less than four percent of all farmers), this number has been growing rapidly in recent years -- jumping from less than 1,000 in 1979 to over 4,000 in 1982). In fact, during the past year (1981-82), the number of farmers using "no-till" grew by 50 percent.

[3] Much of the research on the technical aspects of conventional and reduced tillage is summarized in Pierre Crosson, Conservation Tillage and Conventional Tillage: A Comparative Assessment. Ankeny, Iowa: Soil Conservation Society of America. 1981.

[4] The description of these tillage systems is taken from definitions used by the U.S. Soil Conservation Service.

2. Till-Plant (strip tillage)

   Seedbed preparation and planting are completed in one operation, with tillage in the row limited to a strip not wider than one-third of the total area. The area between the rows is left untilled. A protective cover of crop residues is left on two-thirds of the soil surface of the untilled area. Till-plant can be done on the ridge, on last year's row, or between rows.

3. No-Till (slot tillage, zero tillage)

   Preparation of the seedbed and planting is completed in one operation with no soil disturbance except in the immediate area of the planted seed row. The disturbed area does not exceed 10 percent of the surface. A protective cover of crop residue is left on at least 90 percent of the surface.

The Adoption/Diffusion Model

The shift from conventional to reduced tillage in Iowa is examined in this study using the adoption/diffusion model. This model draws attention to some social and psychological factors that previously have been found to be important to the adoption of different types of innovations. In this study, we were particularly interested in:

* the stages that persons go through in deciding whether or not to adopt new products and practices (e.g., the stages of awareness, interest, evaluation, trial and adoption).
* the attributes and value orientations of persons who adopt innovations with various speed (e.g., early adopters, late adopters, and nonadopters).
* the sources of information and personal influence that are operative at various stages of the decision-making process (e.g., mass media, family, friends, and neighbors, salesmen and dealers, extension agents).

Changes in Adoption Patterns

The adoption/diffusion model has long provided a useful framework for examining how innovations become implemented in practice. But some writers have questioned the continued relevance of this model, especially as to whether or not some of the adoption principles discerned in earlier studies are transferable to modern farming. It may be that continuing changes in American agriculture are serving to alter the processes by which farmers adopt new ideas and practices.

Some ongoing structural changes in agriculture seem critical to the contemporary relevance for adoption patterns of previous research. The 1970 decade witnessed a continuing decline nationally in the number of farms, a corresponding increase in average farm size and capital investment, and an increased concentration in farm production. Today, a relatively small segment of the nation's farmers produce a substantial share of the total agricultural output. Thus, the adoption behavior of a relatively small number of farmers may be increasingly critical to the diffusion of some innovations.

Another structural change that may be altering adoption behavior is the growing prominence of part-owner operations -- that is, where a portion of the farmland is rented. The increased separation of land ownership from its operational use has the potential of shifting the locus of agricultural decisions from farmers to other persons and groups. A related development is the increased prominence of vertical integration, which portends a substantial erosion of operator autonomy.

Yet another change that could alter agricultural adoption patterns is the electronic revolution, especially as it pertains to the transfer of farming information. Today, farmers have the capability of instantaneous access to information about market conditions, weather patterns, pest infestations, and the likely impacts of alternative management decisions. Increased use of microcomputers, in particular, could radically reshape the way in which farmers make decisions.

Recent changes in the characteristics and orientations of farm operators also may hold implications for adoption patterns. For example, a sizeable number of the younger farmers today are college educated, as compared with the often limited educational attainment of their fathers.

Public concerns today about environmental disruptions from agriculture, as well as increases in government regulatory activity in the areas of environmental and consumer protection, may be altering traditional adoption styles. The adoption of "conservation-related practices," for example, may mobilize a different form of adoption behavior than has been previously shown for "commercial practices."

The escalating costs of agricultural inputs, especially for fuels and fertilizer, could have profound effects on adoption patterns. Modern farming is highly dependent upon energy from fossil fuels. Significant shifts in the availability and costs of these fuels is likely to stimulate a greater receptivity of farmers to innovative energy-conservation practices.

Objectives of the Study

The primary objective of this study is to explore the processes by which Iowa farmers make decisions about their tillage practices, and to test for the importance of some background factors (personal characteristics and farming situations) for their adoption decisions. It is evident that Iowa farmers are not embracing various reduced tillage options with equal enthusiasm. This study examines the question: "How might the differential adoption of reduced tillage by farm operators be explained?"

A second objective of the study, to be described in a later report, is to ascertain if certain characteristics of the adoption process, as discerned in previous research, are themselves changing over time. To this end, some of the data gathered in this study were designed to be comparable with data collected in an earlier study (1971) of farm-practice adoptions in the same geographical area.

THE RESPONDENTS

Sample

The respondents in this study were farmers who, in 1982, were residing in 23 counties throughout Iowa (Map 1). The study sites were selected for the purpose of making the present sample comparable to a previous study (1971), with which these data will be compared in a future report.

A sampling rate was established for each county that reflected the proportion that the county's farmers made up of all farmers in the larger study area. Names and telephone numbers of potential respondents were randomly selected from county farm and ranch directories. To be eligible for inclusion in the study, a person had to be farming 80 or more acres. Persons identified as providing the principal day-to-day management decisions on the sampled farms were interviewed.

A total of 484 eligible respondents were contacted. Of these, 425 (88%) agreed to participate in the study. The telephone interviews, which were conducted by the Iowa State University Statistical Laboratory, averaged 20 minutes in length.

Questionnaires were then sent to 408 persons who, in the telephone interviews, agreed to provide additional information about their farming practices. Seventy percent (N=285) of these persons responded. Thus, 59 percent of the initial pool of eligible respondents completed both the telephone interviews and mail questionnaires.

Characteristics of the Respondents

The respondents ranged in age from 22 to 80, with the median age being 49. Nearly all (99%) were male. Educational attainment ranged from an elementary school education to an advanced degree, with the median level being a high school degree.

Characteristics of the Farm Operations

The respondents were operating farms that ranged in size from 80 to over 10,000 acres; the median farm size was 320 acres. One-third (31%) personally owned all of the land they were farming, half were part-owners (renting some land), and eighteen percent were tenants (renting all of their land). For part-owners, the amount of rented land ranged from four to 97 percent of the total acreage. An average of half of the land on the part-owner operations was rented.

The gross farm incomes (1981) of the respondents varied substantially, ranging from less than $20,000 to over $100,000. The median gross farm income was $75,000.

There was substantial concentration among the sampled farms in the amount of acreage being worked.[5] The largest five percent of the farms (which averaged nearly 2,000 acres) accounted for almost a fourth of the total acreage, and the top 10 percent of the farms accounted for a third of the acreage (Table 1).

A substantial number of the farm operators (48%) worked off the farm for pay in 1981. This work ranged from only a few days to upwards of 250 days; the median number of off-farm work days was 28.

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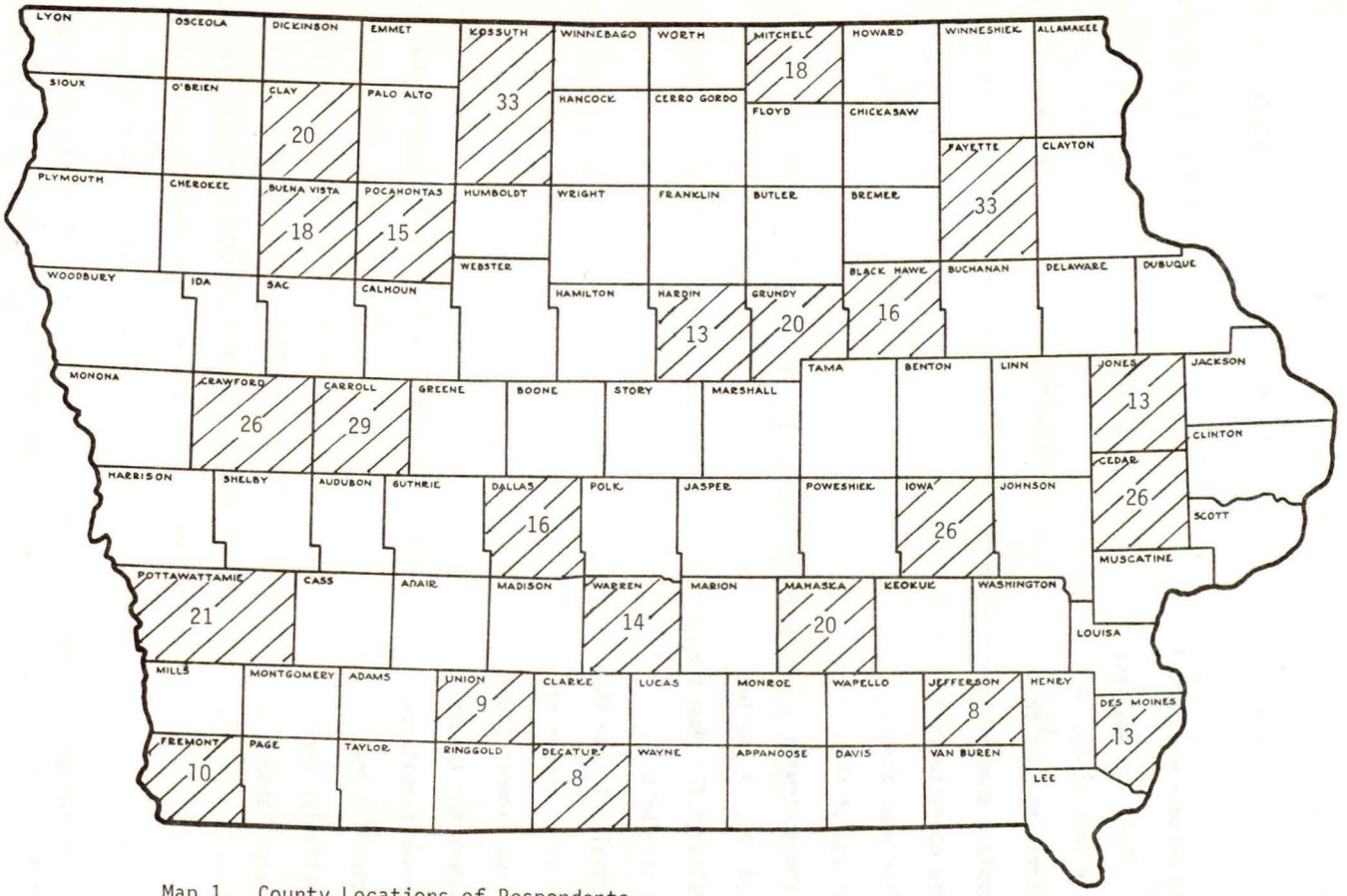
[5] There also is substantial concentration of production in Iowa agriculture, with the top five percent of all farms accounting for about a third of total agricultural sales. Lasley, Paul, and Willis Goudy. Changes in Iowa Agriculture, 1969-1978. Iowa State University: Cooperative Extension Service, PM-1062. 1982.



Map 1. County Locations of Respondents
(Number is telephone interviews in county)

Most of the operators had been farming for a long time (median number of years was 25), although some (16%) had entered agriculture in the past decade. They also displayed substantial longevity in the operation of their present farms, with the median tenure being 19 years.

Representativeness of the Sample

For purposes of this study, only persons who farmed 80 or more acres were interviewed. Thus, the smallest farms in Iowa are not represented in this study. A substantial number (22%) of Iowa farms are less than 80 acres in size. This fact may explain some of the differences (discussed below) in the characteristics of our sample versus the general farm population.

As shown in Table 2, the average age of the respondents (47.5) was similar to the statewide average age of all farm operators (47.2). A smaller number of the respondents were females (1.4%) than the state figure (2.4%). Average farm size of the respondents (448 acres) was substantially larger than the state average (266 acres). A smaller number of the respondents (31%) than of all Iowa farmers (46%) were full-owners (as versus part-owners and tenants). The respondents also displayed a lesser prevalence of full-time, off-farm employment than did Iowa farmers generally (9 and 22%, respectively, were employed 200 or more days off the farm; Table 2).

TABLE 1. CONCENTRATION OF LAND HOLDINGS ON THE SAMPLED FARMS

PROPORTION OF ALL SAMPLED FARMS	TOTAL ACREAGE	AVERAGE ACREAGE PER FARM	PERCENT OF TOTAL ACREAGE ON ALL SAMPLED FARMS
TOP 5 PERCENT	40,010	1,953	22
TOP 10 PERCENT	62,723	1,459	33
TOP 25 PERCENT	103,493	986	55
TOP 50 PERCENT	140,484	666	74

TABLE 2. CHARACTERISTICS OF THE RESPONDENTS AND ALL IOWA FARM OPERATORS*

CHARACTERISTIC	RESPONDENTS (1982 STUDY)	IOWA FARM OPERATORS (1978)
AVERAGE AGE	47.5	47.2
PERCENT FEMALES ARE OF ALL FARM OPERATORS	1.4	2.4
AVERAGE FARM SIZE (ACRES)	448	266
PERCENT OF FARMS OVER 500 ACRES	26	13
PERCENT EMPLOYED ONE OR MORE DAYS OFF THE FARM	48	43
PERCENT EMPLOYED 200 OR MORE DAYS OFF THE FARM	9	22
PERCENT FULL-OWNERS ARE OF ALL FARM OPERATORS	31	46

*IOWA FARM OPERATOR CHARACTERISTICS ARE FROM THE U.S. DEPARTMENT OF COMMERCE, BUREAU OF THE CENSUS, 1978 CENSUS OF AGRICULTURE: VOL. 1, PART 15, STATE AND COUNTY DATA, IOWA. 1981.

CROPPING AND TILLAGE PATTERNS

This study focused on the tillage systems used on two crops -- corn and soybeans. Several different questions determined the number of acres planted (1981) in each of these crops.

Corn Acreage

Corn acreage ranged from zero to 3,400 acres, with the median being 140 acres (average was 213 acres). An average of 46 percent of the acreage on the surveyed farms was planted in corn (Table 3).

Soybean Acreage

Soybean acreage ranged from zero to 3,300 acres, with the median being 80 acres (average was 117 acres). An average of 26 percent of the acreage on the surveyed farms was planted in soybeans (Table 3). A substantially larger percentage of the respondents reported having no soybean acreage than reported no corn acreage (18% and 1%, respectively).

Prevalence of Reduced Tillage

Reduced tillage was defined in this study as any tillage system that does not involve use of a moldboard plow in the preparation of seedbeds. The respondents were first asked for the amount of corn and/or soybean acreage on which they hadn't used a moldboard plow (either in the spring or previous fall) in preparing their 1981 seedbeds.

The amount of corn land on which a moldboard plow wasn't used ranged from zero to 3,000 acres; the median was 120 acres (average was 177 acres). Only 13 percent of all farms that grew corn reported not using reduced tillage on this crop in 1981. This compares with 54 percent who had used reduced tillage on all of their corn acreage. Of the total acreage planted in corn, an average of 76 percent was farmed in 1981 without use of a moldboard plow (Table 4).

The amount of soybean land on which a moldboard plow wasn't used ranged from zero to 800 acres; the median was 30 acres (average was 71 acres). Thirty-six percent of all farms that raised soybeans were not using reduced tillage on this crop in 1981. This compares with 44 percent who reported using reduced tillage on all of their soybean acreage. Of the total acres planted to soybeans, an average of 53 percent was farmed in 1981 without use of a moldboard plow (Table 4).

Toward a More Refined Measure of Reduced Tillage

Because of the smaller amount of crop residue that accrues from soybean production than from corn production, it has not been unusual in the past for farmers to use reduced tillage techniques on fields where corn or soybeans followed soybeans. In order to reflect the full extent of farmers' commitments to reduced tillage, there thus was a need to examine crop rotation patterns. In this study, the respondents were asked how many of the corn and soybean acres on which they had not used a moldboard plow in 1981 had been planted in soybeans the previous year.

As shown in Table 5, a sizeable proportion (average of 70%) of the reduced tillage corn acres had been in soybeans the previous year. As expected, given the usual crop rotation patterns, only a relatively small proportion (average of 9%) of the reduced tillage soybean acres were in soybeans the previous year.

TABLE 3. PERCENTAGE OF TOTAL FARM ACREAGE PLANTED IN CORN AND SOYBEANS, 1981

PERCENTAGE OF TOTAL ACREAGE PLANTED IN DESIGNATED CROP	PERCENTAGE OF ALL FARMS	
	CORN (N=423)	SOYBEANS (N=423)
NONE	1	18
1-25 PERCENT	9	30
26-50 PERCENT	60	49
51-75 PERCENT	24	3
76-99 PERCENT	4	0
100 PERCENT	2	0
TOTAL	100	100
AVERAGE PERCENTAGE OF TOTAL ACREAGE PLANTED IN THE DESIGNATED CROP	46	26

TABLE 4. PERCENTAGE OF TOTAL CORN AND SOYBEAN ACREAGE FARMED IN 1981 USING REDUCED TILLAGE*

PERCENTAGE OF TOTAL ACREAGE UNDER REDUCED TILLAGE	PERCENTAGE OF ALL FARMS	
	CORN (N=418)	SOYBEANS (N=348)
NONE	13	36
1-25 PERCENT	2	5
26-50 PERCENT	8	9
51-75 PERCENT	9	4
76-99 PERCENT	14	2
100 PERCENT	54	44
TOTAL	100	100
AVERAGE PERCENTAGE OF TOTAL ACREAGE UNDER REDUCED TILLAGE	76	53

*REDUCED TILLAGE IN THIS REPORT REFERS TO NONUSE OF THE MOLDBOARD PLOW IN PREPARATION OF SEEDBEDS.

TABLE 5. PERCENTAGE OF REDUCED TILL CORN AND SOYBEAN ACREAGE THAT WAS PREVIOUSLY IN SOYBEANS

PERCENTAGE OF REDUCED TILL ACREAGE PREVIOUSLY IN SOYBEANS	PERCENTAGE OF ALL FARMS	
	CORN (N=361)	SOYBEANS (N=221)
NONE	16	84
1-25 PERCENT	5	3
26-50 PERCENT	12	5
51-75 PERCENT	12	1
76-99 PERCENT	7	0
100 PERCENT	48	7
TOTAL	100	100
AVERAGE PERCENTAGE OF REDUCED TILL ACREAGE PREVIOUSLY IN SOYBEANS	70	9

In light of the demonstrated importance of crop rotation patterns for tillage decisions, the respondents in this study were not classified as having personally adopted reduced tillage unless they were using it in situations where corn or soybeans followed corn. Nonuse of the moldboard plow has been a much more conventional practice in the rotation from soybeans to corn and thus this rotation pattern was excluded from our definition of reduced tillage.

CHARACTERISTICS AND ORIENTATIONS OF ADOPTERS AND NONADOPTERS

Each of the respondents was placed into one of three categories based upon their adoption, or nonadoption, of reduced tillage. Farmers who used reduced tillage (i.e. nonuse of the moldboard plow in preparing seedbeds, either in the spring or previous fall) on some or all of their corn and/or soybean acreage (except where these crops followed soybeans) were "adopters" (67%). Those not presently using reduced tillage, but who expressed an intent to try it, were "potential adopters" (20%). "Nonadopters" (13%) were those who neither used reduced tillage nor had any intent of trying it in the future.

Demographic and Farm Characteristics

Analysis of the personal and farm characteristics of "adopters," "potential adopters," and "nonadopters" revealed important differences between these groups (Table 6). Adopters and potential adopters were younger (average age of both was 46) than nonadopters (54 years). The adopters also had been farming the fewest years (average tenure was 23 years), followed by potential adopters (24 years) and nonadopters (30 years). Furthermore, the adopters and potential adopters had higher levels of educational attainment (82 and 87 percent, respectively, had completed high school) than nonadopters (64 percent had completed high school). Adopters differed from potential adopters in the larger proportion who had some college education (31 and 19 percent, respectively; Table 6).

As regards farm characteristics, adopters farmed substantially more land (average was 509 acres) than either potential adopters (355) or nonadopters (288). They also were renting more land (average was 240 acres) than potential adopters (160) and nonadopters (140). The average gross farm incomes (from sales of all farm products) of adopters substantially exceeded those of both potential adopters and nonadopters (Table 6).

A smaller number of nonadopters (38%) than of the other two groups (50%) were employed in off-farm work. But there was little difference between the three groups in the relative proportion that off-farm income made up of total family income (Table 6).

Risk Orientation

The differential speed with which farmers adopt new farming practices may be attributed partly to variance in their willingness to take risks. Some persons are receptive to trying new things as soon as they become available, although this may entail risk, whereas others hold back until the merits of the practices have been well demonstrated.

We used four statements to measure the risk-taking orientations of the respondents. These statements (which called for a "strongly agree," "agree," "disagree," or "strongly disagree" response) were:

> "I'm the kind of person who is willing to take more risks than others."
>
> "I am generally cautious about accepting new ideas."
>
> "I am a person who likes to try new farming methods."
>
> "I am reluctant to adopt new ways of doing things until I see them working for people around me."

As expected, those who had adopted reduced tillage were more prone to taking risks than were either potential adopters or nonadopters; nonadopters displayed the greatest risk-aversion (Table 7).

To provide a more succinct test of the relationship between adopter type and risk orientation, a "risk-proneness" score was derived by summing

TABLE 6. COMPARISON OF PERSONAL AND FARM CHARACTERISTICS OF PERSONS IN THE THREE ADOPTION CATEGORIES

CHARACTERISTIC	ADOPTION CATEGORY		
	ADOPTERS (N=284)	POTENTIAL ADOPTERS (N=87)	NONADOPTERS (N=54)
(1) AVERAGE AGE	46	46	54
(2) AVERAGE FARM TENURE (YEARS)	23	24	30
(3) EDUCATIONAL ATTAINMENT			
(A) PERCENT COMPLETING EIGHT YEARS OR LESS	10	9	26
(B) PERCENT COMPLETING HIGH SCHOOL	82	87	64
(C) PERCENT WITH A POST HIGH SCHOOL EDUCATION	31	19	15
(4) AVERAGE NUMBER OF ACRES FARMED	509	355	288
(5) AVERAGE NUMBER OF ACRES RENTED	240	160	140
(6) GROSS FARM INCOME, 1981			
(A) PERCENT WITH SALES UNDER $50,000	22	34	48
(B) PERCENT WITH SALES OVER $100,000	40	29	19
(7) PERCENT WITH OFF-FARM WORK, 1981	50	49	38
(8) PERCENT THAT NONFARM INCOME WAS OF TOTAL FAMILY INCOME, 1981	14	15	13

responses to the four attitudinal statements. The responses were scored from one to four, with the larger score reflecting the greatest propensity for risk-taking. The average risk-proneness score of those who had adopted reduced tillage was 10.2, as compared to 9.3 and 8.9 for potential adopters and nonadopters, respectively (Table 7).

Additional analysis of the risk-orientation items revealed that those who were the first to adopt reduced tillage (prior to 1972) differed from the later adopters in their greater receptivity to experimenting with new things without first having to see them used by others. Those who had adopted first, the "innovators," were, in effect, less hesitant than their neighbors to "go out on a limb" in trying something new before its values had been fully demonstrated.

Innovation Orientation

In addition to the four risk-orientation items, a question was asked about the respondents' general willingness to try agricultural practices when they first come along. As shown in Table 8, a sizeable majority of the adopters and potential adopters (82 and 70 percent, respectively) were receptive to trying new practices. But a much smaller proportion (42%) of the nonadopters displayed a receptivity toward trying new things.

Perceived Severity of Soil Erosion

Given the fact that reduced tillage is often promoted as a means of reducing soil erosion, we were interested in whether or not the respondents perceived soil erosion as being a problem -- in Iowa or on their own farms. When queried about the seriousness of soil erosion in Iowa, three-fifths said it was a "large problem" and 34 percent rated it a "medium problem." Only a very few persons (5%) felt that soil erosion was a small or nonexistent problem in the state (Table 9).

The level of concern the farmers displayed about soil erosion in Iowa dropped considerably, however, when they evaluated the seriousness of erosion on their own farms. Here, only 9 percent perceived soil erosion was a large problem, and three-fifths (57%) saw it as a small or nonexistent problem (Table 9). It also was found that those who were using reduced tillage, moreso than the nonadopters, perceived erosion as being a problem on their farms. This differential perception of erosion problems may reflect actual field conditions, but is more likely produced by nonadopters being less sensitive than others to environmental disruption from their farming activities.

Partial Adoption

As has been previously shown, some of the farmers had used a moldboard plow in 1981 on some, but not all, of their corn and/or soybean acreage. There were several reasons for this "partial adoption." First, it was associated with special farming problems, such as rotation out of sod, wet soil, weed problems, and the incorporation of lime and manure.

A second reason for the partial adoption of reduced tillage is that many farmers experiment with new practices before adopting them on a wholesale basis. By first trying reduced tillage, persons can assess its merits without being vulnerable to failure. In fact, the ease of partial adoption (trialability) of reduced tillage seems to be contributing to its rapid diffusion.

The importance of the trial stage for adoption is seen in our finding that most of the adopters (78%) had first experimented with reduced tillage in selected fields before expanding it in their operations. The frequent use of trial applications

TABLE 7. RISK ORIENTATION, BY ADOPTION CATEGORY

STATEMENT	PERCENT OF RESPONDENTS WITH A RISK-PRONENESS ORIENTATION*		
	ADOPTERS (N=176)	POTENTIAL ADOPTERS (N=54)	NONADOPTERS (N=30)
(1) I'M THE KIND OF PERSON WHO IS WILLING TO TAKE MORE RISKS THAN OTHERS	47	28	17
(2) I AM GENERALLY CAUTIOUS ABOUT ACCEPTING NEW IDEAS	28	17	10
(3) I AM A PERSON WHO LIKES TO TRY NEW FARMING METHODS	85	65	53
(4) I AM RELUCTANT TO ADOPT NEW WAYS OF DOING THINGS UNTIL I SEE THEM WORKING FOR PEOPLE AROUND ME	54	34	22
AVERAGE "RISK-INDEX" SCORE**	10.2	9.3	8.9

*A RISK-PRONENESS ORIENTATION WAS "STRONGLY AGREE" AND "AGREE" ON ITEMS 1 AND 3, AND "STRONGLY DISAGREE" AND "DISAGREE" ON ITEMS 2 AND 4.

**THE RISK-INDEX SCORE WAS OBTAINED BY ASSIGNING FROM 1 TO 4 POINTS TO THE RESPONSE CATEGORIES OF THE FOUR STATEMENTS. THE LARGER SCORES REFLECT THE GREATER PROPENSITY FOR RISK-TAKING. THE SCORES RANGED FROM 6 TO 14.

TABLE 8. ATTITUDE TOWARD INNOVATION ADOPTION, BY ADOPTION CATEGORY

ATTITUDE	ADOPTERS (N=186)	POTENTIAL ADOPTERS (N=57)	NONADOPTERS (N=33)
		PERCENTAGE	
POSITIVE: LIKE TO TRY NEW FARMING PRACTICES	82	70	42
NEGATIVE: DON'T LIKE TO TRY NEW FARMING PRACTICES	18	30	58
TOTAL	100	100	100

TABLE 9. PERCEIVED SEVERITY OF SOIL EROSION

RESPONSE	PERCEIVED SEVERITY	
	IN IOWA	ON OWN FARM
	PERCENTAGE (N=282)	
NOT A PROBLEM	--	10
SMALL PROBLEM	5	47
MEDIUM PROBLEM	35	33
LARGE PROBLEM	59	9
UNDECIDED	1	1
TOTAL	100	100

also is seen in the fact that those persons who had most recently adopted reduced tillage (within the past two years) had substantially smaller amounts of their total acreage under this tillage practice than did persons who had adopted it earlier.

Duration of Reduced Tillage Use

Although reduced tillage has been around for many years, for most persons it is a relatively new farming practice. To ascertain the duration of its use among the respondents, persons who were practicing reduced tillage on all or some of their cropland (adopters) were queried as to when it was first used. The duration of use under two crop rotation patterns was examined -- where corn followed corn and where corn followed soybeans.

Reduced tillage in the corn after beans rotation has the longer history, with the period since initial adoption ranging from one to 41 years; the median duration of use was over seven years. Reduced tillage in corn-corn rotation was more recent, with a range of from one to 31 years; the median duration since adoption being less than five years.

It is noteworthy that some farmers have long been practicing reduced tillage. Reduced tillage is not a new idea, although most farm operators have only recently come to it. There have been numerous barriers to a more widespread adoption of reduced tillage, including farmers' concerns about yields, weed problems, and the attractiveness of fields. Also, the heavy hand of tradition (i.e., "my father and grandfather farmed this way") has probably caused some farmers to stick with the moldboard plow.

Perceived Popularity of Reduced Tillage

Not only had many of the respondents personally adopted reduced tillage on part or all of their cropland, many also felt that this practice had become popular in their local areas. When asked how other farmers they knew felt about reduced tillage, the largest number (40%) felt that most preferred it over conventional tillage. An additional 38 percent saw other farmers split about fifty-fifty in their tillage preferences. Fifteen percent said that most farmers were still taking a "wait and see" attitude before making a personal adoption. Only 6 percent perceived most farmers in their areas still preferring conventional tillage (i.e., use of a moldboard plow).

Persons in the three adopter categories disagreed about the positiveness with which other farmers were embracing reduced tillage. A substantial number (50 percent) of the adopter group felt that most other farmers preferred reduced tillage (i.e., not using a moldboard plow). A smaller number of nonadopters (18%), however, perceived most farmers as preferring reduced tillage. Nonadopters saw farmers as being generally split between favoring conventional and reduced tillage (44%), or as taking a wait-and-see attitude (24 percent).

A related question asked the respondents to estimate the proportion of farmers in their local area who were using reduced tillage. Only seventeen percent felt that less than a fourth were using it. A fifth (21%) felt that upwards of three-fourths had adopted reduced tillage, and 50 percent said that half or more were using it.

Again, there was a pattern of selective perception when comparing the responses of adopters, potential adopters, and nonadopters to this question. About two-thirds (63 percent) of the adopters, but only 9 percent of the nonadopters, perceived that half or more of the farmers in their local areas were using reduced tillage. Conversely, nonadopters, to a greater extent than adopters (44 and 8 percent, respectively) felt that less than a fourth were using it.

Opinions About Mandatory Tillage Controls

The opinion is sometimes expressed that farmers should be required to protect the soil; that our society can ill-afford the present rate of topsoil loss from wind and water erosion. We asked the respondents several questions to gauge their personal receptivity to an imposition of more public controls over tillage practices. First, they were asked their agreement or disagreement with the statement: "Fall plowing with a moldboard plow should be prohibited, with a fine imposed on violators." Only a minority (26%) supported a prohibition of moldboard plowing. Those persons who had adopted reduced tillage tended, however, to be the most favorable to prohibition.

A second statement was: "Farmers who exceed a certain limit of soil loss on their land should be forced to pay a penalty." Opinion here was mixed, with 44 percent expressing agreement and 56 percent disagreement. Again, the adopter group was the most amenable to the application of penalties.

Finally, the respondents were asked whether or not: "Farmers need more information about how the use of soil conservation practices will affect their farms." Equally large proportions of the adopters, potential adopters, and nonadopters (about 90%) felt that more information was needed.

Overall, the findings for these three attitudinal items are consistent with previous research in showing that the respondents were receptive to receiving more information about farm problems. Also, that they generally rebel at the idea of being coerced by the government to farm in a prescribed manner. Adopters, however, tended to be somewhat less negative than others toward governmental controls.

ADOPTION STAGES

Previous research has shown that farmers typically rely upon distinct sources of information at various stages in the adoption process. We asked the respondents who were using reduced tillage to identify the sources of information that they had used during the "awareness stage," the "information-evaluation stage," and the "trial-adoption stage."

Awareness Stage

At the awareness stage, or when the farmers had first heard about reduced tillage, mass media represented the most frequently used source of information (Table 10). Forty percent listed mass media (including farm magazines, newspapers, radio and TV) as the source from which they first heard about reduced tillage. Friends, neighbors, and relatives were named by a third of the respondents as this source, followed by government agencies (12%), and commercial dealers (5%). Another 10 percent of the respondents listed other sources.

The relative importance of various information sources in this study is comparable to that shown for the awareness stage in most research on adoption, with the exception here being the ranking of governmental sources ahead of commercial sources. The reordering of these two sources may be partly due to the nature of reduced tillage. Much of the early publicity about reduced tillage grew out of the efforts of government agencies (especially the Soil Conservation Service) and environmentalists to reduce soil erosion. The initial appeal was less directed to income benefits for adopting farmers than has been true of most agricultural innovations.

Information-Evaluation Stage

The second adoption stage identified in this study combined the information and evaluation stages, which often have been separated in previous studies. These two stages, in which an individual is actively seeking additional facts about a practice and going through a mental trial as to its applicability for his farming operation, predate the adoption decision. Previous studies have shown commercial sources, neighbors and friends, government agencies, and mass media, in that order, to be important both at the information and evaluation stages.

The respondents were asked: "After you first heard about conservation tillage, where did you get the information you needed to decide if you should try it on your farm?" Our findings diverge somewhat from past studies in the sources of information which are important during this stage (Table 11). The most often mentioned source was friends, neighbors, and relatives (35%). The next most frequent response was that they had gotten the information on their own (mentioned by 24%), which implies that some were already involved in an on-farm "trial" and were not relying on an external source. This early trial behavior may be due partly to the nature of reduced tillage. This tillage differs from many farm technologies and practices in that it does not necessarily require a large financial outlay. Farmers often already possess the machinery needed to get started in at least some form of reduced tillage. Also, they may have been practicing it in their rotation from soybeans to corn. A second difference is that, unlike hybrid corn, automated livestock

TABLE 10. FIRST MENTIONED SOURCE OF INFORMATION--AWARENESS STAGE

SOURCE OF INFORMATION	PERCENTAGE OF RESPONDENTS (N=276)
MASS MEDIA	40
NEIGHBORS, FRIENDS & RELATIVES	33
GOVERNMENT AGENCIES	12
COMMERCIAL DEALERS	5
OTHER	10
TOTAL	100

TABLE 11. FIRST MENTIONED SOURCE OF INFORMATION--INFORMATION-EVALUATION STAGE

SOURCE OF INFORMATION	PERCENTAGE OF RESPONDENTS (N=277)
NEIGHBORS, FRIENDS & RELATIVES	35
TRIED ON OWN	24
MASS MEDIA	18
GOVERNMENT AGENCIES	12
COMMERCIAL DEALERS	7
OTHER	4
TOTAL	100

feeding systems, and some other new farming practices and products, there is no direct or necessary commercial link in the adoption of reduced tillage. This is probably why commercial dealers rank no higher than fifth, behind both mass media (18%) and government agencies (12%) as an information source for this phase of the adoption process.

Trial-Adoption Stage

Following the information-evaluation stage, the farmer will normally make a decision to either adopt or reject an idea or practice. But before making a wholesale adoption, a practice typically will be tried on only part of one's operation to see how well it works and to determine the specific methods best suited to its fuller implementation. Of our respondents who had adopted reduced tillage, about three-fourths initially tried it on only part of their cropland. Nearly all (97%) of the persons engaged in trial behavior, however, later increased the number of acres on which it was used.

To identify the information sources important to the trial-adoption stages, we asked the respondents: "In deciding to use reduced tillage on your farm, was there any one source of information about it which proved more helpful to you than others?" Only one-fourth (27%) stated that a given source had been especially helpful. Of this group, 23 percent listed commercial sources and dealers as having been the most helpful, with friends, neighbors, and relatives (22%) and mass media (21%) following closely behind. Other sources were government agencies and personnel (mentioned by 16%) and personal experiences (12%). The remaining six percent listed sources apart from these categories.

MOTIVES FOR ADOPTION

Farmers' decisions about whether or not to adopt specific farming practices usually rest on many considerations. Persons identified as "adopters" in this study were given a list of eight reasons which may have influenced their use of reduced tillage. They rated each reason as "very important," "important," "not too important," or "not at all important" to their decision to implement reduced tillage on their farms.

As shown in Table 12, "prevention of soil erosion" was the most important reason for the decision to use reduced tillage; 85 percent rated it as "very important." Other factors also ranking high were reduced fuel expense (rated by 49% as very important) and savings in time and labor (48%). The other five reasons for adoption were given lesser ratings, ranging from 39 percent who saw "soil compaction" as being very important to 18 percent who rated "improved yields" as very important.

It is noteworthy that "advice from others," which was found to be important in the information-seeking process, was seen by relatively few respondents as being important to their final adoption decision. The most compelling factors affecting these final decisions were ecological and/or economic in nature. A sizeable majority of the farmers who had adopted reduced tillage (61%) felt that higher yields were unimportant to their adoption decision. These assessments seem consistent with the finding that reduced tillage may result in yields that are slightly lower than, or at best equal to, those obtained using conventional tillage.

Based upon the results of this study and estimates from other sources, it seems that most farmers are embracing the basic philosophies and techniques of reduced tillage. Obviously, their adoption decisions involve a variety of interlocking rationales. In some ways, it is artificial to isolate any one item, such as soil erosion, as the most important factor in the decision-making process. By itself, concerns about erosion would undoubtedly have less of an effect on decision making than if it were coupled with economic considerations such as fuel reduction. In an era of economic hardship for farmers, energy shortages, and the need to save the soil from excessive erosion, a diverse set of rationale today propel farmers toward changing their operations. Because of the recent convergence of ecological and economic rationale, reduced tillage seems to be an idea "whose time has come."

TABLE 12. REASONS FOR USING REDUCED TILLAGE

REASONS	AVERAGE RATING*	RATING			
		VERY IMPORTANT	IMPORTANT	NOT TOO IMPORTANT	NOT IMPORTANT
		PERCENTAGE OF ADOPTERS (N=284)			
LESS SOIL EROSION	3.76	85	10	2	3
LESS TIME & LABOR	3.11	48	30	7	15
REDUCED FUEL EXPENSE	3.07	49	28	6	17
SOIL COMPOSITION	2.91	39	35	4	22
SOIL COMPACTION	2.89	39	34	6	21
MACHINE WEAR	2.81	36	34	6	24
ADVICE OF OTHERS	2.43	20	36	9	35
HIGHER YIELD	1.92	19	16	4	61

*IN CALCULATING THE AVERAGE RATING, THE RESPONSE CATEGORIES WERE SCORED AS FOLLOWS: VERY IMPORTANT (4); IMPORTANT (3); NOT TOO IMPORTANT (2); NOT IMPORTANT (1).