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ECONOMICS OF REDUCED TILLAGE SYSTEMS

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Reduced tillage, also called minimum tillage, is a broad term which refers to a variety of systems that basically eliminate the moldboard plow and use other tillage implements to reduce the number of machine operations necessary for crop production. It is also frequently referred to as conservation tillage. Conservation is an important aspect of reduced tillage, but the economic benefits and costs of conservation are not a part of this analysis. To qualify as conservation tillage, a system must leave protection cover of crop residue on or near the surface all year long.

Current Research

A great deal of economic research is being done in evaluating the feasibility of reduced tillage. Farmers want to know the costs and returns of making a change in a tillage system that has been with us ever since the development of the moldboard plow. The most economical system may be different for different areas of the United States. A survey of 262 farmers in Washington indicates farmers are generally favorable towards soil conservation, but less than 33 percent use minimum tillage. The reason cited for such a small percentage being involved was "no economic incentive".

Plant Science researchers at South Dakota State University have studied the influence of conservation tillage systems on several weed problems and soil characteristics. Over the past 10 years, records at the Southeast South Dakota Experiment Station show that total weed yields were highest in no-till fields. Conventional tilled fields produced the lowest total weed yields. One would assume from this that substantial herbicide costs in no-till and reduced tillage systems would occur. Four years of records from a study in Tripp County revealed that minimum tillage was the most expensive, with average tillage cost of $27.90 per acre per year. The conventional tillage system was the least expensive, with a cost per acre of $20.30. No-till costs were $23.30 per acre. These figures did not include machinery investment expenses for each system.

With more crop residue left on the soil surface under reduced tillage, the insecticide requirement is often higher. Also, there is a higher probability of sporadic outbreaks under reduced tillage. Because of the need for more information on the economics of reduced tillage, the Economics Department at a SDSU decided to investigate the cost structure of reduced tillage systems compared to conventional systems.

This newsletter is devoted to reporting on a study that used a special computer program to build budgets for selected cropping sequences and tillage systems. Data based on current knowledge regarding reduced tillage in East Central South Dakota along with specified field operations, implement sizes, power units, and type of implement were input to the computer program. The computer then made all the calculations to determine machine costs, operating time, and fuel consumption.

Machine Investment

Table 1 shows the machinery complements and investments (in 1983 prices) assumed under each of conventional, reduced, and no-till systems for corn, soybean, and oat production. It is not customary to produce a single crop. Therefore, one must consider the effect of reduced tillage on the total machinery complement when growing a combination of crops.

Table 1. Machine Investment if Growing Corn, Soybeans, Oats*

	Cost	Conventional Tillage	Reduced Tillage	No-Till
Tractor, 80 HP	16,000	16,000	16,000	16,000
Tractor, 100 HP	35,000	35,000	35,000	35,000
Stalk Shredder, 4 row	2,203	2,203	2,203	
Moldboard Plow, 5-16	9,545	9,545		
Fertilizer Spreader, 45 ft.	4,600	4,600	4,600	4,600
Tandem Disk, 18'	10,923	10,923	10,923	
Spike Harrow, 18'	935	935	935	
Chisel Plow, 15'	3,685	3,685	3,685	
Conventional Planter, 8 row	16,330	16,330		
Minimum Till Planter, 8 row	16,500		16,500	16,500
Conventional Drill, 18'	8,170	8,170		
Minimum Till Drill, 18'	9,000		9,000	9,000
Conventional Cultivator, 9 row	10,575	10,575	10,575	
Sprayer, 500 gal., 8 row	2,550	2,550	2,550	2,550
Swather, 16.5'	20,500	20,500	20,500	20,500
Combine	52,429	52,429	53,429	52,429
Corn Head, 4 row	13,000	13,000	13,000	13,000
Grain Head, 13'	6,956	6,956	6,956	6,956
TOTAL	N/A	214,201	205,656	177,335
			4% less than conv.	17% less than conv.

*Based on new purchase cost at 1983 price levels

The data in Table 1 show a total investment of $214,201 for conventional tillage, $205,656 for reduced tillage, and $177,335 for no-till systems. Reduced investments of 4% and 17%, respectively, are realized for reduced tillage and no-till operations compared to conventional tillage.

Machine manufacturers have been quick to recognize the need for a new technology in tillage machines. The development of the no-till planter has been a major factor in spurring on the adoption of minimum tillage. The planter also represents the major equipment change necessary for making a shift to minimum tillage. A no-till planter also represents a sizeable investment. Though a farmer may decide that, in the long run, it is economical for him to shift to reduced tillage, it is also important to examine the cash flow requirements brought on by a new machine purchase. Other implements that combine traditional field operations such as disking, chiseling, and harrowing into one implement continue to be developed.

Field operations assumed for use in the conventional tillage, reduced tillage, and no-till budgets are presented in Table 2.

Table 2. Field Operations Assumed for Conventional, Reduced and No-Till Tillage Systems

Operation	Conventional			Reduced			No-Till		
	Corn	Beans	Oats	Corn	Beans	Oats	Corn	Beans	Oats
	Times Over								
Shred Stalks	1	1		1	1				
Plow	1	1							
Spread Fertilizer			1			1			1
Disk-Harrow	2	1	1	1					
Chisel			1	1	1	1			
No-Till Plant				1	1		1	1	
Conventional Planter	1	1							
Cultivate	2	1		1	1				
Minimum Till Drill						1			1
Conventional Drill			1						
Spray			1			1	1	1	1
Swath			1			1			1
Combine	1	1	1	1	1	1	1	1	1

Cost of Production

Table 3 presents a summary of the production costs for three tillage systems. For corn and soybeans, conventional tillage has the highest total cost per acre. However, for wheat and oats, the costs are higher with no-till planting. Total cost per acre for wheat production was $134 per acre under conventional tillage compared to $143 for reduced tillage and $155 for no-till planting. Oats had a total cost of $143 per acre for conventional tillage with $141 and $150 per acre for reduced and no-till operations, respectively. Conventional tillage in corn production had a total cost of $180 per acre, with $173 and $175 for reduced tillage and no-till, respectively.

It is important to recognize that these data are intended to serve as guideline figures. Variations among individual farms will exist because of a large number of factors that can influence the machine costs as well as the chemical costs. "Other cash costs", as listed in the cost structure of Table 3, include seed, insurance, storage, drying, and miscellaneous farm overhead costs such as telephone, record keeping, magazines, legal fees, etc. The interest charge on capital includes interest on operating and investment capital at a 12% annual rate. Persons wishing more detail on these budgets should write to the Economics Department, SDSU and ask for Economics Pamphlet 84-2, "Budgets for Minimum Tillage Operations".

Table 3. Summary of Costs Per Acre for Selected Crops and Tillage Systems

Cost Item	CORN FOLLOWING CORN Conventional Tillage	Reduced Tillage	No-Till Planting	SOYBEANS FOLLOWING CORN Conventional Tillage	Reduced Tillage	No-Till Planting	SPRING WHEAT FOLLOWING SOYBEANS Conventional Tillage	Reduced Tillage	No-Till Planting	OATS FOLLOWING CORN Conventional Tillage	Reduced Tillage	No-Till Planting
Herbicide	$ 7.88	$ 7.88	$ 15.92	$ 11.19	$ 16.94	$ 25.86	$ 6.93	$ 6.93	$ 21.19	$ 11.14	$ 11.14	$ 15.79
Insecticide	9.88	11.78	13.58	5.48	8.18	10.88	0.88	1.88	6.88	0.88	0.88	0.88
Fertilizer	19.28	26.48	33.68	4.88	4.88	4.88	19.28	26.48	26.48	21.68	21.68	21.68
Other Cash Costs	24.67	24.67	24.67	25.88	25.88	25.88	17.92	17.92	17.92	21.58	21.58	21.68
Fuel and Oil	9.98	6.98	3.65	9.87	6.88	3.65	6.77	6.48	5.49	7.55	7.19	5.85
Machine Repairs	14.81	9.66	6.81	13.85	7.66	5.67	7.51	7.42	6.75	9.22	9.19	9.49
Total Cash Costs	94.66	96.21	107.33	68.51	68.58	74.98	58.32	68.87	85.75	68.98	68.98	77.12
Interest Charge on Capital	20.71	17.54	14.42	17.57	14.82	12.88	16.88	15.76	14.62	18.79	17.71	16.65
Machine Deprec., Taxes, Ins.	19.97	16.13	11.97	17.37	13.42	11.87	16.48	16.86	14.26	19.28	19.61	17.11
Labor Charge	5.75	4.14	2.38	5.27	3.66	2.38	4.57	3.86	3.27	5.88	4.59	3.88
Land Charge	39.88	29.88	39.88	39.88	29.88	39.88	29.88	29.88	39.88	39.88	29.88	29.88
Total Fixed Costs	85.43	76.81	67.69	79.21	70.18	64.37	75.97	74.68	71.25	81.75	79.91	76.66
TOTAL COST	$180.09	$173.82	$175.84	$147.72	$138.68	$139.35	$134.28	$142.75	$155.88	$142.65	$148.81	$149.78
Hours of Field Time	1.64	1.18	0.66	1.5	1.05	0.66	1.31	1.18	0.96	1.45	1.21	1.11

Total cash costs, shown in Table 3, are greater for no-till than for either conventional or reduced tillage systems. Reductions in fuel, oil and machine repairs tend to be offset by increased cash costs for weed control, pest control, and fertilizer. This may be an important consideration for farm operators that are already having difficulty meeting cash flow requirements. On the other hand, fixed costs decrease as the level of investment decreases for reduced tillage systems. There is a significant saving in labor costs from reduced hours of field time—with greatest savings being realized with the no-till system.

Herbicide programs in this analysis assume broadcast applications for a broad weed spectrum. Banding of herbicides will reduce the costs in row crops. The no-till system assumes total dependence on herbicides for weed control. Minimum tillage practices place increased emphasis on such things as selection of chemical, timing of application, proper placement of chemicals, and proper machine operation.

Table 4 presents cost changes as a result of shifting from conventional to reduced or no-till tillage systems. The data in Table 4 show that cost increases come from additional herbicide,

Table 4. Cost Changes per Acre When Switching from Conventional to Reduced or No-Till Tillage Systems

	Corn Following Corn		Soybeans Following Corn		Spring Wheat Following Soybeans		Oats Following Corn	
	Reduced tillage	No-till	Reduced tillage	No-till	Reduced tillage	No-till	Reduced tillage	No-till
	Dollars Per Acre							
Cost Increases:								
Herbicide	0	8.12	5.75	13.87	0	14.26	0	14.25
Insecticide	2.78	4.58	2.78	5.48	1.88	6.88	0	0
Fertilizer	7.28	14.48	0	0	7.28	7.28	0	0
TOTAL INCREASE	9.98	27.82	8.45	19.27	10.28	27.46	0	14.25
Cost Decreases:								
Machine Costs	12.19	22.33	12.33	19.18	8.98	4.18	8.67	4.19
Labor Costs	1.61	3.45	1.61	2.97	0.71	1.28	0.49	1.28
Interest on Capital	3.17	6.29	3.55	5.57	0.24	1.38	0.68	1.74
TOTAL DECREASES	16.97	32.07	17.49	27.64	1.75	6.76	1.84	7.12
NET CHANGE FROM CONVENTIONAL COSTS	-7.87	-5.85	-9.04	-8.37	+8.45	+20.78	-1.84	+7.13

insecticide, and fertilizer use. Cost decreases come from lower machine costs, labor costs, and interest on capital.

The data in Table 4 are based upon conditions assumed to be typical. However, it is logical to expect farm-to-farm variations from these data—especially in chemical costs. It is important for a farm operator to estimate these costs for his own situation. If total expected cost increases are less than total cost decreases, it is profitable to shift to reduced tillage. This study indicates that cost savings may be realized from reduced tillage with row crops such as corn and soybeans. With small grains (wheat and oats), the costs with reduced tillage may be higher.

Summary

Significant reductions in machine costs and labor may be realized through reduced tillage and/or no-till practices. However, these reductions tend to be offset by increased chemical costs. Many factors influence the chemical costs as well as the machine costs on an individual farm. Special weed and pest control problems may require "prescription" programs by chemical use specialists. The technology of reduced tillage places an increased demand on management. There is an increased concern for such things as chemical selection, timing of application, placement of chemicals, field monitoring for special problems, and proper machine operations.

The effect of tillage systems on crop yields was not a part of this analysis. However, there is no evidence to indicate the yields will necessarily be reduced by minimum tillage. The benefits of conservation are not evaluated in this study. Such benefits may be an important consideration. Even if conservation tillage results in higher costs per acre, it could be an economical way for achieving soil conservation objectives.