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No-Tillage and Conservation Tillage: Economic Considerations

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All crop producers should adopt some form of conservation tillage. Issues of soil erosion and profitability dictate that unnecessary and deep tillage be minimized. Reduced tillage can range from eliminating a single practice such as chisel plowing to eliminating all tillage.

Conservation tillage eliminates moldboard plowing and uses less erosive methods, including chisel plowing or disking, to prepare the soil for planting. No-tillage, the strictest form of conservation tillage, uses no tillage of the soil except for minimal disturbance of the soil surface in the row during planting and, in some cases, during injection of fertilizers. The result is that 60 to 95 percent of the surface of a planted field is covered with crop residue from the previous season. Increased surface residue helps to increase or maintain organic matter, to increase moisture retention and to decrease soil erosion.

The economic value of a ton of soil lost to erosion varies with the productivity of the soil and the relative amount of soil lost. Whatever the short-term cost of erosion, it is clear that long-term erosion will affect the productivity of the land.

In this guide, complete corn and soybean budgets, including details of production activities, inputs and prices, are used to examine the economic consequences of moving from conservation tillage to no-tillage production. Special care is taken to distinguish between those expected cost changes that involve cash and those that don't. Some discussion centers on the specific circumstances necessary to recognize particular savings from adopting no-tillage. A section on leasing discusses the changes that might occur as tenants adopt no-tillage production.

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Cost estimates

The budgets in Tables 1 and 3 present the cost estimates of producing corn using two different tillage systems under reasonable assumptions about practices and prices. Use the column on the right-hand side of the table to enter the activities and inputs for your farm. Budgets for conservation tillage and no-tillage soybean production are presented in Table 5. (Note: See the box at the end of this guide for basic information on developing budgets.)

Many of the production assumptions used in this guide are from the *Missouri No-Till Planting Systems Manual* (MU publication M164). The seeding rate, fertility program and yields are expected to be the same under both tillage systems. The no-tillage corn budget (Table 3) differs from the conservation tillage budget (Table 1) by eliminating two tillage activities and changing the herbicide program.

Other changes (not considered in these budgets) may become necessary when switching to no-tillage production. For example:

- It may be necessary to increase the seeding rate.
- Surface application (not injection) of nitrogen fertilizer will require an increase in the application rate. (An exception is surface-applied ammonium nitrate, which does not require increased application rates.)
- It is sometimes necessary to plant cover crops in poorly drained fields in order to plant early.
- Vole and rodent treatment may be needed.
- Insecticide and fungicide treatment of seed may be more important.
- Implement costs may rise with the need to purchase more expensive no-till planters and drills or to retrofit existing planters and drills to handle the increased residue.

Cost analysis

The corn budgets (Tables 1 and 3) and soybean budgets (Table 5) indicate that switching to no-tillage will probably have little effect on the per acre and per bushel cost of producing either crop. Several concepts

Table 1. Conservation tillage corn budget.

Activity	Operation name	Hours/acre	Labor	Fuel	Total/acre	Your farm
1	Fertilizer application	0.08	$0.56	$0.39	$0.95	
2	Chisel plowing	0.14	$1.01	$0.71	$1.72	
3	Nitrogen application	0.08	$0.59	$0.41	$1.00	
4	Disking	0.15	$1.08	$0.75	$1.83	
5	Planting	0.20	$1.42	$0.99	$2.42	
6	Preemergent herbicide application	0.08	$0.59	$0.41	$1.00	
7	Postemergent herbicide application	0.08	$0.59	$0.41	$1.00	
8	Harvest	0.32	$2.21	$2.38	$4.59	
9	Grain drying	0.00	$0.00	$0.00	$0.00	
Fuel and labor subtotal		**1.15**	**$8.05**	**$6.45**	**$14.50**	
Materials and services						
Activity	**Material**	**Quantity**	**Cost/unit**			
1	Dry fertilizer rig rental	1 acre	$2.50		$2.50	
1	DAP (18-46-0)	150 lb 18-46-0	$0.14		$21.00	
1	Potassium chloride	45 lb K_2O	$0.13		$5.85	
3	Liquid N (UAN)	130 lb N	$0.25		$32.50	
5	Corn seed	0.33 bag	$100.00		$33.00	
6	Preemergent herbicide	1 acre	$20.00		$20.00	
7	Postemergent herbicide	1 acre	$8.00		$8.00	
8	Truck, custom charge	110 bu	$0.10		$11.00	
9	Grain drying, custom charge	110 bu	$0.10		$11.00	
Materials subtotal					**$144.85**	
Repair					$12.57	
Management					$11.00	
Overhead and miscellaneous					$8.60	
Interest on operating capital (10% of above expenses for 6 months)					$9.58	
Total operating costs					**$210.09**	
Land interest ($1,000/acre at 7%)					$70.00	
Land taxes					$5.00	
Total land charge					**$75.00**	
Equipment depreciation					$25.67	
Equipment interest					$20.49	
Equipment taxes and insurance					$4.10	
Total equipment charge					**$50.26**	
Total costs					**$326.36**	
Total cost per unit					**$2.97**	

need to be understood before drawing conclusions from these budgets.

First, the budgets in this guide attempt to represent a group of farmers by making assumptions about production activities and prices. The closeness of the results indicates the importance of individual farmers estimating *their own* costs of switching to a different tillage system. Farmers whose activities and inputs differ substantially from the budgets shown may expect either more or less difference associated with switching production practices.

Second, farmers adopting no-tillage are likely to experience greater differences in *cash flow* than in profitability. Understanding the true economic impact of switching tillage systems requires an understanding of cash and noncash costs, and variable and fixed costs.

Cost categories

Cash costs involve actual cash transactions; noncash costs include expense items such as depreciation, which are not associated with an actual cash transaction. Variable costs increase (or decrease) as use increases (or decreases); fixed costs remain constant as use increases. Table 2 shows where several expenses fit into the scheme of cash and noncash costs, and variable and fixed costs.

Table 2. Comparison of cash, noncash, variable and fixed costs.

	Cash cost	Noncash cost
Variable cost	Fuel, seed, fertilizer, herbicides, equipment repair, hired labor	Some tractor depreciation and interest
Fixed cost	Property tax, insurance, self-employed labor	Some tractor depreciation, implement depreciation and interest, land charge

Table 3. No-till corn budget.

Activity	Operation name	Hours/acre	Labor	Fuel	Total/acre	Your farm
1	Fertilizer application	0.08	$0.56	$0.39	$0.95	
3	Nitrogen application	0.08	$0.59	$0.41	$1.00	
5	Planting	0.20	$1.42	$0.99	$2.42	
6	Preemergent herbicide application	0.08	$0.59	$0.41	$1.00	
7	Postemergent herbicide application	0.08	$0.59	$0.41	$1.00	
8	Harvest	0.32	$2.21	$2.38	$4.59	
9	Grain drying	0.00	$0.00	$0.00	$0.00	
Fuel and labor subtotal		**0.85**	**$5.96**	**$5.00**	**$10.95**	
Materials and services						
Activity	**Material**	**Quantity**	**Cost/unit**			
1	Dry fertilizer rig rental	1 acre	$2.50		$2.50	
1	DAP (18-46-0)	150 lb 18-46-0	$0.14		$21.00	
1	Potassium chloride	45 lb K_2O	$0.13		$5.85	
3	Liquid N (UAN)	130 lb N	$0.25		$32.50	
5	Corn seed	0.33 bag	$100.00		$33.00	
6	Preemergent herbicide application	1 acre	$24.00		$24.00	
7	Postemergent herbicide application	1 acre	$12.00		$12.00	
8	Truck, custom charge	110 bu	$0.10		$11.00	
9	Grain drying, custom charge	110 bu	$0.10		$11.00	
Materials subtotal					**$152.85**	
Repair					$10.24	
Management					$11.00	
Overhead and miscellaneous					$8.70	
Interest on operating capital (10% of above expenses for 6 months)					$9.69	
Total operating costs					**$203.43**	
Land interest ($1,000/acre at 7%)					$70.00	
Land taxes					$5.00	
Total land charge					**$75.00**	
Equipment depreciation					$21.58	
Equipment interest					$19.08	
Equipment taxes and insurance					$3.82	
Total equipment charge					**$44.48**	
Total costs					**$322.91**	
Total cost per unit					**$2.94**	

Fuel, seed, fertilizer and herbicide purchases are cash costs that vary with the number of acres farmed. Property tax is a cash cost that is fixed because it is incurred whether or not the land is farmed.

Land charge is a noncash cost of land ownership. Principal and interest payments are cash *expenditures* associated with land ownership. Land *charge or interest*, when used to estimate the cost of production, is the value of the land farmed times the rate of return that could be gained if the land were sold and the money invested elsewhere. Land charge is a fixed cost incurred whether or not a lien exists on the land and whether the land is farmed or left idle.

Hired hourly labor is a cash cost that increases with the number of acres farmed or cropping activities performed. *Self-employed and salaried* labor is a cash cost that does not necessarily change with the number of acres farmed. Self-employed labor is fixed because farmers have a certain cost of living that must be met regardless of how many acres are farmed.

Because tillage equipment depreciation and interest are functions of age rather than use, they are fixed, noncash costs. Equipment depreciation occurs whether or not the implement is used. Tractor depreciation is a partially fixed and partially variable noncash cost. Fixed depreciation occurs on tractors as they age, regardless of use. Variable depreciation occurs on tractors as they are used more intensively.

Increased costs associated with no-tillage

Herbicide cost, a variable cash cost, is the most obvious cost that increases with adoption of no-tillage. The example analysis shows herbicide cost increasing $8.00 per acre when switching to no-tillage corn production (compare herbicide costs in Tables 1 and 3). Along with an increase in herbicide costs is a small increase in interest on operating capital. The small increase in operating capital indicates that though total cost of production decreases slightly from adopting no-tillage, cash costs actually increase.

See Table 4 for a summary of cost increases as well as decreases associated with conversion from conservation tillage to no-tillage corn production.

Decreased costs associated with no-tillage

Fuel cost is a variable cash cost that decreases with the elimination of two tillage practices when adopting no-tillage. In Tables 1 and 3 the fuel cost decreases $1.45 per acre when switching to no-tillage corn production.

Labor is a cash cost that helps offset the increased costs mentioned above. The budgets presented in Tables 1 and 3 show a labor cost decrease of $2.09 per acre when switching to no-tillage corn production. The budgets assume that labor is hired, hourly labor — a variable cash cost. If salaried or self-employed labor is involved, the cost is fixed and a decrease is not necessarily realized.

Though the number of hours worked per acre will decrease as activities are eliminated, that does not necessarily mean that true farm labor costs will decrease. Labor costs per acre will decrease only if (1) hired labor costs actually decrease (i.e., employees work and are paid for fewer hours); (2) salaried labor is used for other productive activities (e.g., farm more land, work with livestock); or (3) if the farmer-owner does other financially productive activities (e.g., income-creating or expense-saving tasks such as crop scouting, input purchasing, and marketing).

The number of hours and acres that equipment will be used will also decrease with a switch to no-tillage production. Repair is a variable cash cost that is expected to decrease $2.33 per acre (see Tables 1 and 3) with the adoption of no-tillage. The $2.33 per acre decrease shown in the budgets is a result of selling unused tillage equipment and using the tractor fewer hours per year.

Equipment (tractor and implements) property tax and insurance are fixed cash costs that will not decrease with the adoption of no-tillage. The tax and insurance cost per acre will decrease only if the adoption of no-tillage is accompanied by selling some equipment or farming more acres. The slight decrease of $0.28 is due to selling the chisel plow and disk and removing them from the tax roll. No property tax reduction is associated with tractors because none were sold.

Comparison of Tables 1 and 3 shows a $4.09 saving in equipment depreciation and a $1.41 saving in equipment interest from switching to no-tillage production. Again, it is assumed that the chisel plow and disk were sold, resulting in a decrease in equipment depreciation and interest. Additionally, the annual tractor use decreased approximately 200 hours.

When no-tillage is adopted and the tractor is used fewer hours, tractor depreciation slows down but does not stop, because the tractor continues to get older. The decreased cost will not, however, be similar to the per hour cost of leasing a tractor. Tractors depreciate quickly at first and then very little for each additional hour of use. Using a 5-year-old tractor 200 hours less per year does not save as much as renting a tractor for 200 hours per year. Because tractor depreciation and interest are noncash costs, decreasing use is unlikely to aid cash flow until the tractor is sold or traded.

Selling unnecessary equipment gives a one-time influx of cash and stops the annual noncash depreciation charge. Often the resale value of used tillage implements is sufficiently small that farmers prefer to keep the implement on the farm for emergency use and odd jobs. This can be a wise management decision as long as the manager understands that the depreciation cost should still be charged against the crops being grown.

Table 4. Summary of cost changes associated with adopting no-till corn, ($/acre).

	Increases	Decreases
Herbicide	$8.00	
Interest on operating capital	0.11	
Repair		$2.33
Fuel		1.45
Labor		2.09
Equipment taxes and insurance		0.28
Equipment depreciation		4.09
Equipment interest		1.41
Total	**$8.11**	**$11.65**

The above analysis has focused on the corn budgets. A quick look at the soybean budgets (Table 5) reveals some important differences. The herbicide cost increase is projected to be only $3.00 per acre when switching to no-tillage production. This increase is offset by the cost decreases for fuel, labor and repairs. As with corn, the largest cost savings are equipment related, which may not immediately decrease your actual cash needs. No-till soybean production will probably yield a greater profit than conservation tillage production, generate sufficient cash savings to offset any cash expenses, and provide a more effective means of conserving the soil.

Leasing impacts

Tenants often report that landlords do not understand the management of no-tillage crop production. Cash lessors who manage the land properly can often convince the landowner that although the fields may look dirtier with additional residue, the soil is being conserved and weed problems are not increasing. If the lease is a crop share, questions arise regarding the splitting of input costs.

For example, most share leases have the landowner and tenant sharing the cost of inputs such as seed, fertilizer and chemicals. The tenant is usually solely responsible for providing labor, fuel and equipment. The landowner provides the land and improve-

Table 5. Consolidated budget for soybean conservation tillage and no-tillage.

		Conservation tillage				No-tillage			
Activity	**Operation name**	**Hours/acre**	**Labor**	**Fuel**	**Total/acre**	**Hours/acre**	**Labor**	**Fuel**	**Total/acre**
1	Fertilizer application	0.08	$0.56	$0.39	$0.95	0.08	$0.56	$0.39	$0.95
2	Chisel plowing	0.14	$1.01	$0.71	$1.72				
3	Disking	0.15	$1.08	$0.75	$1.83				
4	Planting	0.18	$1.24	$0.86	$2.10	0.18	$1.24	$0.86	$2.10
5	Preemergence herbicide application	0.08	$0.59	$0.41	$1.00	0.08	$0.59	$0.41	$1.00
6	Postemergence herbicide application	0.08	$0.59	$0.41	$1.00	0.08	$0.59	$0.41	$1.00
7	Harvest	0.32	$2.21	$2.38	$4.59	0.32	$2.21	$2.38	$4.59
Fuel and labor subtotal		**1.04**	**$7.27**	**$5.91**	**$13.18**	**0.74**	$5.18	$4.45	$9.63
Materials and services									
Activity	**Material**	**Quantity**	**Cost/unit**			**Quantity**	**Cost/unit**		
1	Dry fertilizer rig rental	1 acre	$2.50		$2.50	1 acre	$2.50		$2.50
1	Potassium chloride	45 lb K_2O	$0.13		$5.85	45 lb K_2O	$0.13		$5.85
1	DAP (18-46-0)	150 lb 18-46-0	$0.14		$21.00	150 lb 18-46-0	$0.14		$21.00
4	Soybean seed w/inoculant	1.2 bag	$17.00		$20.40	1.2 bag	$17.00		$20.40
5	Soybean preemergence herbicide	1 acre	$15.00		$15.00	1 acre	$18.00		$18.00
6	Soybean postemergence herbicide	1 acre	$9.00		$9.00	1 acre	$9.00		$9.00
7	Truck, custom charge	35 bu	$0.10		$3.50	35 bu	$0.10		$3.50
Materials subtotal					**$77.25**				**$80.25**
Repair					$11.02				$8.90
Management					$10.50				$10.50
Overhead and miscellaneous					$5.07				$4.94
Interest on operating capital					$5.85				$5.71
Total operating costs					**$122.88**				**$119.94**
Land interest					$70.00				$70.00
Land taxes					$5.00				$5.00
Total land charge					**$75.00**				**$75.00**
Equipment depreciation					$22.51				$18.77
Equipment interest					$17.97				$16.59
Equipment taxes and insurance					$3.60				$3.32
Total equipment charge					**$44.07**				**$38.69**
Total costs					**$241.95**				**$233.62**
Total cost per unit					**$6.91**				**$6.67**

ments. The problem arises when the landowner sees less expense for inputs supplied solely by the tenant and greater expense for inputs split between the two.

Adopting no-tillage crop production does not necessitate a lease change, but it is a good time to reevaluate a crop share lease. Ideally, a crop share lease should be structured so that both parties receive the percent of yield commensurate with their contributions. Guidelines for determining crop share leases can be found in MU publication G 428, *Customary Farm Rental Agreements.*

Using Tables 1 and 3 to complete a crop share lease form would provide an analysis similar to that shown in Table 6. Whether using conservation tillage or no-tillage production, a lease based on the analysis in Table 6 would probably be a 50:50 lease in Missouri. The table shows that the relative contribution of each person has changed by about 3 percent. Because most leases are approximate (i.e., 50:50 share

Table 6. Crop share analysis of conservation tillage and no-tillage corn production, ($/acre).

	Conservation tillage	No-till
Landowner contribution		
Land interest	$70.00	$70.00
Land taxes	5.00	5.00
Total landowner contribution	**75.00**	**75.00**
Tenant contribution		
Machinery and equipment expense	62.83	54.72
Labor	8.05	5.96
Fuel	6.45	5.00
Management	11.00	11.00
Total tenant contribution	**88.33**	**76.68**
Total landowner and tenant contributions	**$163.33**	**$151.68**
Landowner share	46%	49%

Budgets are a powerful tool for assisting farm management. A listing of inputs and prices helps estimate how much operating capital is needed for production. An estimate of the per bushel cost of production is useful in making effective marketing decisions. Crop share leases can be evaluated using the contributions attributed to both landowner and tenant in a crop budget. The economics of different systems, such as conservation tillage and no-tillage production, can be compared.

Crop budgets are relatively simple for individual farmers to develop. They consist of listing various field activities and the inputs associated with them, along with prices, to arrive at an estimate of the cost of production (see Tables 1, 3 and 5). The step-by-step methodology allows for quick development and easy verification to see if the breakdown is accurate.

Creating generic budgets to compare conservation tillage to no-tillage production is difficult for two reasons. First, farmers are likely to differ on weed management philosophy. One producer may choose tillage as the major weed control method while another relies almost entirely on chemical control. Any two producers using predominately chemical weed control will choose different chemicals to use and apply them at different rates, depending on specific field conditions.

Second, the machinery cost aspects of evaluating different tillage systems can be confusing. Estimating the cost of eliminating a particular activity such as disking may not be best represented by subtracting the custom rate for that activity. Rather, decision makers need to determine what will be the change to *their* financial situation. In other words, would eliminating a disking decrease their actual cost of producing a crop? And if so, how much?

Because generic budgets are approximations of what a typical Missouri farmer would do, it is important to go through the simple process of creating a budget for your particular situation. Space is left in Tables 1 and 3 for you to do that. If significant changes are needed, follow the format of listing activities and inputs to arrive at a meaningful estimate of production costs.

rather than 45:55 share), a change of a few percentage points might not necessitate a share change.

The analysis in Table 4 does not take into account the value of no-tillage production to the landowner in retained land productivity or the additional management expertise needed to farm effectively using no-tillage production methods. If the landowner and tenant were convinced that the annual value of erosion control and increased management contribution of the tenant using to-tillage methods equals $11.65 per acre, no change in their relative contributions would exist.

Summary

Corn and soybean production costs with conservation tillage are about the same as those with no-tillage. The largest cost increase associated with no-tillage is for herbicides and is a cash cost immediately affecting cash flow. The largest decreased cost associated with no-tillage is depreciation and interest costs associated with machinery. Unfortunately, *noncash* cost savings can result in greater profitability while not completely offsetting the increased *cash* expenses of adopting no-tillage crop production.

Estimating typical machinery costs is uncertain because the equipment set of one farmer differs so much from the set of another. Additionally, equipment changes associated with switching to no-tillage can vary. Some will sell unused or underused equipment; others will not. Some will farm more acres with the original equipment; others will not increase farm size.

The greatest economic uncertainty associated with a switch to no-tillage lies in assigning value to soil and management. The budgets in this guide place no value on soil saved. If some value was placed on saving soil (and undoubtedly there should be), no-tillage production would become more economical. If decreased time performing fieldwork led to increased time for management so that savings or income were enhanced on the farm, no-tillage would have additional economic benefits not accounted for in the budgets presented here.

Comparisons of tillage systems using custom rates to estimate machinery expense are usually more encouraging for no-tillage than the analysis presented in this guide. Using custom rates is appropriate if

1. The activity has been hired out in the past (In this case, the cost of not doing the activity is truly a cash saving); or
2. The farmer has made a complete transition to no-tillage production. Farmers who have made the transition have sold unnecessary tillage equipment and found alternative uses for their own labor and tractor power. This frequently means farming more acres so that the fixed tractor and labor costs are reduced for each acre farmed.

Farmers making the transition to no-tillage production will find that financial analysis using fixed and variable, cash and noncash cost concepts will yield a more accurate picture of what to expect.

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