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Costs and Fuel Use for Alternative Tillage Systems

Recent increases in fuel and new equipment prices have again focused attention on alternative tillage systems. In this paper, costs are examined for two systems that have little tillage and two systems that rely on tillage. One of the "low" tillage systems is strip tillage, a system in which a strip is cleared when nitrogen is applied, thereby allowing the strip to warm-up faster in the spring and allowing earlier planting than a no-tillage system. One of the "tillage" systems relies on a v-ripper to perform primary tillage. The ripper performs deep tillage, thereby mixing organic matter in the hopes of increasing yields. Results indicate that the two "low" tillage systems have about $9.50 per acre less costs and between 1 and 2 gallons less fuel use than the two "tillage" systems.

Estimating Costs for Alternative Tillage Systems

Costs are estimated for four systems representing choices farmers are considering:

1. Strip-till. The strip-till system has no tillage except for an application of anhydrous ammonia. During the ammonia application, a "strip" of bare land is left in which corn will be planted. The strip is accomplished by adding coulters and/or sweeps on the toolbar used to apply anhydrous ammonia.

2. No-till. The no-till system does not have any tillage operations. There are, however, other field operations performed including fertilizer and chemical applications, planting, and combining.

3. Typical-till. The "typical" system uses a field cultivator to perform a secondary tillage pass prior to planting. In addition, a chisel plow operation is performed after harvest on land previously planted to corn.

4. Deep-till. The "deep" tillage system is the same as the typical system, except that the chisel plowing is replaced with v-ripping. The v-ripper is meant to represent a deeper operation than the chisel plow.

For each system, costs are estimated by specifying field operations for corn and soybeans. Costs of each field operation then are estimated using material in the 2005 Machinery Cost Estimates, publications that give costs for various field operations (see the "Machinery: Costs and Other Issues" area in the management section of *farmdoc* (http://www.farmdoc.uiuc.edu/manage/index.html). Costs are summed for all field operations to arrive at corn and soybean costs. Finally, average farm costs are determined by averaging corn and soybean costs.

The estimating procedure is illustrated in Table 1 for strip-till. There are seven field operations performed for corn: dry fertilizer application, anhydrous ammonia application, plant, spray, spray, spraying 1/3 of the acres for a rescue operation, and combine. These operations are listed in roughly the order they are performed, beginning in fall after the previous crop has been harvested. Order of operations (particularly spraying and planting) and number of passes (particularly spraying) will vary across farms.

Table 1. Estimated Costs For a Strip-Till System in Illinois.[1]

	Fuel Use	Costs per Acre			
		Fuel & Labor	Implement Overhead	Tractor Overhead	Total
Panel A. Corn Operations	gal/acre	$ per acre			
Dry fertilizer	0.2	$0.61	$0.80	$0.50	$1.91
Anhydrous ammonia	0.6	3.01	3.96	2.52	9.49
Plant	0.4	3.10	4.40	2.00	9.50
Spray	0.2	1.11	1.30	0.90	3.31
Spray	0.2	1.11	1.30	0.90	3.31
Spray (1/3)	0.1	0.37	0.43	0.30	1.10
Combine[2]	1.5	5.99	4.60	14.10	24.69
Total	2.9	$15.30	$16.79	$21.22	$53.31
Panel B. Soybean Operations	gal/acre	$ per acre			
Dry fertilizer	0.2	$0.61	$0.80	$0.50	$1.91
Spray	0.2	1.11	1.30	0.90	3.31
No-till drill	0.5	2.84	9.30	3.20	15.34
Spray	0.2	1.11	1.30	0.90	3.31
Spray (1/3)	0.1	0.37	0.43	0.30	1.10
Combine[2]	1.0	4.00	3.20	13.10	20.30
Total	2.0	$10.04	$16.33	$18.90	$45.27
Average (50-50 corn-soybeans rotation)	**2.4**	**$12.67**	**$16.56**	**$20.06**	**$49.29**

[1] Costs taken from *2005 Machinery Costs Estimates*, Department of Agricultural and Consumer Economics, University of Illinois. No costs are included for grain hauling.

[2] Implement overhead represents header costs while tractor overhead represents separator costs.

For each operation, fuel use is obtained from the 2005 *Machinery Cost Estimates*. Fuel use is multiplied by $2.50 for fuel costs. Lubrication, labor, and overhead costs also are obtained from the 2005 *Machinery Cost Estimates*. These fuel uses and costs are listed in Table 1. For example, corn planting uses .4 gallons of fuel and costs are $3.10 per acre for fuel and labor, $4.40 in implement overhead, $2.00 in tractor overhead. Total costs are $9.50 per acre. Implement charges include depreciation, interest, insurance, housing, and repair charges for the implement while tractor charges includes the above charges for the tractor used to pull the implement.

The 2005 *Machinery Cost Estimates* do not include fuel use and costs for dry fertilizer applications and the anhydrous ammonia/stripper operation. Costs for these two operations are estimated using the same procedures as are used in preparing the 2005 *Machinery Cost Estimates*.

For each crop, fuel use and costs are summed to arrive at field operations costs per crop. Fuel use for strip tillage is estimated at 2.9 gallons for corn and 2.0 gallons for soybeans (see Table 1). Corn tillage costs are $15.30 for fuel and labor, $16.79 for implement overhead, $21.22 for tractor overhead, giving total costs of $53.31 per acre. Soybean tillage costs are $10.04 for fuel and labor, $16.33 for implement overhead, $18.90 for tractor overhead, giving total costs of $45.27 per acre.

Costs are not included for grain hauling or general farm use. Hence, the above costs understate total machinery cost for each crop. However, grain hauling and general use should not vary across tillage systems. Therefore, these costs are not included in this analysis.

Corn and soybean costs are averaged to arrive at an average farm cost. This averaging assumes that 50 percent of the farmland is in corn and 50 percent is in soybeans. For strip tillage, average fuel use is 2.4 gallons per acre. Average costs are $12.67 per acre in fuel and labor costs, $16.56 in implement costs, $20.06 in tractor overhead, giving average total costs of $49.29 per acre. Similar procedures are used to determine costs for no-till (see Appendix Table 1), typical-till (Appendix Table 2) and deep-till (Appendix Table 3). Average costs are compared across systems in the following section.

Fuel Use across Systems

Both the strip and no-till systems have estimated fuel use of 2.4 gallons per acre (see Table 2). Both the strip and no-till systems have lower fuel use than the typical-till. Fuel use for the typical-till is estimated at 3.7 gallons per acre, 1.3 gallons higher than the strip or no-till systems. At a $2.50 per gallon diesel fuel price, fuel use differences results in $3.25 per acre higher costs for the typical-till than for strip-till or no-till.

Table 2. Summary of Alternative Tillage System Costs.

	Fuel Use	Costs per Acre: Fuel & Labor	Implement Overhead	Tractor Overhead	Total
	gal/acre	$ per acre			
Strip-till	2.4	12.67	16.56	20.06	49.29
No-till	2.4	12.18	17.08	19.80	49.06
Typical-till	3.7	17.51	17.13	24.15	58.79
Deep-till	4.0	18.33	17.16	25.21	60.70

Deep-till has 4.0 gallons of fuel use per acre, .3 gallons higher than typical-till. Deep-till replaces a chisel plow under the typical system with a v-ripper. The v-ripper uses 1.7 gallons per acre, .6 gallons higher than the estimated fuel use of 1.1 gallons for a chisel plow. The v-ripper is used on half the acres, resulting in the .3 gallons of higher fuel use for the heavy tillage system across all acres in the farm.

These fuel uses represent needs for field operations. In addition, farms use fuel for grain hauling and general use. Fuel costs contained in Illinois Farm Business Farm Management records suggest that fuel use on farms average between 6 and 7 gallons per acre, with wide variations across farms. Hence, fuel uses in Table 1 represent about half the fuel use on farms.

Tillage system can have impacts on fuel use, with systems that use less tillage having less fuel use. However, fuel use for tillage represents only a portion of fuel use on farms. Reducing fuel use in other areas may have more of an impact on total farm fuel use than tillage choice.

Costs across Systems

The two systems relying on little tillage (strip-till and no-till) have lower costs than the two systems using tillage (typical-till and deep-till). Total costs average $49.29 per acre for strip-till and $49.06 for no-till while typical-till has $58.79 and heavy-till has $60.70 in costs. There is $9.50 per acre difference in costs between strip-till, the “low” tillage system with the highest costs, and the typical-till, the lowest cost system using tillage. These results suggest that tillage adds at least $9.50 per acre in costs.

Most of the costs are in overhead. For example, 74% of the strip-till system’s costs are in implement and tractor overhead. This factor has implications for realizing cost savings from reduced tillage. Most of the overhead is related to depreciation and interest and is incur by owning the equipment no matter how much the equipment is used. To realize cost savings in the overhead area, equipment inventory must be reduced.

Suppose, for example, a farmer is considering moving from typical-till to strip-till. To realize all of the $9.50 is savings, the farmer must sell tillage equipment in order to reduce overhead. If tillage equipment is not sold, only the fuel and labor cost savings are realized. The difference in fuel and labor costs between strip-till and typical-till is $4.84 per acre. Hence, eliminating passes saves 50 percent of the costs saving between strip-till and typical-till. The other 50 percent is obtained by reducing equipment inventory.

Yield differences and pesticide cost differences are not included in this analysis. Differences in yields or costs will impact profitability. Results above would suggest that the typical-till and deep-till systems must either have higher yields, lower pesticide costs, or a combination of higher yields and lower costs in order to have the same profitability as the strip-till and no-till systems.

Concluding Comments

Strip-till and no-till have lower fuel use and lower costs than typical-till and heavy-till systems. Tillage adds about $9.50 in costs per acre and between one and two gallons of fuel use. The economic advisability of adopting these reduced tillage systems depends on whether yield losses occur or pesticide costs are increased with their adoption.

The strip-till system has marginally higher costs than the no-till system. With this slight cost increase, the strip-till system eliminates a major disadvantage of no-till, namely that a strip is tilled that will warm up quicker in the spring, thereby allowing earlier planting. Cost results for strip-till look promising. Further cost reductions likely are possible by evaluating ways of sharing costs in the anhydrous ammonia/stripping operation. Results above assume that the farmer owns the tractor and the tool bar used for the stripping operation. The stripping operation is the only field operation in the strip-till system that requires the use of a tractor with large horsepower. Significant cost savings occur if the large tractor could be eliminated or the costs of ownership are spread over more acres. Options include 1) the farmer who owns the tractor and toolbar could perform custom applications for other farmer, 2) the farmer could sell the large tractor and toolbar and have nitrogen custom applied, 3) the farmer could find other farmers to jointly own the large tractor and the stripping toolbar.

The deep-till system has higher costs than does the other systems. The rationale for using deep-till is to increase yields. Research generally does not indicate that deep tillage operations increase yields. Hence, farmers should evaluate whether or not deep tillage is increasing yields on there own operations.

Fuel use is impacted by tillage choices. Other choices on farms also impact fuel use. Roughly half of the fuel use on farms is not related to field and harvesting operations and is instead related to grain hauling and general farm use. Evaluating these operations may prove beneficial as well as examining tillage choices.

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Appendix Table 1. Estimated Costs For a No-Till System in Illinois.[1]

	Fuel Use	Costs per Acre: Fuel & Labor	Implement Overhead	Tractor Overhead	Total
Panel A. Corn Operations	gal/acre	$ per acre			
Dry fertilizer	0.2	$0.61	$0.80	$0.50	$1.91
Spray	0.2	1.11	1.30	0.90	3.31
No-till plant	0.5	3.13	6.40	2.10	11.63
Nitrogen application	0.5	2.00	3.00	1.90	6.90
Spray	0.2	1.11	1.30	0.90	3.31
Spray (1/3)	0.1	0.37	0.43	0.30	1.10
Combine[2]	1.5	5.99	4.60	14.10	24.69
Total	2.9	$14.32	$17.83	$20.70	$52.85
Panel B. Soybean Operations	gal/acre	$ per acre			
Dry fertilizer	0.2	$0.61	$0.80	$0.50	$1.91
Spray	0.2	1.11	1.30	0.90	3.31
No-till drill	0.5	2.84	9.30	3.20	15.34
Spay	0.2	1.11	1.30	0.90	3.31
Spray (1/3)	0.1	0.37	0.43	0.30	1.10
Combine[2]	1.0	4.00	3.20	13.10	20.30
Total	2.0	$10.04	$16.33	$18.90	$45.27
Average (50-50 corn-soybeans rotation)	**2.4**	**$12.18**	**$17.08**	**$19.80**	**$49.06**

[1] Costs taken from *2005 Machinery Costs Estimates*, Department of Agricultural and Consumer Economics, University of Illinois. No costs are included for grain hauling.

[2] Implement overhead represents header costs while tractor overhead represents separator costs.

Appendix Table 2. Estimated Costs For a "Typical" Tillage System in Illinois.[1]

	Fuel Use	Costs per Acre: Fuel & Labor	Implement Overhead	Tractor Overhead	Total
Panel A. Corn Operations	gal/acre	$ per acre			
Dry fertilizer	0.2	$0.61	$0.80	$0.50	$1.91
Anhydrous ammonia	0.6	2.51	3.30	2.10	7.91
Field cultivate	0.7	2.59	1.80	2.40	6.79
Plant	0.4	3.10	4.40	2.00	9.50
Spray	0.2	1.11	1.30	0.90	3.31
Spray (1/3)	0.1	0.37	0.43	0.30	1.10
Combine[2]	1.5	5.99	4.60	14.10	24.69
Total	3.4	$16.28	$16.63	$22.30	$55.21
Panel B. Soybean Operations	gal/acre	$ per acre			
Dry fertilizer	0.2	$0.61	$0.80	$0.50	$1.91
Chisel plow	1.1	4.85	2.20	4.20	11.25
Field cultivate	0.7	2.59	1.80	2.40	6.79
Disk	0.6	2.10	3.50	2.60	8.20
Plant	0.4	3.10	4.40	2.00	9.50
Spay	0.2	1.11	1.30	0.90	3.31
Spray (1/3)	0.1	0.37	0.43	0.30	1.10
Combine[2]	1.0	4.00	3.20	13.10	20.30
Total	3.9	$18.73	$17.63	$26.00	$62.36
Average (50-50 corn-soybeans rotation)	**3.7**	**$17.51**	**$17.13**	**$24.15**	**$58.79**

[1] Costs taken from *2005 Machinery Costs Estimates*, Department of Agricultural and Consumer Economics, University of Illinois. No costs are included for grain hauling.

[2] Implement overhead represents header costs while tractor overhead represents separator costs.

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Appendix Table 3. Estimated Costs For Deep-Till System in Illinois.[1]

		Costs per Acre			
	Fuel Use	Fuel & Labor	Implement Overhead	Tractor Overhead	Total
Panel A. Corn Operations	gal/acre	$ per acre			
Dry fertilizer	0.2	$0.61	$0.80	$0.50	$1.91
Anhydrous ammonia	0.6	3.01	3.96	2.52	9.49
Field cultivate	0.7	2.59	1.80	2.40	6.79
Plant	0.4	3.10	4.40	2.00	9.50
Spray	0.2	1.11	1.30	0.90	3.31
Spray (1/3)	0.1	0.37	0.43	0.30	1.10
Combine[2]	1.5	5.99	4.60	14.10	24.69
Total	3.4	$16.78	$17.29	$22.72	$56.79
Panel B. Soybean Operations	gal/acre	$ per acre			
Dry fertilizer	0.2	$0.61	$0.80	$0.50	$1.91
V-ripper	1.7	6.00	1.60	5.90	13.50
Field cultivate	0.7	2.59	1.80	2.40	6.79
Disk	0.6	2.10	3.50	2.60	8.20
Plant	0.4	3.10	4.40	2.00	9.50
Spay	0.2	1.11	1.30	0.90	3.31
Spray (1/3)	0.1	0.37	0.43	0.30	1.10
Combine[2]	1.0	4.00	3.20	13.10	20.30
Total	4.7	$19.88	$17.03	$27.70	$64.61
Average (50-50 corn-soybeans rotation)	**4.0**	**$18.33**	**$17.16**	**$25.21**	**$60.70**

[1] Costs taken from *2005 Machinery Costs Estimates*, Department of Agricultural and Consumer Economics, University of Illinois. No costs are included for grain hauling.

[2] Implement overhead represents header costs while tractor overhead represents separator costs.