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ABSTRACT: A mail survey of farmers in Nebraska showed their perceived use of conservation tillage was about 55%. However, using the 30% residue cover criterion that the Conservation Tillage Information Center uses to define conservation tillage, a field survey of seven counties in 1984 showed that actual use of conservation tillage was less than 5%. Fewer than 20% of the producers surveyed had more than 20% residue cover remaining after tillage and planting. The field survey also showed disk tillage systems were used by almost 70% of the producers. The moldboard plow was used by only 15% of the producers, thus creating an impression that conservation tillage had been adopted.

ADOPTION of conservation tillage throughout the central United States has increased steadily over the last 15 years. From 1973 to 1981, the number of minimum tillage hectares increased 125%, and no-till planting increased 78% (*1*). The area planted with conventional tillage increased just 1% during the same period. Minimum tillage and no-till accounted for 18% of the total number of tilled hectares in the United States in 1973. In 1981 these systems accounted for 32%.

Currently, farmers are using conservation tillage methods on about 31% of U.S. cropland. Although total cropland decreased from 158.8 million ha in 1982 to 128.2 million in 1985, the area in conservation tillage increased almost 2 million ha, according to the Conservation Tillage (now "Technology") Information Center (*2, 5*).

The growing trend toward conservation tillage can be attributed to several factors, including labor and fuel prices, government incentives to reduce soil erosion, improved preplant herbicides, equipment modifications, increased farmer awareness, and improved educational programs. As recently as 10 years ago, the dominant tillage system in the Midwest used the moldboard plow, which inverts the surface soil, covering most crop residue, followed by two or more secondary tillage operations. Use of this tillage system was congruent with existing farmer attitudes that a cleanly tilled field provided the best seedbed and that labor and fuel were minor expense considerations.

Such attitudes are not changed easily. Adoption of conservation tillage, like other new technologies, follows a complicated and time-consuming decision process (*11*). The adoption process requires (a) awareness of either a problem or new technology; (b) recognition of the problem's cause and the individual's ability to change the situation; and (c) technical and economic information, assistance, and support for making the change. Well-defined information that addresses specific farmer needs is essential at every step of the adoption process.

Research in the Midwest has indicated several obstacles to farmer adoption of conservation tillage. Farmers often are aware that erosion is a problem nationally, but may not recognize it as a problem in their farm operation. Sheet and rill erosion, two of the most common kinds off soil loss, may be largely invisible to farmers (*12*). Even when farmers recognize the erosion problem, they may not realize that residue management practices can reduce soil losses. Site-specific information that economically motivates change may not be available. Also, farmers may not understand fully or have the appropriate information about what constitutes conservation tillage and residue management practices.

Reducing the number of trips across a field or changing tillage implements leads many farmers to believe they have adopted conservation tillage. A 1980 Iowa study indicated a major discrepancy between farmer perceptions of conservation tillage use and estimates based on recorded field operations (*17*). Of the 330 farmers questioned, 61% claimed to be using conservation tillage for either corn or soybeans and 41% said that they were leaving at least one-third of the prior crop's residue on the soil surface after planting on a majority of their cropland.

However, the Iowa researchers found that 61% of those farmers planting corn in corn residue and 75% of those planting soybeans in corn residue who claimed they were using conservation tillage actually were moldboard plowing. Of the farmers claiming their were leaving at least one-third of the prior crop's residue on the soil surface after planting corn in corn residue, the researchers estimated that only 22% were doing so. For soybeans planted in corn residue, only 15% of the respondents were leaving one-third of the prior crop's residue on the soil surface.

These discrepancies between perceived and actual use may be attributed in part to the fact that conservation tillage has been and is still being used as an umbrella term that includes a variety of tillage systems. Historically, some agencies defined conservation tillage according to type of implement or tillage system, while others defined it according to weight of residue left on the soil surface. Conservation tillage is now commonly defined as any tillage or planting system that leaves at least 30% of the soil surface covered with residue after planting (*3*). Thus, depending upon residue type, a variety of systems can be classified as conservation tillage. These can include no-till, till-plant, ridge-till, and even disking and chisel-

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ing if the number of operations is limited to maintain the minimum residue cover.

Although researchers, extension personnel, conservation workers, and producers have documented the advantages of conservation tillage systems, adoption in some row-crop producing areas has been less than anticipated. While limited to one county in Iowa, the previously mentioned study (*17*) reported a major discrepancy between farmers' perceived and actual use of conservation tillage. Because this discrepancy has a major effect on the development and delivery of educational prorams, a survey similar to the Iowa study, but covering a larger geographic area, was needed. Additionally educators in Nebraska needed a baseline study of conservation tillage use in the state to measure the success of a 5-year, pilot educational program. Therefore, we sought to measure and compare the actual use of conservation tillage with farmer perceptions of use and to identify major tillage systems and the operations used within those systems.

We designed a study to examine actual and perceived use of conservation tillage statewide, using seven counties in eastern Nebraska as a subsample. The Cooperative Extension Service, with input from other state agencies, had targeted these counties for conservation tillage emphasis in the 5-year, pilot educational program because of the region's high erosion potential.

Study methods

We used a field survey in the seven-county target area to measure the percent of residue cover remaining on the soil surface after tillage and planting and the number and type of field operations used since the previous harvest. In addition, we conducted a statewide mail survey to measure the perceived use of conservation tillage. The mail questionnaire incorporated objective questions on tillage use and more subjective questions pertaining to farmer opinions about adoption of conservation tillage practices (*13*).

Field survey. The survey population included fields in the seven-county target area being farmed by row-crop producers. We selected participants from county alphabetical lists of rural residents using the nth number technique with a random start. We contacted those selected by telephone to determine if they were row-crop producers. If appropriate, a personal interview and field visit were scheduled. If a participant was inappropriate for the study, then we selected the next name on the list until we had identified 300 row-crop producers. We obtained information from 294 farmers, about 9% of the row-crop producers in the seven-county area.

We conducted personal interviews and field surveys in May, June, and July 1984. Prior to the interview or field measurements, we established a pattern to identify the field to be included in the survey. The initial site was the first field north of the farmstead that had been planted to corn, soybeans, or grain sorghum. If this field was not appropriate because of ownership or land use, a clockwise rotation about the farmstead was used to select an appropriate site. We then asked the farmer to provide data about all operations on that field since the previous harvest. Additional data obtained about the field, but not discussed here, included residue type, crop planted, slope, soil type, slope length, conservation practice(s) used, and whether the field was irrigated or dryland.

We measured percent residue cover using the line-transect method at three randomly selected sites within each field (*10*). Because of the short time between planting and crop cultivation and the need to measure residue after planting but before cultivation, we obtained only 236 residue cover measurements from the group of 294 fields.

Mail survey. We developed a questionnaire to evaluate farmer perceptions about tillage practices and residue management. We asked respondents to address only tillage practices, not terracing or other conservation practices implemented in the past. Included in the questionnaire was the following definition of conservation tillage:

"*Conservation Tillage* is: Any tillage and planting system that retains *at least 20 to 30%* residue cover on the soil surface after planting or drilling. Conservation tillage includes no-till or slot planting, ridge- or till-plant, strip-till, mulch-till, ecofallow (including stubble mulching), and other tillage and planting systems that meet the 20 to 30% surface residue requirement" (*13*).

This definition was a compromise between the minimum residue covers recommended by CTIC in 1982 and 1983. In 1982 CTIC defined conservation tillage as any tillage or planting system maintaining at least 20% of the previous crop residue on the soil surface after planting. In 1983 CTIC changed the definition, specifying that at least 30% of the soil surface should be covered with residue after planting. The definition was written to contain terms familiar locally, such as ecofallow and stubble mulching. The questionnaire also included photographs of a 25% cover of corn, wheat, and soybean residue to aid the farmer in understanding the definitions of conservation tillage.

Areas examined by the mail survey included awareness and familiarity with conservation tillage and type and number of tillage operations used now, 5 years ago, and 10 years ago. Also included, but not discussed here, were questions about influences on adoption; perceived problems with use; desired sources of information; and demographic questions on age, education, income, and farm management.

We pretested the questionnaire on 45 farmers, then revised and mailed it in February 1985 to obtain information about the 1984 tillage and planting season. The initial mailing included a cover letter; questionnaire; and self-addressed, postage-paid envelope. Two weeks after the initial mailing, we mailed a postcard reminder to those who failed to return the questionnaire. Two weeks after the postcard was sent, we mailed another letter; questionnaire, and postage-paid, self-addressed return envelope to those failing to return the questionnaire.

The population for the mail questionnaire included producers of crops, other than hay, who had more than $1,000 in annual sales as listed by the Nebraska Crop and Livestock Reporting Service. The population for the statewide survey was 45,784 farmers, 5,175 of whom were in the seven-county subsample group. Using the nth number technique with a random start, we selected 250 names from the subsample group. We randomly selected an additional 1,000 names from the remaining population, resulting in a total of 1,250 farmers in the statewide survey. When we calculated statewide estimates, responses were weighted according to the number of farmers in each of the two groups. We eliminated 104 names from the statewide sample because the person was no longer farming or the letter was returned because of no forwarding address. Of the 1,146 in the statewide sample, 59% returned the questionnaire. We excluded 21 names from the subsample group for the same reasons. Of the 229 farmers in the subsample, 56 percent returned the survey.

Results and discussion

Field survey. We grouped the information from the fields surveyed according to the primary tillage or planting implement used, as suggested by Siemens and associates (*15*). Although the moldboard-plow system has been considered the traditional system, its use in the seven-county target area in 1984 was slightly less than 15% (Table 1). Disking was most common, used on 69% of the 294 fields. Farmers used no-till and ridge-plant systems on only 2.5% of the fields. A 1979 survey encompassing both eastern and south central Nebraska reported similar results (*6*).

Table 1 shows the number of operations associated with the various tillage systems.

We defined an operation as any pass across the field that destroyed or appreciably altered residue, such as tillage, planting, stalk shredding, and the placement of fertilizer or pesticides into the soil. Operations such as broadcasting fertilizer or applying pesticides were not counted if no appreciable residue disturbance occurred.

Within each tillage system, farmers used several combinations of tillage implements and sequences of operations. In the past, farmers commonly shredded stalks prior to tillage or planting, but less than 1% of those surveyed used that practice. The most commonly used moldboard-plow system included four operations: moldboard plowing; disking; another secondary tillage operation, such as disking or field cultivation; and planting. Farmers used this sequence on 25% of the moldboard-plowed fields. Although there was no reduction in the mean number of operations between the moldboard-plow and chisel-plow systems, the most commonly used chisel-plow system (used on 28% of the chiseled fields) included three rather than four operations. These were chiseling; a secondary tillage operation, such as field cultivation or disking; and planting. The only difference between the most commonly used chisel and disk systems was the substitution of the disk for the chisel plow. Farmers used three operations on 31% of fields in disk tillage.

Using a chisel-plow or disk system rather than a moldboard-plow system saves fuel and labor (*14*) and offers additional erosion protection in corn residue because neither a chisel plow nor a disk buries as much residue as a moldboard plow (*7*).

Those producers who used a field-cultivate or ridge-plant system generally used one less residue-altering operation than those using the disk system. No-till producers generally used two less operations than those using the disk system.

Within each system listed in table 1, we found both good and poor examples of a conservation ethic. Some producers were conscientious about limiting the number of operations between harvest and planting of the subsequent crop. A few asked the interviewer how to combine or eliminate unnecessary operations. Other producers seemed to feel that some residue on the soil surface or a few weeds left standing warranted another tillage operation. This was exemplified by those individuals who used from 8 to 10 residue-altering operations between harvest and planting.

The tillage implement and the number of field operations determine the fuel and labor requirements of a tillage system. But the percentage of soil surface covered with residue largely determines the erosion control potential of a system. Table 2 shows the percentage of fields within the various tillage and planting systems that had residue covers of 15, 20, 25, or 30%. Using 30% residue cover as the criterion for conservation tillage, only 4% of the fields in the survey could be classified as conservation tillage. Using the 20% residue cover criterion, about 18% of the fields could be classified as conservation tillage. However, 40% of the chisel, disk, and field-cultivate systems had residue covers exceeding 15%. This represents a step toward achieving conservation tillage, although it still does not meet either the 20% or 30% criterion. As expected, none of the moldboard-plowed fields met the minimum criterion of 20% cover, and all of the no-till planted fields exceeded 30% residue cover.

Often, farmers feel conservation tillage can be defined by the choice of implement and number of operations. While this may be true in some situations, soybean residue tends to be quite fragile (*9*). When using the same tillage implement, soybean residue cover will be less than corn residue cover (*8, 16*). A more detailed examination of the disk tillage systems showed that less than 10% of the fields with soybean residue had more than 20% residue cover; none exceeded 30% residue cover. In comparison, 27% of the disk systems used in corn residue left more than 20% residue cover and 7% left more than 30% cover.

Mail survey. Most farmers responding to the mail survey were familiar with the term conservation tillage. About 75% indicated they had tried conservation tillage (Table 3). In the statewide sample, 56% of the respondents said they were using conservation tillage; in the seven-county subsample, 50% said they were using conservation tillage. These perceived usage figures were about 3 to 13 times greater (depending upon the definition) than indicated by the field measurements of residue cover (Table 2).

This discrepancy between farmer perceptions of use (Table 3) and actual field measurements (Table 2) may reflect a terminology problem. Although the questionnaire defined conservation tillage as a function of residue cover, farmers seemed to associate the adoption of conservation tillage with not using the moldboard plow. Between 1974 and 1979 farmers shifted away from the moldboard plow toward the

Table 1. Use of tillage and planting systems for corn, grain sorghum, and soybean production in 294 eastern Nebraska fields in 1984.

Tillage System	System Use		Number of Residue-Altering Field Operations Following Harvest Until the Subsequent Crop was Planted		
	Number	Percent	Mean	Minimum	Maximum
Moldboard plow	44	15.0	4.3	2	8
Chisel plow	25	8.5	4.3	3	6
Disk	202	68.7	3.8	2	10
Field cultivate	16	5.4	2.6	2	5
Ridge-plant	2	0.7	2.5	2	3
No-till	5	1.7	1.2	1	2

Table 2. Percentage of fields within the various tillage and planting systems that had residue covers exceeding 15, 20, 25, and 30%.

Tillage System	Number of Fields	Percentage of Fields with Residue Cover Greater Than			
		15%	20%	25%	30%
Moldboard plow	33	3.0	0	0	0
Chisel plow	20	40.0	15.0	5.0	0
Disk	165	40.0	19.4	9.1	4.2
Field cultivate	13	46.2	23.1	0	0
Ridge-plant	2	100.0	50.0	50.0	0
No-till	3	100.0	100.0	100.0	100.0
All systems	236*	36.4	17.8	8.5	4.2

*Only 236 of the 294 fields used in table 1 are included because some planted crops had been cultivated before residue measurements were obtained.

Table 3. Level of familiarity with tillage programs among Nebraska farmers.

Level of Familiarity	Percent Response	
	Seven-County Target Subsample (n = 82)	Statewide (n = 423)
No response (have not heard of conservation tillage)	2.4	0.6
Heard of the term "conservation tillage"	97.6	99.4
Learned about tillage practices	91.5	94.2
Evaluated if they might apply to farming operation	83.0	87.8
Tried some conservation tillage	72.0	75.8
Now using conservation tillage	50.0	56.3

chisel and disk systems (Table 4). Statewide, 50% of the farmers said their primary tillage system in 1974 included use of the moldboard plow, while only 30% said their primary tillage system in 1979 included the moldboard plow. From 1979 to 1984 there was a similar shift away from the plow. However, this shift seemed to be toward the chisel system and ridge- and no-till systems.

The mail survey results from both the seven counties and statewide showed trends similar to those in the field survey. Fewer than 19% of the farmers used the moldboard-plow system in 1984. Mail and field survey results from the seven-county area indicated about 75% of the respondents used chisel and disk systems, whereas statewide use of the chisel and disk systems was about 65%. On a statewide basis, use of ridge- and no-till systems appeared to be about four times greater than use in the seven-county area.

The rapid shift away from the moldboard-plow system between 1974 and 1984 and the corresonding farmer perception that conservation tillage has been adopted may influence the conservation tillage use estimates reported by CTIC. In 1983 the estimated use of conservation tillage for Nebraska and the seven-county area was 52 and 48%, respectively (*3*). Statewide, use was only 45% in 1984 (*4*). Also, about one-half of the farmers responding to the mail survey in 1984 indicated they were using conservation tillage.

However, in the seven-county area, the estimated use in 1984 reported by CTIC was 23%. Using a 20% minimum cover as the criterion for conservation tillage in the seven-county area, rather than a 30% cover, the field survey results would show 18% use of conservation tillage, which is closer to the level of use reported by CTIC. It should be noted that the 1984 estimates of use of conservation tillage reported by CTIC were made after the preliminary results from the seven-county field survey were released. This possibly explains why the seven-county estimated use of 23% was about half the estimate of statewide use. Using residue measurements from the fields surveyed and the 30% minimum cover criterion, less than 5% of the area should have been classified as conservation tillage.

Conclusions

Perceived and estimated uses of conservation tillage were about three times greater than the measured use of 18% when we used 20% residue cover as the criterion. Using the 30% residue criterion, the measured use of conservation tillage was less than 5%.

A reason for the discrepancy between the measured and perceived use of conservation tillage appears to be related to a change in type of tillage implements used. In 1974 the primary tillage system used by more than 50% of the farmers was the moldboard-plow system. By 1984 this use had decreased to about 15%, creating an impression that conservation tillage had been adopted. In the same 10-year period, use of chisel-plow and disk systems increased a corresponding amount, and there was some increase in the use of ridge- and no-till systems.

Although about 75% of the farmers used the disk and chisel-plow systems in 1984, the mean number of residue-altering operations was not lower than the mean for the moldboard-plow system. Farmers using a field-cultivate or ridge-plant system tended to have one less residue-altering operation than those using a disk system.

There were few differences between the results from the statewide and seven-county mail survey. The major difference was in the case of ridge-planting, which was used by 8% of the farmers statewide but only 1% in the seven-county area. Fewer than 3% of the farmers in both surveys used no-till planting systems.

Table 4. Primary tillage or planting system used in 1974, 1979, and 1984 as indicated in the mail survey of Nebraska farmers.

Tillage or Planting System	System Use (%)		
	1974	*1979*	*1984*
Statewide	(n = 404)	(n = 406)	(n = 413)
Moldboard plow	50.6	30.1	16.2
Chisel plow	13.2	18.7	29.2
Disk	29.2	40.4	36.5
Ridge-plant	3.4	4.6	8.3
No-till	0.4	1.6	3.0
Sweep or blade plow	3.2	4.6	6.8
Seven-county target	(n = 75)	(n = 78)	(n = 80)
Moldboard plow	78.6	52.5	18.8
Chisel plow	4.1	7.7	25.0
Disk	14.7	37.2	52.6
Ridge-plant	1.3	1.3	1.2
No-till	0.0	1.3	1.2
Sweep or blade plow	1.3	0.0	1.2

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