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FARMERS' EXPERIENCE WITH NO-TILL CORN PRODUCTION IN ONTARIO COUNTY, NEW YORK

Roger Wentzel

K. L. Robinson

Department of Agricultural Economics
Cornell University Agricultural Experiment Station
New York State College of Agriculture and Life Sciences
A Statutory College of the State University
Cornell University, Ithaca, New York, 14853

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A special project was initiated in Ontario County, New York during 1980 and 1981 to encourage farmers to adopt no-tillage practices on their farms. The Agricultural Stabilization and Conservation Service (ASCS), the Soil Conservation Service (SCS), and the Cooperative Extension Service were all involved in promoting the project. ASCS cost-sharing assistance was available for herbidices and herbicide application, and for labor and equipment used in planting. A total of 51 farmers participated in the project in 1980 and 102 in 1981.

In order to gain from their experience, a sub-sample of those who participated in the no-tillage program was interviewed in February and March of 1982. The sample was drawn from farmers who had participated in the program in both 1980 and 1981. A total of 38 farmers met this condition, of whom 34 were interviewed.

Characteristics of the Farms Surveyed

Nearly 30 percent of the 34 farms included in the survey raised only corn and other crops for cash sales. The remaining 70 percent (24 farms) raised both crops and livestock. Of this group, eight farms had a dairy enterprise.

Most of the farms were located on Palmyra-Ontario and Honeoye-Lima soil associations. These are productive high-lime soils. Some farms, however, were located on Odessa-Schoharie or Darien-Romulus soil associations which are less well drained and are more difficult soils to manage.

The 34 farms had an average of 812 acres in crops, of which an average of 428 acres was planted to corn. Eight farms operated at least 1,000 acres of cropland. Three of the larger farms had sizable acreages of vegetable crops as well as corn. Eight farms had less than 300 acres of cropland. These farms were either full-time dairy farms or part-time crop and livestock farms.

Reasons for Participation

The farmers were asked why they decided to participate in the no-till project. Multiple answers were allowed because many of the farmers had more than one reason. The distribution of responses is given in Table 1.

The responses obtained from the farmers interviewed indicate the project was valuable as a means of experimenting with a new management practice. More than half the farmers gave this as a reason for their participation. The availability of rental equipment was probably an important element because this allowed participants to try no-tillage corn without making a long-term investment in planting equipment.

* This publication is a summary of Chapter V of an M.S. thesis written by Roger A. Wentzel entitled The Economics of Soil Conservation in Western New York.

Table 1

Reasons for Participating in the No-tillage Project

Reason given	Number of farms	Percent of farms
To experiment with a new practice	18	55
Soil conservation	12	36
To reduce production costs	8	24
Urged by ASCS personnel or other farmers to participate	5	15
Labor savings	4	12
Fewer stone problems with no-tillage	1	3

Soil conservation was given as an additional reason for participation by a large number of farmers. This was the major reason for SCS involvement in the project.

Possible savings in costs and reduced labor requirements were important considerations in the minds of a number of farmers who elected to participate. Some simply did so on the recommendation of other farmers or ASCS personnel.

Level of Adoption

Farmers generally planted less than half their corn acreage using no-tillage techniques in 1981. More than a third used such techniques on less than 15 percent of their corn acreage (Table 2). Only 5 of the 34 farms planted more than 45 percent of their corn acreage using no-tillage techniques. This suggests that most of the farmers consider the technique as experimental and simply wanted to gain experience with it before committing their entire acreage to no-till. A few farmers, however, are sufficiently convinced of the merits of the practice to adopt it on most or all of their acreage. Nine of the 34 farmers had purchased no-tillage equipment at the time of the survey.

Table 2

Importance of No-tillage Corn on Survey Farms in 1981

Percentage of corn planted with the no-tillage system	Number of farms
< 15	13
15-30	8
30-45	8
> 45	5

Herbicide Effectiveness

Because success with the no-tillage system is contingent on good weed control, the farmers were asked to rate the effectiveness of the no-tillage herbicide program they followed. The responses, which are found in Table 3, indicate that most were satisfied with the level of weed control they attained. A rating of good or excellent was given by 85 percent of the farmers. The remaining 15 percent said that the weed control was only fair, suggesting less than complete satisfaction.

Table 3

Herbicide Effectiveness on No-tillage Corn

Rating of weed control	Number of farms	Number of farms that spot sprayed
Excellent	12	3
Good	17	10
Fair	5	3

The number of farms that had to make an additional herbicide application is included in the last column of Table 3. Nearly half of the 34 farms surveyed did some spot spraying on part or all of their no-tillage corn. Four farmers had to spray a second time because the previous sod crop was not completely killed by the first application. Six farms made an additional spray application to control dandelions or milkweed, two weeds that normally are not a problem in conventional corn.

Spot spraying appears to be a necessary part of shifting to no-tillage corn because cultivation is no longer an option for post-emergence weed control. With no-tillage corn the farmer must be willing and equipped to use herbicides for any weeds that are not controlled by the herbicides applied at planting time.

Details on the herbicide programs were obtained from each farmer to compare the costs of no-till and conventional tillage systems. A great deal of variation in costs was found among the farms.

A major cost difference between the two systems is the need for a knock-down herbicide to kill existing vegetation. Four of the farms were able to omit the knock-down herbicide because they were planting in weed-free corn residue. The remaining 30 farms used paraquat on at least part of their no-tillage corn. Rates of herbicide application and costs for these 30 farms are shown in Table 4. The rate of paraquat application depends on the amount of growing vegetation to be killed. One quart is the standard rate for previous sod and cover crops. Lower rates can be used on fields previously in a grain crop. Ten farms were able to apply less than 1 quart, reducing the cost substantially.

Eight farms reported using glyphosate (Roundup) on part of their no-tillage corn. This treatment was generally limited to fields with serious weed problems or heavy sod. The farmers said the treatment would have been made regardless of the tillage system employed. In these cases, glyphosate replaces paraquat but would not be an additional cost over conventional tillage.

Table 4

Rate of Application and Cost of Knock-down Herbicide

Rate of paraquat application (qts./acre)	Number of farms	Cost per acre*
1.5	1	$ 17.31
1.0	19	11.67
.75	3	8.85
.25 -.50	7	3.22-6.04

* Paraquat at $45.08 per gallon. Includes .25 pint of surfactant per acre at $12.80 per gallon.

Knock-down herbicides must be augmented by residual herbicides if weeds are to be controlled effectively in a no-till program. Recommendations for no-tillage corn generally call for higher residual herbicide application rates; however, the majority of the farmers interviewed were applying about the same amount of residual herbicides as with conventional tillage. Differences in the cost of residual herbicides between conventional and no-tillage corn and the effectiveness ratings for each group are reported in Table 5.

On 25 of the 34 farms surveyed, the cost of residual herbicides was equal to or less than for no-tillage corn. Many of the farms in this group used the same products at identical rates for both systems. Other farms used different products but with no increase in costs per acre.

Table 5

Relative Cost and Effectiveness of Residual Herbicides Used on No-tillage Corn

Cost per acre relative to conventional use	Number of farms	Rating of control achieved		
		Excellent	Good	Fair
		(number of farms)		
Lower cost	5	1	3	1
Same cost	20	8	8	4
$0 to $5 higher cost	5	1	4	-
$5 to $10 higher cost	4	2	2	-

Nine farms had per acre costs for the no-tillage corn that were significantly higher than with conventional corn. The farmer who spent an additional five dollars or more per acre for residual herbicides had the best weed control. The five farmers who spent up to five additional dollars obtained only slightly better control than the lower cost group.

Insecticide Use and Effectiveness

All 34 farmers used a systemic insecticide at planting time on their no-till acreage. Use of an insecticide is recommended on no-till corn regardless of the rotation being followed. On nearly 40 percent of the farms surveyed, both the insecticide used and the rate of application were the same as that conventionally used on corn (Table 6). Thus, there was no increase in costs associated with insecticide application on such farms. But

for the remaining farms in the sample, insecticide costs per acre exceeded what they normally spent. In some cases this was due to using a different product, and in other cases applying an insecticide to a higher proportion of the acreage or applying the insecticide at higher rates. The experience of farmers in Ontario county indicates that farmers adopting the new practice can expect to apply more insecticides than they would if they followed conventional practices.

Table 6

Insecticide Use on No-till Corn Compared to Conventional Practices

Use Compared to Conventional Practices	Number of farms
Same product and rate	13
Used only on no-till acreage	7
Used on all of no-till acreage and part of conventionally tilled acreage	6
Different product used on no-till acreage	5
Same product used but higher application rate on no-till acreage	3

The majority of farmers reported that they encountered more serious insect problems with no-till corn. The number of farmers reporting different kinds of pest problems is shown in Table 7. Slugs and armyworms were the principal pests encountered on no-till acreage. These pests were generally found on land that had previously been in sod or covercrops, thus creating a favorable environment for such pests.

Of the seven farmers who identified slugs as a problem, three had significant crop damage while four had only minor damage. One farmer said he would plow fields in the future to reduce the likelihood of slug damage. Another farmer indicated he would be reluctant to increase no-till acreage on his farm because of the potential problem with slugs.

The armyworm problem in no-till corn is easier to deal with because insecticides are available for effective control. Of the seven farmers reporting armyworm damage, three farmers did not have a serious infestation and decided spraying was unnecessary. The other four applied an insecticide. One farmer did not detect the armyworm infestation soon enough to avoid economic loss. The field was sprayed but he estimated a 50 percent yield reduction for that particular field.

Table 7

Incidence of Pest Problems on No-till Corn Acreage

Type of Pest	Number of farms
Slugs	7
Armyworms	7
Cutworms	2
Corn borer	2
Wireworms	1

Corn borer was reported to be more serious in no-tillage corn on one farm. Many of the other farmers said they had minor problems with corn borer but the damage was thought to be no greater than that associated with conventional tillage.

No unique disease problems on no-till corn acreage were reported by the farmers surveyed, but many expressed concern about the greater vulnerability of no-till corn to disease damage. One farmer plowed much of his corn stubble in 1981 because he wanted to avoid the spread of anthracnose. This limited the area that he could plant to no-till corn in 1982.

Fertilizer Use

Few differences were found between conventional and no-till corn acreage in the quantity of fertilizer applied. The switch to no-till corn involved mainly a change in the form of fertilizer applied and the method of application.

None of the farms used different application rates for phosphorus or potassium. Most farmers said they applied these nutrients based on soil tests, with specific rates varying from one field to the next. In some cases, the rates differed slightly between conventional and no-tillage corn because different equipment was used.

A clear majority of the farmers (28) said they applied the same quantity of nitrogen per acre on their conventional and no-tillage corn. None of these farmers expressed concern about the rate for no-tillage being too low or indicated that they would increase the rate in future years. The remaining six farms included in the survey applied 20 to 25 percent more nitrogen on

their no-tillage corn. One farmer said he was applying more nitrogen the first three years to compensate for whatever nitrogen might be tied up in decomposing the residue. Another farmer said he applied 20 to 25 percent more liquid manure (as a source of nitrogen) although he was not sure it was necessary.

These results suggest the need for more research on nitrogen requirements for no-tillage corn. The experience of the farmers in this survey, although limited to two years of growing no-tillage corn, does not support the usual recommendation that additional nitrogen be applied to no-till corn.

For many farmers, the switch to no-till corn forced them to change the method of fertilizer application. Eleven of the farms surveyed did so by switching to a surface spray or changing from anhydrous ammonia to liquid nitrogen. Five of these farmers had the nitrogen custom applied on their no-tillage corn but not their conventionally tilled corn acreage. Switching from anhydrous ammonia to liquid nitrogen normally increases costs.

The farmers also were asked about the differences in lime requirements between their conventional and no-tillage systems. The no-tillage corn was not regarded as needing more lime by 82 percent of the farmers. Many of these said they did not need to apply lime on conventional corn and saw no reason to do so with no-tillage corn. Three farmers said more lime was needed and the remaining three farmers were not sure. These responses must be considered tentative because two years of experience with the system is probably not enough time to develop a serious pH problem in the surface layer.

Seeding Rates and Plant Population

A higher seeding rate is recommended for no-tillage corn to offset germination problems that may be encountered owing to lower soil temperatures. Many of the farms in the survey were following this recommendation with 70 percent reporting higher seeding rates. The other 30 percent used the same rate for conventional and no-tillage corn. A few of the farmers felt that stands in their no-tillage corn were better than in conventionally tilled fields, and some were planning to cut back the seeding rates because germination was better than expected. Overall, 22 farmers, or 65 percent of those surveyed, reported they obtained an adequate plant population.

Twelve farmers said the plant population on their no-till fields was lower. Three of these used conventional seeding rates for their no-tillage corn. The reasons advanced by these farmers for the poor stands in their no-tillage corn are given in Table 8. The greatest problem appears to be poor soil conditions at planting time. Planter adjustment problems were also a factor. More experience with the system will most likely help to cure these problems. Three farmers reported that their poor stands were the result of pest problems.

Table 8

Reasons Given for Poor Stands in No-tillage Corn Fields

Reasons for Poor Stands	Number of farms
Poor soil conditions at planting time	6
Improper planter adjustment	4
Slugs	2
Stones	2
Cutworms	1

Changes in Equipment, Fuel and Labor Use

It is difficult to generalize from the sample of farmers interviewed about the impact of shifting to no-till techniques on machinery, fuel and labor costs because most of them were continuing to use conventional tillage practices on more than half of their corn acreage. Only 3 of the 34 farmers interviewed planted all their corn using no-tillage techniques in 1981. Furthermore, few of the farmers kept detailed machinery, fuel and labor records, and thus it was not possible to make a direct comparison from their records between conventional and no-tillage practices. For this reason, changes in equipment costs, fuel use and labor requirements had to be estimated on the basis of each farmer's description of what equipment was used and the operations conducted on each field. Knowing the type of equipment used on each field and the number and kinds of tillage operations, it was then possible to estimate fuel use and labor requirements using standard coefficients from engineering studies. 1/

The full cost advantages of shifting to no-tillage techniques can be realized only if it is possible to cut back to only one set of equipment. At present, most farmers are still experimenting with no-till corn, and consequently are using two sets of equipment. One advantage of using a combination of tillage practices is to lengthen the life of conventional tillage equipment. One farmer indicated that he found combining no-tillage and conventional tillage an advantage because it enabled him to make more effective use of his planter. He had insufficient tractor and plowing capacity to keep

1/ For a more detailed description of the manner in which machinery, fuel and labor savings were estimated, see Wentzel, pp. 60-70 and 128-131.

up with his planter, and consequently, by shifting between conventional and no-tillage practices, he was able to avoid this bottleneck. If he tried to plant all of his land using conventional techniques, he would have been compelled to purchase additional tillage equipment. Several farmers cited the advantage of lower machinery maintenance costs with the no-tillage system.

One of the three farmers who had converted entirely to no-tillage techniques had recently sold his cows and had shifted to cash crop production. He was planning to sell his conventional tillage equipment. His tractors were older models but adequate to handle the reduced work load of the no-tillage system. Another of this group was a part-time farmer who relied on a custom operator for his no-tillage planting. His equipment was old and probably fully depreciated. By shifting to no-till, he was able to minimize repair costs which can be substantial with older equipment. The third of this group of farmers was in the position of having to replace or discard his conventional tillage equipment. The switch to no-till corn allowed him to buy a smaller tractor when he traded in his old one and to replace his existing equipment with a new no-till planter.

Fuel consumption was estimated by obtaining information from some but not all of the 34 farmers interviewed on the make and model of tractor used for each field operation. University of Nebraska Tractor Test Data were then used to estimate fuel consumption for each operation. Fuel use per acre for conventional and no-tillage operations were estimated for each of the 13 farms from which complete data were obtained. The average reduction in fuel consumption for all preharvest operations was 70 percent for no-till corn. The reduction is attributable to the elimination of operations which have high fuel requirements such as plowing or chiseling. The calculated average fuel consumption for conventional tillage was 4.82 gallons of diesel fuel per acre; for no-till corn, the average was 1.45 gallons per acre. No-tillage estimates ranged from 1.0 to 2.2 gallons per acre. On some farms, the savings amounted to as much as 4 gallons per acre.

Pre-harvest labor requirements were estimated for the conventional and no-tillage systems by summing the hours of equipment use for each of the components of the two systems. The estimates of labor use obtained in this way varied widely among farms. This is not surprising owing to the wide range in farm sizes and types of machinery used. The average hours of labor use per acre computed on the basis of equipment currently being used for conventional tillage operations ranged from .39 to 1.79, with an average of .81 hours. Comparable figures for the no-tillage acreage ranged from 0 to .71 hours per acre, with an average of .40 hours. The zero figure is for a farmer who custom hired all of his no-till and spraying operations.

The foregoing figures obviously do not give a fair comparison of total labor requirements because of differences among farms in the number and types of operations that were performed by custom operators. To make the labor estimates comparable, imputed labor requirements for the custom operations performed on each farm were added to the operator labor estimates. When such estimates were included, the no tillage labor estimates ranged from .32 to .75 hours per acre. Fifty six percent of the farms had a preharvest labor figure of between .4 and .6 hours per acre.

The distribution of the estimated labor use (taking account of the imputed labor cost of custom operations) associated with no-till corn as a percent of labor used with conventional tillage for the entire sample of 34 farms is given in Table 9. Farms with a substantial reduction in labor use (total labor use less than 60 percent of conventional tillage requirements) had a higher percentage of acreage in no-till corn than farms with only a 30 to 40 percent savings in labor use. This implies that labor savings are proportional to the percentage of acreage shifted to no-till.

Table 9

Distribution of Farms Based on the Relationship of No-tillage to Conventional Tillage Labor Requirements

No-tillage labor requirements as a % of conventional tillage	Number of farms	Average % of total corn acreage under no-till
>70	9	13
60-70	11	24
45-59	8	35
< 45	6	61

On several farms, the no-tillage system offered little or no savings in labor use. These were generally larger farms who made efficient use of large-scale equipment. As a result, labor requirements for their conventional tillage system were low. Labor comparisons also were influenced by the small area of land shifted to no-till on such farms. Many of these farms were using small-scale equipment on their no-till acreage in contrast to the large equipment which was being used on their conventionally tilled acreage. If these farms eventually convert entirely to no-till corn, they will be able to utilize larger, specialized equipment and consequently reduce their labor costs.

Farms on which no-tillage was exceptionally advantageous relative to conventional tillage were generally small. The substantial savings on such farms is attributable to the high labor requirements for conventional tillage which is associated with small fields and older equipment.

The reduction in labor requirements which a number of farmers experienced was valued highly by livestock and dairy farmers. Competing demands for labor at planting time make the no-till system especially attractive. Some farmers commented that the no-tillage system enabled them to improve the timeliness of corn planting and permitted them to plant more acreage than would have been possible using conventional tillage practices.

Cost Comparisons

Farmers who shift to no-till corn can expect to achieve economies in labor use, equipment costs and fuel consumption. 2/ These savings, however, may be offset by higher costs for seed (owing to higher seeding rates) and the use of larger quantities of herbicides and insecticides. In an attempt to assess the magnitude and types of savings that might be achieved, budgets were prepared of growing costs per acre (exclusive of labor costs) for three types of tillage systems. These budgeted costs are shown in Table 10. In making these calculations it was assumed that fertilizer application rates and insecticide use would be the same regardless of which tillage system was used. The principal savings are in repairs and maintenance and fuel use. The only cost items which are higher with no-till are herbicides and seed. Total cost savings are modest, amounting to less than $3 per acre for no-tillage relative to conventional tillage. The budgeted cost of reduced tillage is slightly less than for no-tillage corn.

Table 10

Variable Growing Costs (Excluding Labor)
for Continuous Corn by Tillage Method

Cost Elements	Conventional	Reduced	No-tillage
	dollars/acre		
Seed	18.85	18.85	19.94
Fertilizer	48.11	48.11	48.11
Herbicides	14.80	14.80	21.35
Insecticides	12.60	12.60	12.60
Fuel	7.02	4.76	1.19
Oil and grease[a]	1.05	.71	.18
Repairs and maintenance	4.68	2.78	1.14
Total Growing Costs	$107.11	$102.61	$104.51

a/ Oil and grease costs are estimated at 15 percent of fuel costs.

2/ Estimates of savings in labor requirements, tractor, equipment and fuel use based on studies carried out in other states are shown in Appendix A, Tables A-1 to A-3.

Yield Comparisons

Relative yields obviously are an important consideration in deciding whether or not to shift to a no-tillage system. Consequently farmers were asked about the yields they obtained on their no-till fields relative to those obtained on fields conventionally tilled. Unfortunately, few of the farmers kept accurate yield records. In a few cases, preharvest yield estimates had been made by the county ASCS office, but most farmers had to rely on indirect methods of estimating yields, both on their no-till acreage and on that conventionally tilled.

The yield reported for no-till acres ranged from 60 to 186 bushels per acre, with an average for the 29 farms that made such an estimate of 104 bushels per acre. Subjective yield comparisons were made by all 34 of the farmers interviewed. The responses are summarized in Table 11. Roughly one third of the farmers reported yields on no-tilled fields were equal to or higher than yields on conventionally tilled fields, while about 40 percent said they were the same. Only 9 of the 34 farmers said yields on the no-tilled fields were lower. Farms on which yields were low generally attributed the yield reduction to insect or disease damage or to a poor stand. One farmer blamed his poor stand on the condition of the planter he had rented. Planting on poorly drained fields also may have contributed to low yields on some farms. In general, farms with low yields had a higher percentage of poorly drained land. Lack of experience with planting, especially on soils that tend to be wet or heavy, also may help to explain why yields on some of these farms were low. Slugs were the major cause of low yields on three farms.

Table 11

Yields on No-tillage Corn Acreage Relative to Conventionally Tilled Corn

Relative Yield	Number of farms	Percent of farms
Higher	5	33
Equivalent or higher	6	
About the same	14	41
Lower	9	26

Advantages of No-till Corn

Thirty two of the 34 farmers interviewed said they planned to plant at least some of their corn acreage using no-till techniques again in 1982. These farmers were then asked to list the most important advantages they identified with growing no-till corn. Their responses, which are summarized in Table 12, indicate that economic advantages are more important than conserving soil in

the minds of most farmers. Labor savings and lower fuel requirements were each mentioned by at least half of the farmers. Another 15 percent said that no-till corn reduced production costs without specifying which costs. A lower machinery investment was cited by less than 10 percent of the farmers but nearly one quarter felt that lower machinery maintenance cost was an important advantage. Improved timeliness, fewer stone problems, and moisture conservation were listed as other advantages.

Table 12

Advantages of No-tillage Corn

Advantages Mentioned	Number of farms
Reduces labor	22
Saves fuel	17
Helps to conserve soil	15
Reduces machinery costs	8
Improves timeliness in field operations	6
Fewer stone problems	5
Lower costs	5
Lower machinery investment	3
Helps to conserve moisture	2

One of the advantages mentioned by several farmers but not listed in the foregoing table was that they encountered fewer harvest problems on their no-till acreage because the ground was firmer. They were able to get on to such fields at a time when it was difficult to harvest acreage that was conventionally tilled. This was especially true in 1981 when excessive rainfall during the harvest season delayed harvest operations on many farms. One farmer also found it easier to harvest silage on his no-till acreage. He noted improved stability with trailing equipment, especially on sloping fields.

Future Plans

One of the best indicators of satisfaction or dissatisfaction with a new practice is what farmers intend to do another year. All but two of the farmers interviewed indicated they would plant at least some acreage using no-tillage techniques again in 1982; 14 said they planned to increase the acreage planted to no-till corn, and 10 said they would plant about the

same acreage. Eight of the 34 farmers said they would decrease the proportion of acreage planted using no-till techniques. Thus, of the group sampled, approximately three quarters planned to maintain or increase the proportion of acreage devoted to no-till corn.

The two farmers who planned to discontinue planting no-till corn were asked about the reasons for their decision. One said that from his point of view, the system involved too much risk and did not appear to be suitable for his farm. Planting the no-till acreage on his farm had to be delayed because of the heavy application of manure which he had made earlier. Delayed planting he thought reduced his yield. The other individual who decided against planting no-till corn was a part-time farmer. He had recently updated his machinery and did not want to make an additional investment at this time. He also said that no-till corn required more careful management and that he did not think the practice was well suited to the imperfectly drained soils on his farm.

Summary and Conclusions

Thirty-four farmers in Ontario County, New York who participated in 1980 and 1981 in a program designed to encourage no-till corn production were interviewed in the spring of 1982 to obtain their reactions to shifting from conventional to no-till corn. The majority of farmers participating in the survey planted only part of their acreage using no-till techniques. Only three farmers were using no-tillage practices on all of their corn acreage. Most plan to maintain or increase their no-till acreage in the future, but want to continue experimenting with the technique before committing their entire acreage to this planting method.

Economic advantages were most frequently cited by participating farmers for planting no-till corn. The principal savings achieved were in labor requirements and fuel use. Per acre labor requirements were reduced by an average of 42 percent relative to those required for conventionally tilled corn. Dairy farmers and others with livestock valued highly the savings in labor made possible by planting using no-till techniques. Several commented that this enabled them to plant more corn than would have been possible using conventional tillage methods and also improved the timeliness of planting. Savings in fuel consumption based on equipment used on no-till and conventionally tilled fields ranged from around 2 to 4 gallons per acre.

Yields on no-till fields were rated by a clear majority of farmers as equal to or better than on conventionally tilled fields. Those who obtained lower yields attributed this to poor stands (often associated with wet or poorly drained soils) or to insect damage. Slugs were a serious problem on some of the no-till acreage. The most frequently cited management problem was with pests, principally slugs and armyworms.

A substantial part of the savings in labor, equipment and fuel costs may be offset by higher costs for herbicides, seed and insecticides. Most farmers who participated in the survey, however, spent very little if any more for seed, insecticides and fertilizer applied to no-till acreage than they did on acreage that was conventionally tilled. Despite recommendations for

higher levels of nitrogen application on no-till corn, the majority of farmers made fertilizer applications identical on no-till and conventionally tilled acreage. They also used about the same amount of insecticides per acre and few increased the seeding rate on their no-till acreage. The principal increase in cost was for a knock-down herbicide; that is, a herbicide to kill the preceding crop, particularly where this was a sod or a cover crop. Application rates for residual herbicides on no-till corn differed little from those used conventionally; however, a number of farmers found it necessary to apply spot sprays after the initial application to control weeds. Farmers contemplating planting no-till corn clearly must have the capability and willingness to make additional herbicide applications if necessary.

The availability of cost-sharing subsidies from ASCS unquestionably helped to encourage participation in the project. Equipment costs tend to be high during initial stages of adoption because farmers are still operating conventional equipment, and the use of specialized no-till equipment adds to costs. The potential economic advantages of no-till techniques cannot be fully realized until farmers feel confident in maintaining only one set of equipment.

Support among farmers for the program appears to be quite strong. They have now established their own no-tillage organization. At the time of the survey, nine of the participating farmers had already purchased a no-till planter.

APPENDIX A

Table A-1. Estimated Labor Requirements by Tractor Size and Tillage System

Tractor Size (hp.)	Conventional	No-tillage
	hours/acre	
55	2.32	.50
75	1.86	.50
95	1.34	.42

SOURCE: Rask, Norman, G. B. Triplett, Jr., and D. M. VanDoren Jr. "A Cost Analysis of No-tillage Corn." Ohio Report 52(1): 14-15, 1967.

Table A-2. Estimated Annual Average Machinery Costs Per Acre for Five Different Tillage Systems

Tillage System	Average Annual Machinery Costs ($/acre)
Fall plow	33
Spring plow	36
Chisel	31
Disk	28
No-tillage	22

SOURCE: University of Illinois at Urbana-Champaign. Tillage Systems for Illinois. College of Agriculture, Extension Service Circular 1172, June 1979.

Table A-3. Estimated Fuel Use Per Acre for Three Different Tillage Systems by Type of Operation

Operation	Tillage System		
	Conventional	Reduced	No-tillage
	-------gallons of diesel fuel/acre-------		
Moldboard plow	1.9	-	-
Chisel plow	-	1.1	-
Disk	1.4*	.7	-
Spring tooth harrow	.8*	.4	-
Plant	.5	.5	.5
Spray	-	-	.3
Cultivate	.6	.6	-
Fertilizer	.2	.2	.2
Total	5.4	3.5	1.0

* Two disk or harrow operations.

SOURCE: Koelsch, Richard K. "Energy Requirements for Various Tillage Practices." Conservation Tillage for the Northeast States: Conference Proceedings. Soil Conservation Society of America, Empire State Chapter, Syracuse, New York, 1981.

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