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Cost Effective Corn and Soybean Production Without Tillage: Fact or Fiction? (May 1988)

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COST EFFECTIVE CORN AND SOYBEAN PRODUCTION WITHOUT TILLAGE:

FACT OR FICTION?

by

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for

DEPARTMENT OF AGRICULTURAL ECONOMICS
PURDUE UNIVERSITY
WEST LAYAYETTE, INDIANA

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D I S C L A I M E R

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PREFACE

Using farm level data developed in conjunction with the Lake Erie Conservation Tillage Demonstration Project, the authors show that farmers can manage reduced tillage systems to maintain yields and increase profits. While the specific results are not applicable to all areas, the findings do show that farmers are able to manage emerging tillage technologies effectively.

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Brief Resumes

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Stephen B. Lovejoy, Associate Professor, has been in the Department of Agricultural Economics at Purdue University since 1980. He received his Ph.D. from Utah State University in 1980. He is a member of the agricultural honorary Gamma Sigma Delta, the scientific research honorary Sigma Xi, the American Agricultural Economics Association, the Soil Conservation Society of America, and the Rural Sociological Society. Dr. Lovejoy has written extensively on agricultural and natural resource issues.

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COST EFFECTIVE CORN AND SOYBEAN PRODUCTION WITHOUT TILLAGE: FACT OR FICTION?

The 1980's may become known as a critical turning point for American agriculture. Farmers face an increasingly complex set of factors which effect their production decisions. Many observers have reported upon the disastrous consequences of the high interest rates, declining export markets and falling land prices. All of these have precipitated a major financial crisis in agriculture which encompasses the producer as well as input suppliers, credit institutions and those in the marketing chain. The American public has been inundated with information on the crisis from major news programs, movies and benefit concerts.

While the movies portraying the farm financial crisis are fading into the background of the American consciousness, those of us in agriculture know that for many of America's farmers, the crisis continues. For many farmers, recent commodity prices reflected by $1.60 corn are not sufficient to cover all costs, often not even enough to cover variable inputs. As advisors to farmers and managers of farmland, we must consider alternative ways for them to stay in business. We can help them find ways to maximize their profits, or in many cases, minimize their losses until a longer term solution to the farm problem can be found. At this time in the history of American agriculture, cutting costs may be the best advice we can offer .

In the past 50 years of American agriculture, we, the agricultural professionals, have assisted farmers by stressing new methods for increasing yields or cultivating larger tracts of land to spread overhead costs and achieve economies of scale. For some farmers, such technical advice is still relevant as they struggle with operations that are too small or continue to utilize seed varieties that are not well suited to their situations. However, for many of our clientele, it is not feasible to increase their size and they are already making use of the best available information on hybrid selection and other fine tuning actions to maximize output. Any moves that can achieve cost reductions while maintaining revenues seem more relevant. Many have begun using this approach in their fertilization program with increasing attention to maximum economic rather than physical yield. Another area of increasing scrutiny is cutting costs by changing tillage operations. In the Corn Belt, the vast majority of producers no longer use a moldboard plow on all their land. This change in tillage practices has been at least partially in response to rising fuel costs and labor constraints. Most have found that a chisel plow decreases costs without affecting yield. In recent years there has been increased attention toward other tillage techniques that may reduce costs even further. Advocates of no-till and ridge till have recently begun suggesting that these techniques provide a means of achieving economic as well as conservation goals.

Many farm management professionals have dismissed these suggestions as more rhetoric from the conservationists and have suggested that increased costs of herbicides to control weeds more than offset fuel and machinery savings and that the increased managerial skills will more than offset the labor savings. The information provided by many land grant universities has been contradictory and often not fully believed because the techniques have been suggested as soil conservation techniques while most farmers are more concerned with the survival of their farm operation than with saving soil for future generations. In addition, much of the research has been conducted on experimental plots which some farmers have felt do not translate well to actual field conditions.

In view of these problems with research results and the continuing need to assist farmers in their efforts to survive, we have undertaken an investigation of the effects of different tillage systems on net returns in actual field conditions in the Lake Erie Basin. The data were developed as part of the Lake Erie Conservation Tillage Demonstration Project, a program that sought to encourage farmers in the Lake Erie Basin to utilize no-till and ridge till by subsidizing matched plot experiments on their farms (National Association of Conservation Districts, 1985 and 1986). Participating farmers were asked to select two adjacent plots on their farm and plant the same crop on the two plots; one using their conventional tillage system (moldboard, chisel, disk, etc.) and the other utilizing a no-till or ridge till system.

Data on each plot were collected by local professionals. In addition, during the fourth year of the project, an independent survey was made of a sample of the farmers in the program for more detailed information on their machinery compliments, attitudes toward alternative tillage systems, financial conditions, and so on. The survey results were combined with plot information reported by farmers on yield, herbicide and other pesticide use, fertilizer use, planting rate, other variables related to production during 1985 as well in order to analyze the economic viability of the no-till and ridge till systems in the Lake Erie Basin. The large number of observations reported on direct comparisons of the no-till and conventional systems add reliability to the results. Due to the small number of ridge till plots, the ridge till findings should be used with caution.

The economic analysis of tillage systems concentrates on the factors that may vary significantly by tillage and planting activities; yield and various aspects of production costs. Farmers know that machinery costs can be expected to decrease under reduced tillage systems since (1) less tillage equipment is required, (2) power requirements are lowered, and (3) the number of passes over the field decreases. The decrease in tillage implement costs are offset somewhat by higher planter costs and, at least for the ridge till system, higher cultivation costs. The primary direct production costs that may be expected to vary include: herbicides and other pesticides, fertilizers, fuel and lubricants, machinery repair, and labor requirements.

This analysis is based on the 1985 tillage demonstration plot data and a survey of a sample of project participants conducted during February and March, 1985 by the Department of Agricultural Economics, Purdue University. For many of the participants, this was their fourth year in the project so they had had time to learn to manage alternative tillage systems and make independent decisions concerning the viability of the no-till and ridge till systems for their particular conditions. Revenues and costs are first considered separately and then combined to consider the effects of changes in net returns related to tillage system choice that accrue to land, labor, and other non-varying inputs.

Yields Obtained by Project Participants

Probably the first question a farmer considers when looking at a new or different technology is, "How will the use of ______ affect the yields I can expect on my farm?" After using no-till and ridge till production practices in this demonstration project, it appears that, on average, project participants are not only able to maintain yields, but increase them by slight but significant amounts for the most common crop rotations. As shown in table 1, corn yields for no-till were from two to five bushel per acre higher depending on the previous crop. For corn after soybeans, the increase was about 2.5 bushel per acre and highly statistically significant in the data reported by project participants. For beans following corn, the increase was in the neighborhood of a bushel per acre. While beans following beans or other crops had slightly lower yields, such rotation choices are relatively uncommon. Yields were also maintained or improved for both corn and soybeans in rotation using the ridge till system, but the smaller sample size decreases the confidence in the results.

Input Use by Project Participants

When comparing fertilizer use by tillage system and crop rotation, there were no significant differences noted in phosphorus and potash application rates among tillage systems for any given crop rotation. For nitrogen applications on corn, the data were not sufficiently precise to account for differences in nitrogen source and time/method of application to recognize differences due to tillage system choice. Also, at least from a fertility viewpoint, it appears that both the conservation plot and the matched conventional plot were treated the same in most cases. Since research results show that differences in nitrogen application requirements are more affected by yield goal, nitrogen source, and time/method of application than tillage system choice, the nitrogen costs reported in the budgets are based on current Purdue University findings (Van Beek, Fletcher, and Mengel).

Herbicide use is expected to increase with decreased tillage, and the data support this hypothesis. The question is, how much? Based on the matched plot results as well as the results from all plots included in the demonstration area, the actual increased herbicide use, particularly for no-till corn production, is lower than previous studies might suggest (Doster, et. al., Klemme). Average no-till pesticide costs (herbicides, insecticides, and fungicides) increased by about $5.00 per acre for corn planted in corn residue, $3.00 for corn in bean residue, and $9.00 for corn in other crop residue. Increases experienced in soybean production were slightly higher, ranging from $7.50 for second year beans to $10.50 for beans in corn residue. Smaller herbicide use increases were reported for the ridge till system, about $2.00 per acre per year for a corn-soybean rotation (table 1).

Changes in seed costs and drying costs have also been attributed to changing tillage systems by past studies, but there is no indication of differences in seed drop by tillage system reported in the plot results, and no data were obtained on drying costs. An individual farmer may wish to anticipate such potential cost changes for his situation, however.

Machinery costs are expected to decrease as tillage decreases. To find out what farmers can expect in this area over the life of a machinery set, information on machinery complements was obtained from a sample of the project participants, and representative machinery complements constructed for conventional tillage systems. These sets for 750 acre farms were found to exhibit essentially the same cost characteristics as the representative farm sets used by Cooperative Extension Tillage Specialists at Purdue University (Doster, et. al.).

Based on the same timeliness characteristics, machinery sets for no-till and ridge till representative farms were constructed and the anticipated overhead costs, repair and maintenance costs, and fuel costs were compared to conventional costs. Using this analysis, the no-till system can be expected to cut total machinery related expenses, including fuel and repair, by about $14 to $16 per acre per year over the life of a machinery set while the ridge till system would decrease the same costs by $10 to $12 per acre per year. Savings in per acre machinery costs are expected to be slightly greater for larger farms of 1000 acres and up while the savings will be less for smaller farms of less than 500 acres.

Labor costs are also expected to decrease, but the actual value of the labor saved to a given farm is highly dependent on farm structure, fixed labor availability during tillage, planting, and cultivating periods, and personal preferences of individual operators. The no-till and ridge till systems do affect labor timing requirements differently. Both eliminate the need of fall and spring preplant tillage operations, but the ridge system imposes additional cultivation requirements for weed control and to form ridges during the late spring and early summer. Although these cost savings may be significant in many instances (e.g., where hired labor is utilized), the actual value can only be determined by the individual farmer given his situation. Therefore, the cost estimates reported do not take these savings into account; rather all labor is included in other factors for which net returns are calculated. Although this assumption does not handle the labor input problem explicitly, it makes the analysis applicable to a wider number of farming situations.

In summary, fertilizer and seed costs are not necessarily significantly affected by tillage system choice while pesticide costs tend to increase with reduced tillage. Machinery costs including overhead, fuel, repair, and maintenance and labor requirements also decrease with reduced tillage, but the value of the labor saved varies significantly among farmers. Other costs may also be affected by tillage choice, but less is known about the level of such changes. For instance, depending on maturity rate, drying costs may be affected if the crop matures at a later date.

The Bottom Line: Do Conservation Tillage Systems Pay?

Many conservationists have suggested that conservation tillage is just as profitable as conventional tillage systems. Also, many university test plots have shown similar yields and net returns from conservation tillage. However, many farmers have been skeptical of the ability of these results to be replicated in real farming situations. The data provided by farmers participating in the demonstration project suggest that yields can be maintained and profits increased by adopting conservation tillage.

Based on the 1985 data gathered from the Lake Erie Project, farmers have been able to adapt the no-till and ridge till system to area conditions to maintain or increase yields. At the same time, farmers have experienced increased pesticide costs and lower fuel costs for tillage operations. To compare these differences, budgets were developed for representative farms in the study area. A set of such budgets are given in table 2 for farms using six row equipment assuming a representative soil type for the area.

Comparisons are limited to those systems where the data are adequate to have reasonable levels of confidence in the results. The top part of table 2 compares the conventional system to no-till and ridge till systems. The increased pesticide costs are much more than out weighed by the yield increases and/or machinery cost decreases. Corn production using the no-till system shows increased returns of $14 to $18 per acre per year depending on the previous crop and an increase of about $9 for soybeans following corn. The ridge till system shows higher increases for soybeans ($24/acre) after corn but a lower increase for corn after beans ($11/acre) than displayed by the no-till estimates.

The analysis above assumes that the primary nitrogen source is anhydrous ammonia regardless of the tillage system. If other nitrogen fertilizer programs are followed, both the price per unit of actual nitrogen and the amount required may change. For example, many no-till and ridge till farmers apply their herbicides using nitrogen solutions as the carrier. Although nitrogen needs are expected to be about the same regardless of tillage system, the amount of nitrogen necessary to apply to have the same amount of nitrogen available to the plant may increase significantly if the nitrogen fertilizer is broadcast on a surface covered with heavy residue. For example, if the primary nitrogen application is made as a 28% liquid broadcast before planting, perhaps as a herbicide carrier, an additional 60 pounds of N per acre ($13 @ $.22/lb) may be required to meet the nitrogen needs for second year corn using no-till (Van Beek, Fletcher, and Mengel). Such a situation is explored in the section of table 2 on alternative input assumptions. There are other possibilities for nitrogen management that can combine applying part of the nitrogen as a herbicide carrier while using a more efficient method such as banding or injecting for the remainder. The primary message for nitrogen management in conservation tillage is that efficiency can be maintained but not without careful evaluation of production practices and fertilization alternatives.

In addition, the analysis used the average per acre cost of pesticides as reported by project participants, but individual costs varied significantly. The variation among farmers within each tillage category due to differences in pesticide choice, weed pressure, and management techniques appears greater than the variation due to tillage practices. This suggests that, for an individual farmer, the level of pesticide costs will be largely determined by factors other than tillage choice. A farmer can expect, however, to have some increased costs with reduced tillage. To consider these effects, the bottom section of table 2 uses costs representative of the high one-third of reported rates as indicative of high pesticide use and the low one-third as low pesticide use. Note that the increased difference in pesticide costs under high use situations between tillage systems are not as great as the average rate increase for any particular system. Similar relationships are indicated for low pesticide use. The net effect is that while pesticide costs varied by farmer, the differences between tillage systems were relatively consistent for all application levels.

All of the alternative assumptions considered affect only the magnitude of the difference in net returns, not the direction of the difference between conservation and conventional tillage systems. For each crop and rotation considered in this analysis, conservation tillage is found to be significantly more profitable for corn and soybean production in the Lake Erie Basin than the conventional systems that have traditionally been used.

Summary

While the demonstration project was designed to show producers the environmental benefits of using conservation tillage, it appears that a major accomplishment will be the demonstration that conservation tillage is economically profitable. While too much can be made of the economic differences between agricultural practices, it seems clear that if a practice does not provide an economic incentive, the probability of adoption and use is greatly diminished. At the same time, economic advantage does not necessarily lead immediately to increased usage. Economic considerations seem to be a necessary but not sufficient condition for use of a new technology.

Among project participants, however, we expect increased use of conservation tillage if the results of this economic analysis prove accurate. As part of the Purdue survey, participants were asked,

> "Would funds ... be available to you to finance the machinery purchase necessary for you to change from convention tillage to conservation tillage?"

Eighty per cent said, "Yes." Those that indicated the funds were available were then asked,

> "If ... you were convinced that conservation tillage was at least as profitable as conventional tillage, would you use those funds available to you to make the switch in tillage systems?"

Again, eighty per cent said yes. Based on these results, about two thirds of the project participants can be expected to use conservation tillage when and if they are convinced that the economic incentives are there. If this happens, it seems likely that the Lake Erie Conservation Tillage Project will be considered a success from an environmental perspective. In addition, it appears that, at least in this instance, environmental concerns and farm management objectives can be accomplished simultaneously. Farming without tillage helps the environment by reducing sediment and phosphorus loading in surface runoff and helps the farmer by increasing their returns per acre. The bottom line is improved for both farmers and those concerned with environmental quality.

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Table 1. Differences in Yields, Herbicide Costs, and Total Pesticide Costs between Conservation Tillage Plots (No-Till and Ridge Till) and Matching Conventional (All Other Systems)

TILLAGE SYSTEM	CROP	PREVIOUS CROP	YIELD* DIFFERENCE (bu/ac)	HERBICIDE* COST DIFFERENCE ($/ac)	TOTAL* PESTICIDE COST DIFFERENCE ($/ac)	SAMPLE SIZE
NO-TILL	CORN	CORN	2.21 (1.24)	3.99 (3.61)	5.09 (4.13)	59
NO-TILL	CORN	BEANS	2.53 (2.95)	2.78 (6.33)	3.02 (6.63)	221
NO-TILL	CORN	OTHER	5.02 (2.54)	7.46 (5.56)	8.76 (5.83)	82
NO-TILL	BEANS	CORN	1.04 (1.79)	10.52 (8.43)	10.52 (8.43)	104
NO-TILL	BEANS	BEANS	-1.29 (-1.03)	7.47 (3.86)	7.47 (3.86)	36
NO-TILL	BEANS	OTHER	-3.89 (-2.31)	8.93 (1.84)	8.93 (1.84)	10
RIDGE TILL	CORN	BEANS	1.05 (0.25)	1.76 (1.77)	1.76 (1.77)	16
RIDGE TILL	BEANS	CORN	3.50 (1.73)	1.81 (1.15)	1.81 (1.15)	14

* Average values reported; t values in parenthesis.

NOTE: All statistics are calculated: (conservation tillage plot value - matched conventional plot value).

Positive numbers indicate the value for the conservation plot exceeded that of the matched conventional plot.

Table 2. Break Down of Revenues and Costs Expected to Vary by Tillage System and Rotation Choice

	CONTINUOUS CORN		ROTATION CORN			ROTATION SOYBEANS		
	CONV	NO-TILL	CONV	RIDGE	NO-TILL	CONV	RIDGE	NO-TILL
REVENUE								
Yield (bu/ac) [1]	125.00	127.00	135.00	136.00	138.00	44.00	47.00	45.00
Gross Revenue ($/ac) [2]	275.00	279.40	297.00	299.20	303.60	220.00	235.00	225.00
EXPENSES								
Operating Costs								
NH3 (# actual N) [3]	150.00	154.00	143.00	144.00	147.00	-----	-----	-----
Nitrogen cost (@ $.14/#)	21.00	21.56	20.02	20.16	20.58	-----	-----	-----
P2O5 and K2O [1]	20.00	20.00	22.00	22.00	22.00	7.00	7.00	7.00
Pesticide Cost [1]	29.00	34.00	21.00	23.00	24.00	26.00	28.00	37.00
Machinery fuel and repair [4]	23.12	15.81	23.12	17.73	15.81	23.12	17.73	15.81
Seed [1]	20.00	20.00	20.00	20.00	20.00	10.00	10.00	10.00
Interest charge [5]	6.79	6.68	6.37	6.17	6.14	3.97	3.76	4.19
Subtotal:	119.91	118.05	112.51	109.06	108.53	70.09	66.49	74.00
Machinery Overhead Costs								
Tillage machinery cost [4]	14.65	6.90	14.65	8.87	6.90	14.65	8.87	6.90
Other machinery cost [4]	12.37	12.37	12.37	12.37	12.37	12.37	12.37	12.37
TOTAL ALLOCATED EXPENSES	146.93	137.32	139.53	130.30	127.80	97.11	87.73	93.27
NET RETURNS (to Land, Labor, and All Other Inputs)	128.07	142.08	157.47	168.90	175.80	122.89	147.27	131.73
ALTERNATIVE INPUT ASSUMPTIONS								
N Source -- 28% Liquid Broadcast Spring Preplant								
N Rate (# actual N) [3]	158.00	218.00	150.00	160.00	163.00	-----	-----	-----
N Cost ($.22/#)	34.76	47.96	33.00	35.20	35.86	-----	-----	-----
Adjusted Net Returns	113.49	114.09	143.71	152.95	159.60	-----	-----	-----
High Pesticide Use								
Pesticide Cost [1]	41.00	43.00	29.00	N/A	33.00	32.00	N/A	47.00
Adjusted Net Returns	115.35	132.54	148.99		166.26	116.53		121.13
Low Pesticide Use								
Pesticide Cost [1]	17.00	25.00	14.00	N/A	15.00	18.00	N/A	26.00
Adjusted Net Returns	140.79	151.62	164.89		185.34	131.37		143.39

N/A - Insufficient data for estimate.

[1] Based on 1985 plot level data reported by participants in the Lake Erie Conservation Tillage Demonstration Project.

[2] Based on representative corn (@ $2.20/bu) and soybean (@$5.00/bu) prices at harvest.

[3] Based on Purdue University recommendations for nitrogen requirements depending on yield, form of nitrogen, application method, and time of application.

[4] Based on results of survey conducted by Purdue University of a sample of Tillage Demonstration Project Participants in 1985.

[5] Based on 6 months interest on listed operating expenses at 12%.

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16. ABSTRACT

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17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTIONS		b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field Group
Tillage	Ridge Till		
Costs	Lake Erie		
Corn	Yields		
Soy Bean	Machinery		
Soil	Conservation Tillage		
No-Till			

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