

THE DIFFUSION OF NO-TILL CORN INFORMATION
AND ADOPTION IN SELECTED COUNTIES
IN VIRGINIA

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INTRODUCTION

The process by which farmers become aware of new farming technology involves the passage of information from one source to another over a period of time. The actual adoption of a technological change passes through a similar pathway as an increasing number of farmers adopt a change, with the passage of time. These processes, whereby the knowledge and the adoption of technological change are spread from one source or location to another, are generally termed: the diffusion of knowledge and adoption or simply the diffusion process.

This diffusion process was responsible for the spread of the no-till method of corn production in Virginia in recent years. Since the early 1960's, when less than 500 acres of no-till corn were planted, use of the method has grown and in 1971 there were an estimated 130,000 acres in Virginia.

A study of the diffusion of the no-till corn method in Virginia is of value not only in following the spread of this particular farming technique, but also in predicting the diffusion path of future farming innovations in the State.

One purpose of this study was to determine the information sources used by farmers and the time element involved in the diffusion of no-till corn information and adoption throughout Virginia. A second purpose was to determine the perceived operational changes caused by a shift to no-till production.

Specific objectives of the study were:

1. To determine the information sources from which farmers first learned of no-till
2. To determine the information sources from which farmers sought additional information before deciding to adopt no-till
3. To study the time element associated with the spread of knowledge about no-till and its adoption
4. To determine changes in cropping program, livestock program and corn yields associated with conversion to no-till
5. To determine the extent of use of state-supported farm related services including the state soil testing laboratory, VPI & SU and branch experiment stations, and Extension agents as information sources

LITERATURE REVIEW

Historical Background of No-Till

No-tillage denotes a procedure where a crop is planted directly into the soil of a chemically-killed sod or crop residue, without prior mechanical seedbed preparation (Moody et al., 1965). Modern interest in reducing the amount of tillage required to produce a corn crop can be traced at least as far back as 1912 when in a USDA publication (Cates and Cox, 1912) six years of testing cultivation methods were compared. From these experiments it was concluded that there was no advantage in cultivation except for weed control and that excessive cultivation could be harmful.

The Ohio Agricultural Experiment Station began tests in 1937 comparing six methods of tillage as follows: (1) standard plowing followed by disking; (2) sod plowing with minimum soil preparation; (3) rotary tillage; (4) subsurface sweep tillage leaving surface trash; (5) sod killed with shallow rotary tillage or disking; and (6) standard plowing, disking plus mulch (Page, Willard, and McCuen, 1946). The authors concluded that tillage should be held to a minimum consistent with meeting acceptable seedbed requirements. Ahlgren (1948) reported on experiments in New Jersey in which tillage was limited to seedbed preparation and weed control was obtained with 2,4-D. In two years of tests normal yields were obtained with this method. In the mid 1950's researchers advocated such minimum tillage methods as wheel-track planting, developed in Van Buren County,

Michigan, (Johnson, 1954), and plow-plant, developed at Cornell (Aldrich, 1955).

Actual no-tillage (or zero-tillage) work with corn was attempted in North Carolina in 1948, but was unsuccessful due to inadequate vegetative control (Klingman and Spain, 1965). An experiment by Dr. George Scarseth in Indiana, reported by Strohm (1952) is one of the earliest successful attempts to grow corn without conventional tillage. In this experiment corn was planted directly in a mulch of weeds and corn stalks using an experimental planter. Weeds were controlled but not killed using two shallow diskings. With heavy fertilizer application, a substantial net profit was realized. This cropping procedure was found to greatly increase erosion control when compared with a neighboring clean-tilled field during a heavy rain.

Tests were begun in 1949 in New Jersey using chemicals for sod kill in pasture renovation tests (Sprague, 1952). These tests showed good control of bluegrass-white clover sod and indicated promise for chemical control of vegetation.

Success with the use of chemical vegetation control for no-till corn planting was reported by Barrons and Fitzgerald (1952). In tests conducted by Dow Chemical Company various herbicides were used on Ladino clover sod, and crops of oats, flax, wheat, corn, and soybeans were planted in the killed sod. Average or above average yields were reported. Again the soil conservation possibilities of this method were recognized, and the authors suggested possible use of this method for crops on hillsides.

Research was continued by Dow Chemical Company in 1953 and 1954 testing several chemicals for control of grasses and broadleaf weeds in no-till corn and soybean culture (Davidson and Barrons, 1954). These tests showed that yields of corn grown, using conventional tillage and chemically killed sod, were essentially the same.

Except for research on no-till strawberries conducted in New Zealand (Porter, 1959), little work was undertaken for several years after the initial studies in the early fifties.

Experiments were begun in 1960 at VPI & SU to compare the effects of several tillage treatments including no-till with chemically killed sod. Partial results comparing no-till with conventional tillage were reported in 1961 (Moody, Shear, and Jones). The growth rate of no-till corn was found to be significantly higher at all measuring dates than the growth rate of conventionally tilled corn. Soil moisture data were collected throughout the growing season and the no-till plots were found to contain more moisture than conventionally tilled plots at all times. Yields were not significantly different for the two methods and it was concluded that the results indicated the feasibility of corn production in a killed sod without tillage.

Soon after experiments were begun in Virginia, corn was being produced by the no-till method. Sherman Gold, a Soil Conservation Service employee in the hilly Holston River District, Virginia, was an early promoter of the no-till method to expand corn acreage (Shear, 1968). In 1960, 150 acres of no-till corn were planted on

12 farms with the aid of a sod planter modified by Soil Conservation Service workers (Gold, 1967). Three years of field production showed reduced erosion during hard rains with no-till.

Field research on no-till corn has continued in Virginia. Experiments have been conducted comparing conventional and no-tillage systems from the aspects of soil moisture conservation and corn growth and yield. The results of six years of field tests showed that corn growth and yield were increased with no-till when compared with conventional tillage (Jones et al., 1968). Additional comparisons of tillage systems found lower runoff and higher soil moisture with no-till (Jones, Moody, and Lillard, 1969).

In addition to research dealing with the crop yield and soil aspects of no-till, experiments have been conducted on crop rotations and cover crops suited to no-till production (Moschler, Jones, and Shear, 1969; Moschler et al., 1973). The various benefits of cover crops and crop rotations including small grains, orchard grass, and orchard grass-red clover have been investigated and it has been shown that crop rotation is unimportant in yield determination if a suitable mulch is provided by the cover crop and weed control is obtained (Moschler et al., 1973).

Research has continued in other states as well, with the success of the no-till system differing in various sections of the country (Shear, 1968). Since its early beginnings, no-tillage corn production has grown into a major production method in certain areas of the country with promise of greater future use.

The Diffusion Process

The diffusion of information about new farm techniques and subsequent adoption of these techniques require the communication of different kinds of information (Wilkening, 1956). Several researchers have undertaken to study the sources of this information (Bohlen and Beal, 1957; Lionberger, 1954; Mason, 1964; Ryan and Gross, 1950) while others have studied the characteristics of those who first adopt new practices and therefore first utilize this information (Bohlen and Beal, 1957; Lionberger, 1955; Photiadis, not dated).

Bohlen and Beal (1957) divided the diffusion process into five steps or stages which they termed: (1) Awareness stage, (2) Interest stage, (3) Evaluation stage, (4) Trial stage, and (5) Adoption stage. Other investigators have followed this same general division (Mason, 1964; Wilkening, 1952; Wilkening, 1956; Copp, Still, and Brown, 1958; Subcommittee, 1955) and refer to essentially the same stages.

As well as referring to essentially the same stages of adoption, diffusion researchers recognize that, generally, different sources are utilized for information in the different stages (Bohlen and Beal, 1957; Mason, 1964; Wilkening, 1956; Copp et al., 1958; Photiadis, undated; Wilkening, Tully, and Presser, 1962; Subcommittee, 1955).

Mass media has been shown to be the most common source of first learning about new practices (Wilkening et al., 1962; Copp et al., 1958; Mason, 1964; Subcommittee, 1955; Bohlen and Beal, 1957).

Bohlen and Beal (1957) found that mass media was still the most common information source in the interest stage with government agencies such as Extension workers and Soil Conservation Service workers the second most common source. In the evaluation stage, Bohlen and Beal (1957) and Subcommittee (1955) reported that neighbors and friends constituted the most frequently consulted information source and government agencies the second most frequently consulted source. These two sources were also cited as the major disseminators of information in both the trial and adoption stages (Bohlen and Beal, 1957; Subcommittee, 1955). Mason (1964) reported that the use of mass media is lower in the final adoption state than all other sources and that the use of authoritative (agencies), peer (neighbor), and commercial sources is consistently increased as the farmer passes through the stages of the adoption process.

Lionberger (1954) found that less than one percent of those interviewed had received farming information directly from meetings at the agricultural college. Extension bulletins were used by 23.0% of the respondents and 30.0% obtained information from the county Extension agent. Other farmers, including friends, relatives, and neighbors were the most frequently cited source with 90.0% of the respondents indicating that they obtained information from this source.

Wilkening (1956) found that 62.7% of the respondents indicated farm papers, farm magazines and newspapers as the communication agent through which they usually first learned about new ideas. In

addition, 47.0% of the respondents listed other farmers as the most helpful factor in deciding to try out a new idea and 34.7% indicated the county agent and the university were frequently consulted to obtain the necessary information to carry out the idea.

In a study on contacts with agricultural agents Photiadis (undated) found that 65.6% of those interviewed indicated farm papers and magazines as the most helpful source of information about new farming practices over all stages, 21.0% indicated neighbors and friends, while 13.9% considered talks with the county agent the most helpful overall source.

Farmers who first pass through the adoption stages, first use the information sources, and who are the first in their community to adopt a new practice, are considered innovators (Bohlen and Beal, 1957). Rogers and Burge (1961) divided adopters into five categories: (1) innovators, (2) early adopters, (3) early majority, (4) late majority, and (5) laggards. It was found that innovators generally had larger farms, had relatively higher net worth, and subscribed to more farm-related publications than those who adopted a practice later. Lionberger (1955) found that early adopters had larger farms and were more frequent users of the county agent as an information source than those who adopted later. Ryan and Gross (1950) correlated earlier adoption with larger corn acreage and found significant difference between extreme acceptance groups with a steady drop in corn acreage with each adoption category.

Use of the Mail Questionnaire

Several researchers dealing with farm innovation diffusion have used personal interviews to gather information (Photiadis, undated; Wilkening et al., 1962; Rogers and Burge, 1961). A study conducted in Iowa by Beal and Bohlen (A.O. Andapia, 1964. Adoption proneness and response to mail questionnaires. M. S. Thesis. Iowa State University), however, made use of the mail questionnaire technique of information assimilation.

The use of a mail questionnaire for data collection has been condemned by some researchers due to difficulty in securing adequate response; however, with certain precautions it has been found to be a satisfactory method (Moser and Kalton, 1972). Cohen and Lipstein (1954) found that results of a mail questionnaire when compared with data obtained by personal contact were consistent and that reporting bias and reporting errors were small and compensatory. Greenberg and Manfield (1957) studied three groups of respondents and found highly similar responses in personal interview results among respondents and non-respondents to a mail questionnaire. They also found that mail survey non-respondents showed essentially similar attitudes as those who responded to the questionnaire. From their study they concluded that a mail survey including 65.0% of the sample provided results that were representative of the entire sample.

Several researchers have investigated methods of increasing returns of a mail questionnaire. Sponsorship of the survey was

found important by Moser and Kalton (1972); for the same questionnaire when sent by a government agency achieved a 93.0% return, an 89.0% return when sent by a university and a 90.0% return when sent by a commercial organization. The importance of a covering letter, which replaces the interviewer, was stressed by Moser and Kalton (1972). The covering letter should make clear why and by whom the survey is being undertaken and why the addressee should take the trouble to reply (Moser and Kalton, 1972).

One of the most effective methods of increasing returns is the follow-up, consisting of a reminder letter, a stamped return envelope and another copy of the questionnaire (Tallent, 1959; Moser and Kalton, 1972; Kephart and Bressler, 1958). In one survey 74.8% returns were obtained with no reminder and 95.6% returns with two reminders (Moser and Kalton, 1972). Another survey determined that there was no advantage in the second follow-up; that one follow-up produced the best results (Tallent, 1959).

To be able to utilize the follow-up and still insure anonymity of the respondent, Brant (1955) suggested use of the "postcard technique." This technique makes use of a postcard stating that the respondent has returned the questionnaire. This postcard is then returned by separate mail. This allows a follow-up of those who do not respond to the first mailing without the necessity of having the respondents sign the questionnaire or using numbered questionnaires.

Moser and Kalton (1972) suggested the follow-up letter be sent

one week after the original mailing; however, Bradt (1955) suggested following a daily curve of returns to determine the most optimum time for the follow-up.

Another technique for increasing returns is the use of stamped rather than franked return envelopes which has been determined to increase the returns of a mail questionnaire (Roehrer, 1963; Moser and Kalton, 1972).

As evidenced by relevant literature, there are certain guidelines and precautions which if followed will increase the chances of obtaining a successful survey and will help insure adequate returns to draw inferences about the population.

METHODOLOGY

The population for this study included all known no-till growers in 28 of the 31 major no-till corn producing counties in the State of Virginia. Counties that were in the study were selected by Extension Specialists and a list of names of known no-till growers was obtained from county Extension personnel in each county included in the survey. The completed list contained 1,189 names and represented the majority of no-till growers in the State of Virginia.

There was no control group in this study. The study is exploratory in nature in that it seeks to obtain information on a subject not previously investigated.

Data were collected in the summer of 1973 using a mail questionnaire. The form was two and one-half pages long and contained 16 questions. (See Appendix B.) It was designed to gather data concerning information sources and operational changes connected with the conversion to the no-till method. Questions were also included pertaining to no-till corn acreage for the 1973 season and use of the state soil testing laboratory, branch experiment stations, and county Extension agents as farming information sources. Responses were indicated by checking the appropriate blank or by writing in a short reply.

The "postcard technique" and one follow-up were used, as previously described, to help insure adequate returns. The follow-up

was mailed three weeks after the initial mailing.

Questionnaires were precoded to simplify computer analysis of the data. A cross-tabulation of variables was compiled by the computer which included percent response. Each possible response to a question was considered a variable. Independent variables of this study were year of awareness, year of adoption, acreage, county of residence, contacts with the county agent per year, and lag time or the difference in years between year of awareness and adoption.

RESULTS AND DISCUSSION

Returns

Six hundred and thirty-nine questionnaires were returned which met the requirements of this study. An additional 95 were returned with a notation that the respondent did not produce no-till corn. Based on total returns 62.0% of those polled responded, with 57.3% of the total usable.

The Diffusion of No-Till

As previously stated one objective of this investigation was to study the spread of knowledge about no-till corn production and the actual adoption of the method. Included in this are information sources used by individuals in the learning process, those information sources considered most beneficial, and the time difference between awareness and adoption.

Time Factors

The percentage of respondents who first heard of or first adopted no-till in a given year is shown in Figure 1. The spread of knowledge is somewhat concentrated in the years 1967 through 1969. During this three year period just over one-half of the respondents (51.5%) became aware of no-till. Similarly, in 1968 through 1970 over one-half (55.0%) became adopters.

The spread of information and adoption have very similar curves,

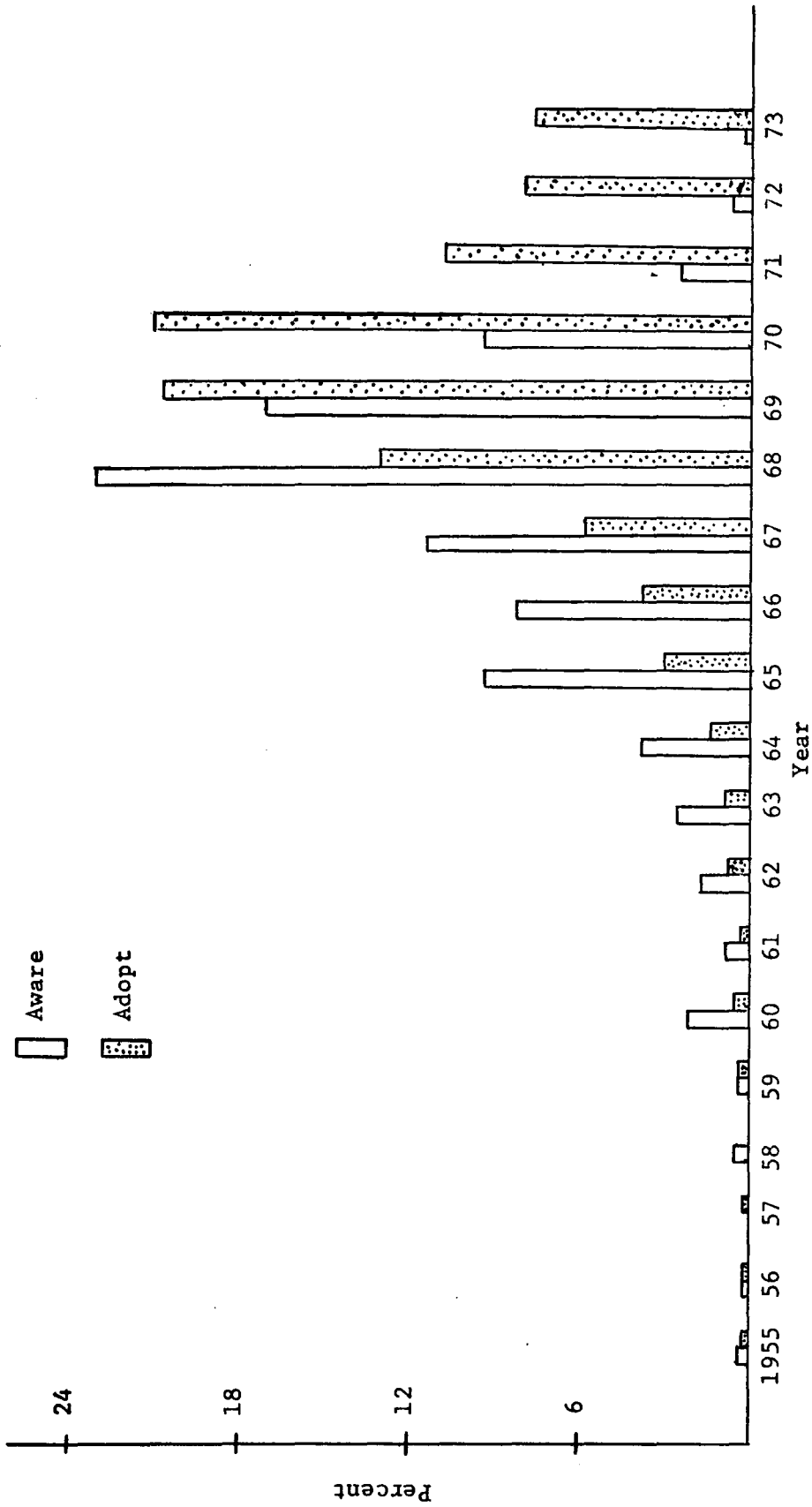


Fig. 1. Percentage of Respondents Becoming Aware or Adopting No-Till Corn in 1955-1973.

with both displaying a long slow period of growth prior to 1965; when percentage adopting and becoming aware more than doubled in one year. The observation that there is no lag between the first year of awareness and the first of adoption, can be made upon inspection of Figure 1. Other research dealing with farm innovation has found a lag of one to several years between the first to become aware and the first to adopt (Beal and Rogers, 1960; Ryan and Gross, 1950). The mode year for awareness occurred 13 years after the first respondent heard of the no-till method. The mode year of adoption came 15 years after the first case of no-till adoption. (There is only 0.3% difference in adoption for 1969 and 1970; therefore, either year could be considered the mode.) The mode year of adoption, therefore, followed the mode year of awareness by roughly one year.

From the cumulative adoption and awareness curves in Figure 2, it can be seen more clearly that adoption lagged an average of two years behind awareness through much of the diffusion process. By the beginning of 1970 just over one-half of the farmers had adopted no-till, whereas by this same time, over 80% were aware. The curve for awareness follows closely the normal growth curve, but the adoption curve does not reach the point of decreasing slope in the time period under study.

Individuals who adopted no-till during different time periods had different lag periods between awareness and adoption. Those who were among the first to adopt had the shortest lag time and the last to adopt had the longest lag time. (See Table 1.) Those who became

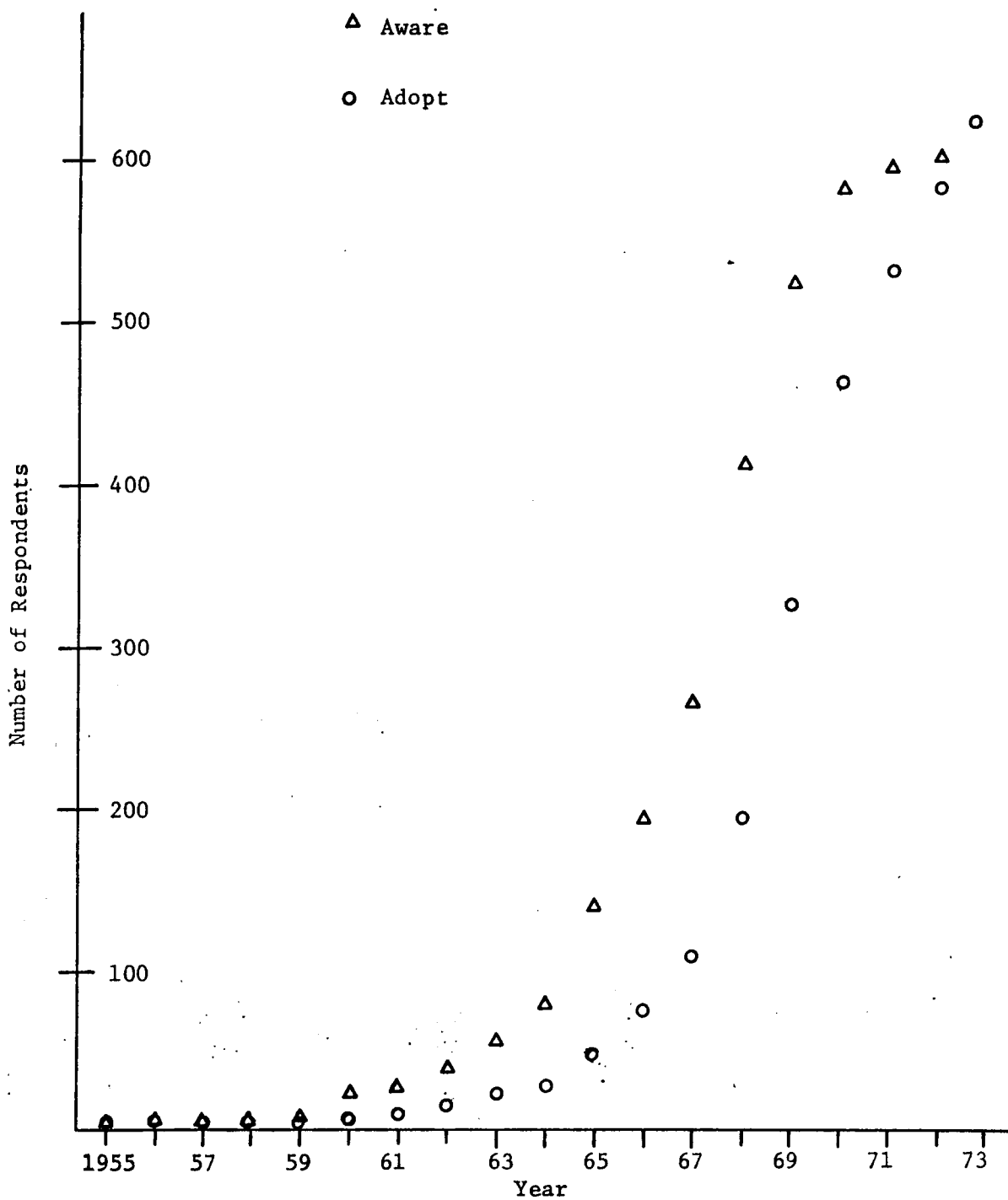


Fig. 2. Cumulative Respondents Aware of or Adopting No-Till Corn in 1955-1973.

Table 1. Percentage of Respondents in Four Adoption Periods with Specified Lag Times.

Lag Time Years	Respondents Adopting No-Till Corn				All Respondents
	Percent before 1965	Percent in 1965-68	Percent in 1969-71	Percent in 1972-73	
0	34.4	26.2	17.0	3.4	19.8
1	31.1	36.9	38.0	12.4	33.6
2	31.0	14.4	21.9	13.5	19.1
3	3.4	15.6	10.5	19.1	12.8
4	0.0	1.9	4.0	23.6	6.1
5	0.0	1.9	6.2	10.1	5.3
6	0.0	1.3	0.9	3.4	1.2
7	0.0	1.3	0.6	4.5	1.2
8	0.0	0.6	0.6	4.5	1.0
9	0.0	0.0	0.0	1.0	0.2
10 and over	0.0	0.0	0.3	4.5	0.8
No. of Cases	29	160	324	89	602 ^{1/}
Mean Lag	1.0	1.5	1.8	3.9	1.8

^{1/} Lag unobtainable for 37 cases.

adopters before 1965 averaged only one year between awareness and adoption whereas those who adopted between 1972 and 1973 (inclusive) averaged 3.9 years. Just over one-half of those who adopted in 1972 and 1973 had heard of no-till by about 1968 but took over twice as long to decide to adopt as the other groups. Just over one-third (36.7%) of those who became aware before 1965 adopted no-till before 1965. Awareness early in the diffusion cycle did not necessarily lead to adoption early in the cycle.

Considering all respondents, most adopters did not delay many years after becoming aware, for the average lag was only 1.8 years, almost three-fourths (72.5%) waited two years or less, and only 4.4% waited over five years to adopt.

Although the adoption of no-till required some change in technology and equipment (either purchase of equipment, modification of equipment, or use of custom work) the lag times found are considerably shorter than those found by Ryan and Gross (1950) for the adoption of hybrid seed corn which required no change in operation. The average lag time is very similar, however, to that found by Beal and Rogers (1960) for the adoption of 2,4-D and antibiotics. Since adoption lagged an average of only two years behind awareness, it appears that the rate of the spread of knowledge was somewhat of a deterrent in the adoption process.

Information Sources

The spread of knowledge about no-till corn or any farm innovation is a complex network beginning usually with primary sources such as universities, private companies and other research facilities spreading to secondary information sources such as farm journals, the Extension Service, Soil Conservation Service, and other agencies, finally down to the intended recipient, the farmer.

Information sources were determined for the awareness stage of the diffusion process. Since previous studies have shown that the same information sources remain important throughout the last three stages of the diffusion process, these stages were combined into one question. Additional information sources, especially those indicated as most beneficial are considered to be the influencing sources in the adoption stage for this study since all respondents were adopters.

The information sources used in the awareness by respondents in four periods of awareness are shown in Table 2. Previous studies have found that the influence of various information sources for both awareness and adoption tends to change with the passage of time (Wilkening, 1952; Ryan and Gross, 1950). Those sources, which are most important early in the awareness stage, are replaced by other sources later in the sequence. As can be seen in Table 2, however, this is not the case for most of the awareness sources. The influence of neighbors as an awareness source did increase through the periods and the farm supply dealer increased somewhat as a source. The other sources remained fairly constant throughout the cycle without the expected

Table 2. Information Sources of Respondents in Four Awareness Groups.

Awareness Source	Percent Before 1965	Period of Awareness				Percent all Respondents
		Percent in 1965-68	Percent in 1969-71	Percent in 1972-73	Percent in	
Farm Journals	69.6	72.0	63.4	60.0	69.0	
Newspaper	2.5	3.9	2.2	0.0	3.0	
Radio-T.V.	0.0	3.0	1.6	0.0	2.0	
County Agent	50.6	54.1	47.3	20.0	51.3	
Vocational or Veterans Class	1.3	6.3	4.8	0.0	5.2	
Farm Supply Dealer	20.2	26.1	27.4	0.0	24.7	
Neighbor	36.7	48.6	56.6	80.0	49.3	
<hr/>						
Most Beneficial Awareness Source						
Farm Journals	35.4	27.4	27.4	0.0	28.8	
Newspaper	0.0	0.3	0.3	0.0	0.2	
Radio-T.V.	0.0	0.6	0.0	0.0	0.3	
County Agent	45.5	43.3	33.2	20.0	40.2	
Vocational or Veterans Class	1.3	2.9	2.2	0.0	2.3	
Farm Supply Dealer	11.4	17.8	18.2	0.0	17.2	
Neighbor	25.2	34.0	41.4	80.0	35.5	
<hr/>						
Number of Cases	79	333	186	5	612 ^{1/}	

^{1/}Data missing for 27 cases.

decline in the use of farm magazines (farm journals). Use of the county agent was greater than would be expected from past findings. This was especially true in the early years. County agent use also showed little tendency to change during the diffusion. Overall, the greatest source of first knowledge was farm journals with a 69.0% response. The next most widely used source was the county agent with a 51.3% response, followed by neighbors with a 49.3% response. Respondents used an average of 2.0 sources in the awareness stage.

Sources considered most beneficial in the awareness stage were somewhat different from those found important in the spread of first knowledge. Farm journals were replaced as first choice by the county agent in this category with a 40.2% response followed by neighbor with a 35.5% response. There was a slight decrease in percentage checking both farm journals and county agent from earlier to later awareness periods, and percentage choosing farm supply dealer and neighbor as the most beneficial awareness source increased slightly in later periods. Farm journals, the county agent and neighbors were clearly the major sources of the awareness stage in the diffusion of no-till corn. The order of their importance varied somewhat from sources of first knowledge to those considered most beneficial, but these three are clearly the principal media through which most respondents first learned of no-till corn.

Respondents were asked to indicate the sources used in their quest for information following the awareness stage. While the attainment of first knowledge may often be a passive process (i.e. an

individual may become aware of an innovation by chance while reading a farm publication or talking with a neighbor who is aware of the innovation), the search for further information is, however, an active one. It would, therefore, be expected that the importance of the various information sources would vary from the awareness to the adoption stage. This was the case, for in the awareness stage, farm journals were most frequently cited (69.0%) while in the adoption stage they ranked only fourth as a source (Table 3).

There was an increase in the percentage using farm journals in the later years. This is the opposite of the expected for previously it has been found that use of mass media sources (farm journals, newspapers, radio, etc.) declined in later years. The importance of farm supply dealers as an information source greatly increased over the awareness stage as farmers sought specific information on equipment and materials needed for the change from conventional to no-till corn production. The percentage assigning farm supply tended to change little from early to late years of the adoption stage. The use of the county agent although high in the awareness stage, increased even more during the active information seeking period. The role played by neighbors increased with the passing years as more farmers became adopters and therefore in a position to give advice on no-till corn production. Respondents used an average of 2.2 sources in the adoption stage.

Of the sources listed the county agent was considered most beneficial over other sources by 45.5% of the respondents. (See

Table 3. Information Sources of Respondents in Four Adoption Groups.

Additional Information Sources	Period of Adoption				Percent all Respondents
	Percent Before 1965	Percent in 1965-68	Percent in 1969-71	Percent in 1972-73	
Farm Journals	24.2	33.5	39.4	31.4	35.7
Newspaper	0.0	1.2	2.4	1.0	1.9
Radio-T.V.	0.0	1.2	1.8	3.9	2.0
County Agent	69.0	76.9	66.1	65.9	68.9
Vocational or Veterans Class	0.0	4.9	5.4	8.9	5.6
Farm Supply Dealer	41.4	45.6	54.1	45.0	50.1
Neighbor	24.1	39.6	57.6	61.0	51.5
<hr/>					
Most Beneficial Additional Information Sources					
Farm Journals	10.3	12.8	10.4	8.0	10.5
Newspaper	0.0	0.6	0.3	1.0	0.5
Radio-T.V.	0.0	0.6	0.6	0.0	0.3
County Agent	51.7	54.4	43.4	40.0	45.5
Vocational or Veterans Class	0.0	1.2	2.7	1.0	1.9
Farm Supply Dealer	20.7	21.3	27.6	16.0	23.8
Neighbor	17.1	21.9	31.2	47.9	31.0
<hr/>					
Number of Cases	29	164	337	99	629 ^{1/}

^{1/} Data missing for 10 cases.

Table 3.) Neighbors followed in importance behind the county agent with a 31.0% response and farm supply dealer was third with a 23.8% response. It can be seen that the order of importance for most beneficial sources is exactly the same as that for additional information (i.e. (1) county agent, (2) neighbor, (3) farm supplier). This was not the case in the awareness stage for the order of importance changed from introductory sources to those considered most beneficial.

While farm journals were the major source of first knowledge, the county agent and neighbors also played an important role in the dissemination of introductory knowledge. In addition, the county agent and neighbor were considered the most beneficial sources in the awareness stage; in the adoption stage these two sources play a major role both as influencing sources or those considered most beneficial. Rather than two very distinct media responsible for the information diffusion in the two stages, there appears to be an overlap of important media between awareness and actual adoption. While farm journals were the most prevalent source of first knowledge and the county agent was the major source of additional knowledge, the role of neighbors cannot be discounted in either case.

In addition to the possible information sources listed on the questionnaire, a space was provided for respondents to list "other" sources they had used in each category. Some of the sources given in the awareness stage included the Soil Conservation Service, Young Farmer Association and the Piedmont Experiment Station. In the adoption stage "other" responses included Soil Conservation Service,

chemical supply companies and the Piedmont Experiment Station. Each of these sources was given by five or more respondents and they no doubt played a role in some areas in the spread of knowledge.

No-Till Corn Acreage

Information was obtained as to the number of acres each respondent planted to no-till corn in the 1973 growing season. The number of acres planted ranged from zero to 600 acres. Some 60 operators indicated that they had not planted no-till in the 1973 season for various reasons but considered themselves no-till growers. The percentage of growers who fell within given acreage ranges is shown in Table 4. Excluding those who failed to plant in the 1973 season, over one-half (58.1%) planted less than 51 acres, and over three-fourths (76.1%) planted less than 101 acres. The average acreage for those who planted no-till corn in 1973 was 59.4 acres, with a total for all respondents of 34,416 acres. The total acreage by counties of the study is shown in Figure 3. Loudoun County had the greatest acreage with 6,149 acres and Prince Edward had the least with 39 acres.

In the past it has been found that earlier adopters tend to use the innovation on more acres (where applicable) than later adopters. Such was the case with hybrid corn studied by Ryan and Gross (1950) where it was found that average hybrid corn acreage dropped steadily from early to late adoption groups. This does not appear to be true for no-till corn growers in this study. When acreage was determined for the adoption groups, no steady trend could be determined. The last adoption group had on the average about half of the acreage of the other groups but there was little difference among the other adoption groups. (See Appendix A, Table 1.) It appears then that

Table 4. Percentage of Respondents with 1973 No-Till
Corn Acreage in a Given Range.

Acreage Range	No. Cases	Percent of Total
0	60	9.4
1-10	71	11.1
11-20	107	16.7
21-30	77	12.0
31-40	69	10.8
41-50	48	7.5
51-60	42	6.6
61-70	24	3.8
71-80	17	2.7
81-90	17	2.7
91-100	18	2.8
101-200	64	10.0
201-300	15	2.3
301-600	10	1.6

adoption time did not influence no-till corn acreage for respondents.

Operational Changes Due to No-Till

The decision to adopt an innovation and make the operational changes necessary for its adoption is based on accumulated knowledge and reasoning specific for the farmer and his farming operation. The instigation of this innovation may lead to secondary changes in farm operation and management related to but different from those needed for the adoption.

Reasons for Converting to No-Till

The adoption of any innovation such as no-till corn which necessitates an operational change and some capital investment must be judged to be worth the investment by the adopter. The reasons given for the adoption of an innovation therefore generally reflect this expectation of economic benefit. This assumption is borne out by the responses of most of the operators. By far the most frequently cited reason for the change was the expectation of less time and/or labor involved with production (73.1% response). The ability to expand corn production to land not suited to conventional tillage was another popular motive (47.6% response). Of lesser magnitude were the expectation of greater yields (23.2% response), the expectation of lower production costs (18.3% response), and dual use of fields (22.1% response).

Space was provided to write in responses of other reasons for

the conversion. By far the most frequently added or "other" response dealt with erosion control or soil conservation. This was considered a determining factor for 65 respondents or 10.2% of the total. Ten respondents or 1.6% indicated conservation of soil moisture influenced them and 12 or 1.8% indicated that rainy spring weather with fields too wet to plow influenced their conversion to no-till corn.

Changes in Operation

Associated with the adoption of an innovation are frequently other operational changes more indirectly related to the innovation. These changes could be in cropping program, livestock program, or other management areas.

When asked if the change to no-till had caused a change in their cropping program 76.7% of the respondents indicated that it had. The most common change accredited to no-till concerned reduced labor requirements of no-till as opposed to conventional tillage (68.2% response). Many farmers indicated that they were able to grow more acres of corn due to the change to no-till production (46.8% response). The necessity of purchasing new or different equipment was attributed to the change to no-till production by 44.4%. A change in crop rotation, dual cropping (two crops/field/year) and use of less mechanization were all changes due to no-till for about 25% of the respondents. In all, respondents felt that the conversion to no-till caused an average of between two and three changes in their cropping program. (The average response was 2.5 changes each.)

Although production of no-till corn requires a special planter, only 44.4% of the operators purchased new or different equipment due to the change to no-till production. This may suggest use of custom planting work or equipment sharing by several farmers. Possibly in some cases existing equipment was modified for use with no-till.

Only one response was written in as an "other" cropping change accredited to no-till. This dealt with reduced erosion with no-till and was given by 11 respondents.

The great majority of respondents, 94.5%, indicated that they had a livestock program. The possibilities for changes in livestock programs were more limited than for cropping programs. The most prevalent change was increased herd size following the adoption of no-till (46.0% response). A few operators changed from one type of livestock to another (5.0% response) and 0.8% raised less livestock. The remainder (45.4%) had experienced no change in livestock program. The major change then was an increase in herd size for just under one-half of the farmers. The percentage who reported an increase in herd size is almost equal to the percentage who reported an increase in corn acreage (46.0% and 46.8% respectively) due to the conversion to no-till corn. This may suggest that many of those who were able to increase corn acreage increased their livestock herd to utilize the additional corn produced.

Another source of increased corn production came as increased yields and may well have played a part in the increased herd size of some respondents. Just over one-third (36.6%) experienced an increase

in yield after converting to no-till. The majority of farmers (52.1%) experienced no appreciable change in yield, however.

A summary of the operational changes brought about by conversion to no-till is given in Appendix A, Table 2.

Problems Associated with No-Till

Almost every farming innovation, although beneficial to its adopters, brings with it some inherent and sometimes unique problems. No-till also has its own associated problems.

On the average each respondent checked 1.4 problem areas as those experienced since changing to no-till. When asked to indicate the areas in which they would like additional information the number of areas checked was almost the same as for the problem areas (1.7 average). The most prevalent problem with no-till production was weed control as evidenced by a 55.7% response with 56.0% desiring additional information in this area. Insect control appeared as a common problem with 48.8% checking this area, and 45.1% desiring additional information. The only other major problem was planting, with 20.7% checking it, and 16.3% desiring more information in this area. Although only 4.7% experienced problems with fertilization, 15.0% indicated they wanted additional information on fertilization. There were about twice as many respondents desiring information on disease as considering it a problem (11.9% and 6.1% respectively).

Crop rotation was an additional category of information requests, and was not included in the question on problems. Response was fairly

good with 23.9% of the operators indicating a desire for additional information on crop rotation.

There were several "other" problems given by respondents. The most common "other" response indicated that some respondents had experienced problems obtaining a good stand of no-till. Thirty farmers added this to the list of problems. Others indicated problems with bird and mouse damage to seeds and seedlings. An addition to the list by 22 respondents or 3.5% indicated no problems had been experienced up to that time. No "other" responses of any significance were made to the list of additional information areas on the questionnaire.

The most prevalent problems in no-till production found were weed and insect control as evidenced by the responses of most operators. These are problems which are certainly not unique to no-till production, but may be aggravated by the ground cover which is essential to the method. A summary of the problems experienced with no-till is given in Appendix A, Table 3.

Utilization of State Soil Lab, Branch
Stations and the County Agents

The extent to which the no-till growers used certain state supported farm agencies for information was determined in addition to information directly related to the adoption of no-till corn. This information can probably be used as a guide to many Virginia farmers' use of these facilities. This is possible since most farmers had moderate no-till corn acreage, the great majority had

livestock programs in addition, and therefore cannot be considered specialized farmers but rather are more general and diversified in farm operation.

Use of the state soil testing laboratory was high among respondents with 91.5% indicating that they had sent soil samples to the lab within the past five years. A chi square test for independence found no significant relationship between count of residence and use of the state soil lab (Chi square=59.88, d.f.=54; not significant at the 5% level). It appears then that location or distance from the state soil testing laboratory did not affect use by farmers.

The majority of respondents (70.0%) also obtained farming information directly from VPI & SU or one of the branch stations within the previous five year period. This is a greater percentage than would be expected to make direct contact with primary information sources such as the university and branch stations from findings of previous studies (Bohlen and Beal, 1957; Lionberger, 1954). As with the soil lab use, county of residence played no significant part in use of these facilities. A chi square test for independence found no significance between county of residence and use of these facilities. (Chi square=60.67, d.f.=54; not significant at the 5% level). Again it appears that distance from these facilities was not a factor in their use.

The county agent was contacted for information during the previous five year period by 91.1% of the respondents. Slightly

fewer (0.4%) farmers had contacted the county agent during the period in question than contacted the state soil lab.

Those who had contacted the county agent was requested to indicate how many times per year they normally did so. Responses ranged from one to 65 times per year. Forty-one respondents (6.4%) indicated that they contacted the county agent "when needed" or a similar statement which could not be interpreted as a number. Of those who replied with a number, the majority (66.3%) contacted the county agent from one to six times a year and 77.0% from one to 12 times. Only 7.7% had more than 12 contacts per year.

To test the relationship of number of county agent contacts per year to several variables associated with the changes caused by conversion to no-till corn and reasons for the conversion, a chi square test for independence was used.

No relationship was found between county agent contacts and a change in yields, either increased or decreased yields, following conversion to no-till. For increased yields chi square=26.14, d.f.=28; not significant at the 5% level, for decreased yields chi square=24.33, d.f.=28; not significant at the 5% level. Only two of the possible changes in cropping program were significantly related to the number of contacts with the county agent. Significant at the 5% level were the use of less labor with no-till (chi square=40.79, d.f.=28) and an increase in corn acreage (chi square=43.06, d.f.=28). All other possible changes in cropping program were not significant at the 5% level. There was no significant relationship

between any of the possible changes in livestock program and county agent contacts at the 5% level.

SUMMARY AND CONCLUSIONS

The spread of knowledge and adoption of no-till corn began in 1955, and was still in progress at the time of this study. The majority of farmers in the study, however, became aware or adopted within a relatively short interval of this time span.

Most farmers delayed a relatively short time to adopt after becoming aware. Later adopters delayed longer than those who adopted early in the diffusion process.

The sources from which farmers first learned about no-till corn differed somewhat from the sources influencing them to adopt. Some of the same sources were important in both stages but the extent of use varied between stages. The one major source of awareness was farm journals and the one major adoption influencing source was the county agent.

Reasons given by respondents for converting from conventional to no-tillage were varied. The major reasons given were increased acreage and reduced time and labor with no-till.

The major benefits perceived by farmers as a result of their conversion to no-till were reduced labor, increased corn acreage and an increase in livestock capacity.

The major problems associated with no-till were weed and insect control.

The use of state supported farm-oriented agencies was relatively high with the great majority of farmers using all three agencies listed.

Number of county agent contacts per year was significantly related to a decrease in labor use and an increase in corn acreage following the conversion to no-till production.

In general, the respondents in this study are diversified enough in farming operation not to be classified as specialized farmers. Returns of the questionnaire were sufficient to make some inferences about the population and possibly other non-specialized farmers in Virginia. The findings of this study could therefore possibly be utilized in some future program of farm innovation diffusion in Virginia.

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APPENDIX A

Additional Tables

Table 1. No-Till Corn Acreage for Four Adoption Groups.

Acres of No-Till	Percent Before 1965	Percent in 1965-68	Percent in 1969-71	Percent in 1972-73	Total Percent
0	3.4	8.5	8.6	10.0	9.4
1-20	31.1	22.5	26.2	44.0	27.8
21-40	17.2	12.2	25.4	24.0	22.8
41-60	13.8	15.8	14.8	8.0	14.1
61-100	10.3	17.1	12.5	3.0	12.0
101 and over	24.2	19.5	11.9	9.0	13.9
No. of Cases	29	164	337	99	629 ^{1/}
Mean Acres	64.4	71.8	60.2	33.3	59.4

^{1/}Data missing for 10 cases.

Table 2. Percentage Respondents Checking Possible Operational Changes Caused by No-Till Corn.

Type Change	Percent Response
Cropping Program	
More Acreage	46.8
Less Acreage	2.2
More Labor	0.2
Less Labor	68.2
More Mechanization	9.5
Less Mechanization	25.0
New Equipment	44.4
Change Crop Rotation	23.2
Dual Cropping	26.0
Livestock Program	
More Livestock	46.0
Less Livestock	0.8
Different Livestock	5.0
No Change	45.4
Yields	
More Yield	36.6
Less Yield	6.7
No Change	52.1

Table 3. Percentage Respondents Checking Problem Areas Associated with No-Till Corn.

Problem Area	Percent Response
Weeds	55.7
Insect Control	48.8
Planting	20.7
Fertilization	4.7
Harvesting	0.9
Disease Control	6.1
Additional Information	
Areas	
Weed Control	56.0
Insect Control	45.1
Planting	16.3
Fertilization	15.0
Harvesting	3.1
Disease Control	11.9
Crop Rotation	23.9

APPENDIX B

Covering Letter

Questionnaire

Follow-Up Letter



COOPERATIVE EXTENSION SERVICE
VIRGINIA POLYTECHNIC INSTITUTE AND STATE UNIVERSITY

Blacksburg, Virginia 24061

Dear No-Till Corn Grower:

In order to determine the role of the Extension Service in the distribution of new farming ideas, we are conducting a survey of selected no-till corn growers. The knowledge gained through this survey will be used to improve the future service to farmers and to provide information in the areas farmers indicate it is needed. This is an opportunity for you as a farmer to help the Extension Service help you, and we ask your cooperation to obtain this information.

For your convenience, we have enclosed a questionnaire on which you can fill out the needed information. There is enclosed also a stamped addressed envelope in which to return the questionnaire to us.

You need not sign the questionnaire, but please sign the enclosed post card and mail it separately so that we can later remind those who fail to return the questionnaire, should it be necessary to do so.

It will probably take no more than five minutes for you to fill out this questionnaire. It is most important for the success of this study that each one who received this questionnaire provide us with the needed information.

Your answers to these questions are strictly confidential. Your name will never be used in any way.

We wish to thank you in advance for your cooperation in filling out this questionnaire. Only your help can make this study a success and you as well as the Extension Service stand to gain from it in better future service.

Very truly yours,

Extension Specialist
Soil Fertility

n"

Enclosures

NO-TILL CORN STUDY

1. What year did you become aware of the no-till method of corn production? _____
(1, 2)

2. What year did you first grow corn by the no-till method? _____ (3, 4).

3. How many acres do you now have in no-till corn? _____ (5, 6, 7).

4. From what source or sources did you first become aware of the no-till method of corn production? (Place an x in the appropriate box or boxes).

_____ Farm papers or magazines	(8)	_____ Vocational or veterans classes	(12)
_____ Newspapers	(9)	_____ Farm supply dealer	(13)
_____ Radio or TV programs	(10)	_____ Neighbor or other farmer	(14)
_____ County (Extension Agent)	(11)	_____ Other	_____

5. Of the sources in question 4 which one did you consider the most beneficial?

_____ Farm papers or magazines	(15)	_____ Vocational or veterans classes	(19)
_____ Newspapers	(16)	_____ Farm supply dealer	(20)
_____ Radio or TV programs	(17)	_____ Neighbor or other farmer	(21)
_____ County (Extension) Agent	(18)	_____ Other	_____

6. After first learning of the no-till method, from what source or sources did you seek additional information?(check all that apply to you).

_____ Farm papers or magazines	(22)	_____ Vocational or veterans classes	(26)
_____ Newspapers	(23)	_____ Farm supply dealer	(27)
_____ Radio or TV programs	(24)	_____ Neighbor or other farmer	(28)
_____ County (Extension) Agent	(25)	_____ Other	_____

7. Of the sources in question 6 which one did you consider was the most beneficial?

_____ Farm papers or magazines	(29)	_____ Vocational or veterans classes	(33)
_____ Newspapers	(30)	_____ Farm supply dealer	(34)
_____ Radio or TV programs	(31)	_____ Neighbor or other farmer	(35)
_____ County (Extension) Agent	(32)	_____ Other	_____

8. Has the change to the no-till method changed your cropping program?

_____ Yes (36-1)
_____ No (36-2)

If yes, how has the change to the no-till method changed your cropping program? (check one or more)

_____ More labor	(37)
_____ Less labor required than with conventional tillage	(38)
_____ More corn acreage	(39)
_____ Less corn acreage than with conventional tillage	(40)
_____ More mechanization	(41)
_____ Less mechanization than with conventional tillage	(42)

2

- New (different) equipment was required (43)
 A change in crop rotation (44)
 Ability to obtain two crops in the same field in a year (45)
 Other _____

9. Do you have a livestock program on your farm?

- Yes (46-1)
 No (46-2)

If yes, how has the change to the no-till method changed your livestock program?

- Now raising more livestock (47)
 Now raising less livestock (48)
 Now raising a different type livestock (49)
 No change (50)

10. What are your yields as compared with yields under conventional tillage?

- Greater yields than with conventional tillage (51)
 Less yields than with conventional tillage (52)
 About the same yields (53)

11. What was your reason for making the change from conventional to no-till? (Check appropriate reason or reasons.)

- Expected greater yields (54)
 Expected lower production costs (55)
 Would be able to grow corn on land not possible with conventional tillage (56)
 Expected dual use of fields (two crops per year etc.) (57)
 Expected less time and/or labor to be involved with production (58)
 Other _____

12. What are some of the problem areas you have experienced with the no-till method? (check appropriate problems).

- Weed control (59)
 Insect control (60)
 Planting (61)
 Fertilization (62)
 Harvesting (63)
 Disease control (64)
 Other _____

13. In which of these areas would you like to obtain additional information? (check one or more).

- Weed control (65)
 Insect control (66)
 Planting (67)
 Fertilization (68)
 Harvesting (69)
 Disease control (70)
 Crop rotation (71)
 Other _____

14. Have you sent soil samples to the state soil lab for testing within the past five years?

Yes (72-1)
 No (72-2)

15. Have you obtained farm information, other than soil testing, directly from VPI or a branch experiment station within the last five years?

Yes (73-1)
 No (73-2)

16. Have you obtained farm information from the county (extension) agent within the last five years?

Yes (74-1)
 No (74-2)

If yes, about how many times a year do you contact the county (extension) agent for information? _____ (75-76).

Please indicate which county you reside in. _____



COOPERATIVE EXTENSION SERVICE
VIRGINIA POLYTECHNIC INSTITUTE AND STATE UNIVERSITY

Blacksburg, Virginia 24061

August 16, 1973

Dear No-Till Corn Grower:

About three weeks ago you should have received in the mail an envelope from Virginia Polytechnic containing a short questionnaire which you were asked to fill out and return to us. The questionnaire, you may recall, was concerned with your production and information sources of no-till corn.

We are writing to again stress how important it is to us that you fill out and return the questionnaire. Since you represent one of a limited number of no-till growers in the state we cannot consider the study to be a success unless we receive your questionnaire.

We realize that this is a busy season for farmers and you may not have been able to find time to fill out this questionnaire and return it to us. However, we will appreciate your help in returning the completed form as soon as possible.

We are enclosing a duplicate form and another return envelope in case you have misplaced the one previously sent you.

Thank you again for your cooperation in this study.

Sincerely,

Extension Specialist
Soil Fertility

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Enclosures

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the scanned document**

THE DIFFUSION OF NO-TILL CORN INFORMATION AND
ADOPTION IN SELECTED COUNTIES IN VIRGINIA

by

Mary-Louise Spann

(ABSTRACT)

The information sources used prior to the adoption of no-till corn production, the time pattern of the adoption, and the changes caused by the adoption of the no-till corn method were investigated. A mail questionnaire was utilized for data collection.

Farm journals were found to be the major source of initial knowledge about no-till corn production, and the county agent was the major source utilized for additional information on the subject. Those who adopted during different time periods had different lag times between awareness and adoption. Earlier adopters had shorter lag times.

The majority of respondents experienced reduced labor requirements after converting to no-till corn production. The most common problem associated with no-tillage production was weed control.

The majority of respondents had contacted the county agent for information in the five year period prior to the study. Most farmers contacted the county agent at least once a year. Use of the state soil testing laboratory was high, as was use of branch experiment stations as information sources.