Tillage Selection: Soil Stewardship versus Financial Survival

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Introduction

After December 31, 1989, the basis by which row crop producers select tillage systems could change for many planning to participate in government programs. According to the conservation compliance guidelines set out in the 1985 Food Security Act (FSA), land classified as highly erodible will be subjected to various tillage restrictions depending upon its intended use. On January 1, 1990, row crop producers are expected to have an approved conservation plan specifying the type of tillage and cropping systems they have elected to implement on the highly erodible land they use for the production of annual crops. In states like Kentucky, where approximately 46 percent of the cultivated land is classified as highly erodible, conservation compliance may mean a major change in specific tillage use.

Prior to the enactment of the 1985 FSA. the acceptance of conservation tillage practices was strictly a voluntary decision. Despite educational efforts of the universities, Soil Conservation Service (SCS), and other related groups, the adoption and application of conservation tillage practices have been limited. In fact, the SCS estimates the current annual rate of sheet and rill erosion in Kentucky to be approximately 12 tons per acre per year on soils that have a tolerable soil loss of only 3 to 5 tons. This situation is somewhat of an enigma in a state where years of conservation tillage research have resulted in numerous recommendations to growers suggesting the many benefits of no-tillage crop production. It is difficult to understand why such no-tillage advantages as increased moisture availability, reduced soil loss, improved soil structure, reduction in machinery and labor expenses, and finally increased yields have not convinced more producers to adopt no-tillage production practices.

The Case Farm

To investigate the economics of various tillage systems in Kentucky, a "typical" west Kentucky cash grain farm was investigated. The assumed farm consisted of 400 tillable acres that were well suited to either conventional tillage, reduced tillage or no-till methods of crop production.

The case farm used a rotation of 200 acres of corn, 100 acres of full season soybeans (FSSB), 100 acres of wheat, and 100 acres of doublecrop soybeans (DCSB). It was assumed that the owner-operator of the farm supplied all labor required by the operation. All cultural practices used were those recommended by the University of Kentucky.

Defining Tillage Systems, Machinery Requirements, and Costs

This analysis examined three different tillage systems defined as follows by the SCS:

Conventional tillage involved planting the crop in a prepared seedbed where less than 30 percent ground cover from the previous crop's residue or cover crop is maintained. For this analysis the conventional till operation included chisel plowing (twisted shanks) + 2 diskings.

Reduced tillage planted the crop in lightly tilled soil where 30 to 90 percent ground cover from the previous crop's residue or cover is maintained. The more erosive the land, the more residue required. The reduced-till operation included chisel plowing (twisted shanks) + 1 disking.

No-tillage refers to planting the crop in undisturbed soil with a minimum of 90 percent ground cover from the previous crop's residue or cover crop.

Machinery cost information was obtained by a survey of six major west Kentucky equipment dealers during the summer of 1986. Based on this information, the total initial machinery investment for the conventional/reduced tillage systems was $173,880. The cost of the no-till system was $158,282.

Yields. Results of tillage research in Kentucky suggest that, on average, higher yields can be expected from reduced tillage and no-till systems than those produced by conventional methods. Yield levels were selected for each crop based on the yield capability of a well-drained Class IIe soil in west Kentucky.

The assumed yield levels used in this analysis were as follows: For the conventional tillage system: corn = 100 bu/acre, DCSB = 31 bu/acre, FSSB = 40 bu/acre, and wheat = 45 bu/acre. For the reduced tillage system: corn = 105 bu/acre, DCSB = 32 bu/acre, FSSB = 40 bu/acre, and wheat = 45 bu/acre. For the no-till system: corn = 110 bu/acre, DCSB = 34 bu/acre, FSSB = 40 bu/acre, and wheat = 45 bu/acre.

Input Costs and Grain Prices. The input costs used in this analysis are those that prevailed in west Kentucky during the summer of 1986. Assumed crop prices used in the analysis

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were: corn, $1.93/bu.; soybeans, $460/bu.; and wheat, $2.50./bu.

Economic Comparison of Tillage Systems

The Beginning Farmer

For the beginning producer, all machinery is newly purchased. The annual costs of machinery ownership were obtained by amortizing the total cost of the equipment complement over its average useful life. Equipment used in the conventional tillage system was assumed to last 10 years. Machinery used in the reduced till or no-till system was assumed to last for the same number of hours, and therefore more years than in the conventional tillage system.

Based on this analysis, the net return of $33.53 per acre from the no-till system was the greatest. The net return of $26.49 per acre provided by the reduced tillage system was second. The lowest return of $15.85 per acre came from the conventional system (Table 1).

The Established Farmer

For the farmer equipped to till and plant by conventional methods, a switch to no-till would require the purchase of a new no-till drill and a new planter or the modification of

Table 1. Crop production budgets using conventional, reduced, and no-tillage production systems.

	Conventional production				Reduced till production				No-till production			
BUDGET ITEM	**Corn**	**FSSB**	**DCSB**	**Wheat**	**Corn**	**FSSB**	**DCSB**	**Wheat**	**Corn**	**FSSB**	**DCSB**	**Wheal**
EXPECTEDRETURNS												
Acres	200	100	100	100	200	100	100	100	200	100	100	100
Price/Bu	$1.93	$4.60	$4.60	$2.50	$1.93	$4.60	$4.60	$2.50	$1.93	$4.60	$4.60	$2.50
Yield/Ac	100	40	31	45	105	40	32	45	110	40	34	45
TOTALRETURN												
PER ACRE	$193.00	$184.00	$142.60	$112.50	$202.65	$184.00	$147.20	$112.50	$212.30	$184.00	$156.40	$112.50
TOTAL FARM RETURNS		$82,510.00				$84,900.00				$87,750.00		
OPERATING COSTS												
Seed	$19.38	$8.24	$8.24	$11.25	$19.38	$8.65	$9.51	$12.37	$20.93	$9.06	$10.87	$13.50
Innoculant	.00	1.00	1.00	.00	.00	1.00	1.00	.00	.00	1.00	1.00	.00
Nitrogen	17.50	.00	.00	14.40	19.60	.00	.00	16.00	21.00	.00	.00	19.20
Phosphate	10.80	7.20	.00	14.40	10.80	7.20	.00	14.40	10.80	7.20	.00	14.40
Potash	5.40	5.40	5.40	.00	5.40	5.40	5.40	.00	5.40	5.40	5.40	.00
Lime	8.00	8.00	.00	8.00	8.00	8.00	.00	8.00	8.00	8.00	.00	8.00
Herbicides	16.16	25.03	25.03	1.65	16.93	25.03	25.03	1.65	22.38	31.26	31.26	7.87
Insecticides	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
Fungicides	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
Custom Hire	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
Drying	15.00	.00	.00	.00	15.75	.00	.00	.00	16.50	.00	.00	.00
Interest	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
Labor	7.25	7.25	4.80	7.70	6.20	6.20	4.80	6.30	4.35	4.35	4.35	4.30
MACHINERY COSTS												
Fuel & Oil	$7.09	$7.09	$4.51	$7.59	$6.01	$6.01	$4.51	$6.09	$3.26	$3.26	$3.26	$3.21
Rep & Main	11.67	11.67	9.57	12.81	11.48	11.48	10.07	12.42	9.78	9.78	9.78	11.60
TOTAL OPERATING												
COSTS PER ACRE	$123.25	$85.88	$63.55	$82.80	$124.55	$83.97	$65.32	$82.23	$127.40	$84.31	$70.92	$87.08
TOTAL FARM OP COSTS:		$47,873.00				$48,062.00				$49,711.00		
RETURNS ABOVE												
OP. COSTS/ACRE	$69.75	$98.12	$79.05	$29.70	$78.10	$100.03	$81.88	$30.27	$84.90	$99.69	$85.48	$25.42
TOTAL FARM RETURNS												
ABOVE OP COSTS:		$34,637.00				$36,838.00				$38,039.00		
ANNUAL MACHINERY												
OWNERSHIP COST:		$28,298.17				$26,241.41				$24,625.33		
PER ACRE:		$70.75				$65.60				$61.56		
TOTAL FARM COSTS:		$76,171.17				$74,303.41				$74,336.33		
PER ACRE:		$190.43				$185.76				$185.84		
WHOLE FARM												
NET RETURNS:		$6,338.83				$10,596.59				$13,413.67		
PER ACRE:		$15.85				$26.49				$33.53		

an existing planter allowing for the proper placement of the seed in heavy residue conditions. To analyze this situation the annual costs of ownership were determined for a producer who switches tillage systems in year 6 after initial startup of his conventional tillage operation. Changing to reduced tillage required no new investment in equipment. It did extend the useful life of existing machinery and thereby reduced the annual ownership cost. Adoption of no-till required the purchase of new coulters ($1,733) for the planter and a no-till drill ($12,275) in year 6. It was assumed that the producer would keep the existing tractor for use in the no-till system.

Costs and returns resulting from this switch to reduced tillage or no-till are summarized in Table 2. As was the case with the beginning farmer, the no-till system proved to be the most profitable with a net return per acre of $28.43. Reduced tillage returns of $24.10 per acre were slightly less.

Despite the cost associated with purchasing new equipment for no-till production, conservation tillage methods proved to be most profitable for both the beginning and established farmer when higher yields were assumed. However, many producers may not be in a position similar to those assumed in our base farm situation.

Economic Profit vs. Net Cash Flow

Based on the results of this tillage analysis, we would have to conclude that many farmers in Kentucky are not using the most profitable tillage system available. Perhaps they simply

Table 2. Crop production budgets after change to reduce/no-till production systems.

	Reduced tillage production				No-till production			
BUDGET ITEM	**Corn**	**FSSB**	**DCSB**	**Wheat**	**Corn**	**FSSB**	**DCSB**	**Wheat**
EXPECTED RETURNS								
Acres	200	100	100	100	200	100	100	100
Price/Bu	$1.93	$4.60	$4.60	$2.50	$1.93	$4.60	$4.60	$2.50
Yield/Ac	105	40	32	45	110	40	34	45
TOTALRETURN PER ACRE	$202.65	$184.00	$147.20	$112.50	$212.30	$184.00	$156.40	$112.50
TOTAL FARM RETURNS:		$84,900.00				$87,750.00		
OPERATING COSTS								
Seed	$19.38	$8.65	$9.51	$12.37	$20.93	$9.06	$10.87	$13.50
Innoculant	.00	1.00	1.00	.00	.00	1.00	1.00	.00
Nitrogen	19.60	.00	.00	16.00	21.00	.00	.00	19.20
Phosphate	10.80	7.20	.00	14.40	10.80	7.20	.00	14.40
Potash	5.40	5.40	5.40	.00	5.40	5.40	5.40	.00
Lime	8.00	8.00	.00	8.00	8.00	8.00	.00	8.00
Herbicides	16.93	25.03	25.03	1.65	22.38	31.26	31.26	7.87
Insecticides	.00	.00	.00	.00	.00	.00	.00	.00
Fungicides	.00	.00	.00	.00	.00	.00	.00	.00
Custom Hire	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
Drying	15.75	.00	.00	.00	16.50	.00	.00	.00
Interest	.00	.00	.00	.00	.00	.00	.00	.00
Labor	6.20	6.20	4.80	6.30	4.35	4.35	4.35	4.30
MACHINERY COSTS								
Fuel & Oil	$6.01	$6.01	$4.51	$6.09	$4.08	$4.08	$4.08	$4.00
Rep & **Main**	11.48	11.48	10.07	12.42	10.51	10.51	10.51	12.30
TOTAL OPERATING COSTS PER ACRE	$124.55	$83.97	$65.32	$82.23	$128.95	$85.86	$72.47	$88.57
TOTAL FARM OP COSTS:		$48,062.00				$50,480.00		
RETURNS ABOVE OP COSTS/ACRE	$78.10	$100.03	$81.88	$30.27	$83.35	$98.14	$83.93	$23.93
TOTAL FARM RETURNS ABOVE OP COSTS:		$36,838.00				$37,270.00		
ANNUAL MACHINERY OWNERSHIP COST:		$27,196.81				$25,898.05		
PER ACRE:		$67.99				$64.75		
TOTAL FARM COSTS:		$75,258.81				$76,378.05		
PER ACRE:		$188.15				$190.95		
WHOLE FARM NET RETURNS:		$9,641.19				$11,371.95		
PER ACRE:		$24.10				$28.43		

cannot afford it! While conservation tillage systems may be more profitable than conventional, it may not be financially feasible for a producer to adopt the new technology.

Economic profit or net return as it has been used in this study is the return to all unspecified factors of production. In our analyses, this has been referred to as the return to land and management since all operating costs and machinery ownership costs have been specified.

Net cash flow is the amount of actual cash (cash coming in less cash going out) that is generated by an enterprise or business. To arrive at net cash flow for our case farm, one simply deducts total cash spent for operating inputs from total returns from sale of all crops. The resulting net cash flow is the amount (per acre, enterprise, or total farm business) that remains to: (1) provide the farm owner-operator family living expenses, (2) repay outstanding debts, or (3) contribute to savings for the future.

The immediate concern in Kentucky is for the established producer using conventional-till methods to produce annual crops on highly erodible land. Assuming a grower is required to use no-tillage in order to remain in conservation compliance, can he afford to buy the equipment to make the conversion? Normally, the established producer would change to a no-till system only if the additional net cash flow generated by the new tillage system was sufficient to pay for the added machinery investment.

Table 3. Net cash flow advantage of conservation tillage systems over conventional tillage, established producer, constant yields.

Crop	Conv. tillage	Reduced tillage	Advantage to reduced tillage	No-till	Advantage to no-till
Corn	$69.75	$ 69.20	$ -.55	$65.55	$-4.20
FSSB	98.12	100.03	1.91	98.14	.02
DCSB	79.05	77.28	- 1.77	70.13	-8.92
Wheat	29.70	30.27	.57	23.93	-5.77
Total net cash flow advantage above conv. tillage system:			$ -39.00		$ -2,307.00
Net cash flow advantage of no-till system over reduced tillage system:			$ -2,268.00		

Due to less than perfectly adapted soils, inexperience, and new management requirements, many producers switching to no-till for the first time may not be able to significantly improve yield over their conventional-till production. The net cash flow generated by each tillage system when equal crop yields across all systems are assumed is shown in Table 3. As indicated, when yields are equal for all tillage systems the net cash flow generated by either conservation tillage system is less than that provided by conventional tillage. If reduced tillage is used, it would generate **$39.00** less in total farm net cash flow than would conventional tillage. If no-till is used, the net cash flow for the farm would drop by $2,307.00.

Conclusions and Implications

The implications for the established conventional tillage producer are clear. Unless yields improve with conservation tillage, net cash flows will be reduced by a switch in tillage systems. This reduced net cash flow would make it impossible for the established producer to repay any loan associated with the purchase of no-till equipment.

Further, if all labor for the operation is supplied by the owner-operator, there is no cash outflow associated with the labor used by any tillage system. Thus, the labor saving aspects of either reduced tillage or no-till are not realized as increased cash flow. This situation would simply act to place the conservation tillage systems at a greater cash flow disadvantage than reflected in these results.

Certainly, there are numerous long-term advantages to be derived from conservation tillage systems for both society and the individual producer. However, this study provides one possible explanation of why no-till production has not escalated. More importantly, it suggests that already financially strapped crop producers required to switch to no-till for conservation compliance may be forced into further financial hardship.