

Performance of Alternative Tillage Systems on Ohio Farms

In 1993, the Ohio Farm Household Longitudinal Study included detailed questions concerning crop production practices for the panel of cooperating Ohio farm households. This report is the fourth of a series highlighting the 1993 findings of the study. It summarizes farm characteristics, income and expense data for farm businesses employing different crop production systems. This report differs from the previous ones in the series in that only commercial-sized farms (here defined as farms with gross sales greater than \$40,000 annually) are included in these analyses.

Ohio farmers use a variety of farming systems. These vary greatly in the way they employ labor, machinery, and chemical inputs. They also differ in their degree of reliance on herbicides and pesticides and the degree to which they protect soils from erosion. It is expected that they perform differently in response to disparate weather conditions. Farmers using these systems may vary by size of farm business, degree of enterprise diversity, degree of employment off the farm, or by other attributes.

Description of the farming systems

Four primary tillage systems were identified -- no-till, ridge-till, moldboard-plow and reduced-till. Reduced tillage includes farmers who use a chisel plow or disc for primary tillage. Ridge-tillage involves the use of special planting and tillage equipment that forms ridges for planting. Ridge-till farmers usually apply bands of herbicides to protect the planted row, and cultivate twice during the year to remove weeds from the row middles and to form the ridge. Nitrogen fertilizers are often split into two or three applications, occurring at planting and with each subsequent tillage pass. No-till farming does not include a tillage operation. Weed control is accomplished with herbicides prior to planting, and in some cases, after emergence of the crop. Each surveyed farmer is associated with one of the columns in Table 1 -- the tillage system used on the majority of the farmer's acreage. Farmers who used two or more tillage systems with no system being used on over half of cropped acreage are included in the *Mixed-Systems* category. Reduced-tillage is the most common tillage system, representing 36 percent of commercial farms. No-till is the primary tillage system on a quarter of Ohio commercial farms. The moldboard plow is the primary tillage tool on 23 percent. Ridge-till is the primary tool on about 2 percent of Ohio commercial farms (Table 1, top row).

Farm size does vary significantly among the tillage groups (Table 1). The ridge-till group had the largest cropped acreage (669 acres). Mixed-system and no-till farmers had the next largest cropped acreage (662 and 658 acres, respectively). Farmers using the moldboard plow had the smallest cropped acreage, with an average of 278 acres. Total farm size includes more than the crop enterprise. Nearly three-quarters of the moldboard plow had livestock on the farm, accounting for over half of total gross receipts. Ridge-till farmers had the lowest degree of involvement with livestock; only 47 percent have livestock on the farm, for an average of only 19 percent of gross receipts. No-till, reduced-till and mixed system tillage groups each reported an average of about one-third of gross sales arising

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from livestock.

The farmers in the various groups also differed in their reliance on leased land. Moldboard plow farmers owned the greatest percentage of their land, averaging nearly 56 percent owned. Ridge-till farmers had the greatest reliance on leased land, averaging 64 percent leased. The other tillage groups averaged about half of their land controlled through leasing. Ridge-till farmers had the greatest average reliance on debt capital, with an average debt-to-asset ratio of nearly 30 percent. Moldboard-plow farmers had the lowest average debt-to-asset ratio (11 percent).

Table 1. Farm description by primary tillage method.

Measure	Primary Tillage System				
	Ridge-Till	No-Till	Reduced-Till	Moldboard Plow	Mixed System
Percent of Commercial Ohio farms	2.0	25.4	35.9	22.8	13.8
Total Acreage per Farm	716.5	798.4	589.8	335.5	803.7
Acreage Cropped per Farm	669.0	658.5	503.5	278.1	661.9
Farms with livestock (%)	46.9	65.6	68.1	70.2	63.0
Percent of sales from livestock	19.4	31.3	35.0	53.9	33.1
Percent leased land	63.6	54.8	55.1	44.2	52.3
Debt-to-asset ratio (%)	29.6	21.7	21.7	10.9	14.8
Average Operator Age (yrs)	44.2	49.7	49.9	50.2	50.4
Average Operator Education (yrs)	13.7	13.0	13.0	12.7	12.9
Operators working off-farm:					
Seasonally (%)	8.2	10.1	7.1	9.2	3.5
Weeks worked	20.5	24.3	5.8	23.6	3.5
Year-around (%)	10.2	20.6	21.5	19.0	8.5
Hours worked per week	38.0	31.5	37.9	40.3	32.0

Age, education and off-farm employment of the farmers differed by tillage system. The ridge-till farmers were the youngest. They also had the most education, averaging nearly two years beyond high school. The no-till and reduced-tillage groups were very similar in both age and education. Likewise, the moldboard plow and mixed system groups had similar average age and education levels.

Mixed system farmers had the lowest involvement in work away from the farm. Only 8 percent worked away from the farm year-around -- those farmers who worked off-farm averaged about 32 hours per week employment. Ridge-till farmers had the next lowest incidence of off-farm employment, with 10 percent working year-around and 8 percent working seasonally off-farm. The other three groups had similar levels of off-farm employment, with an average of about 20 percent of operators working year-around off the farm.

Farmers in all but the mixed category operated primarily with a single system (Table 2). On average, ridge-till farmers used ridge-till methods on 92 percent of their cropped acreage; No-till farmers used no-till practices on 85 percent of cropped acreage; Reduced-till farmers used the chisel plow on 52 percent of their cropped acreage, and discing was the primary tillage on 27 percent; Moldboard plowing was done on 80 percent of cropped acreage for the moldboard-plow group.

Table 2. Percentage of acres tilled with various primary tillage methods.

Measure	Primary Tillage System				
	Ridge-Till	No-Till	Reduced-Till	Moldboard Plow	Mixed System
Primary tillage method	----- Percent of cropped acres -----				
No-till	1.0	84.6	8.7	2.9	23.6
Ridge-till	92.4	1.6	2.5	0.0	5.8
Chisel Plow	1.1	5.4	51.9	4.2	15.6
Discing Only	2.8	4.1	27.1	10.7	8.8
Moldboard	1.8	3.8	8.1	80.5	17.7
Other	0.9	0.6	1.7	1.7	28.4
Total	100.0	100.0	100.0	100.0	100.0

Crop mix and yields

Both the mix of crops grown and yield performance varied among the tillage categories for 1992 (Table 3). Ridge-till farmers used a crop mix that was dominated by corn and soybeans -- these crops accounted for over 69 percent of ridge-till crop acreage. Farmers in the other tillage categories included more wheat, other small grains, and hay in their rotations.

The 1992 production season was very favorable for production in most areas of the state. State average yields for corn, soybeans and wheat were 143, 40 and 53 bushels per acre, respectively. Yields for the sampled farmers were very close to these estimates, averaging 140.9, 42.4 and 53.0 bushels per acre for corn, soybeans, and wheat. However, there was substantial variation among farmers in different tillage categories. Ridge-till farmers reported the highest corn yields at 147 bushels (Table 3). Moldboard plow, mixed system, and reduced tillage farmers had the next highest corn yields, averaging near the state average. No-till farmers had the lowest average corn yields, averaging 136 bushel per acre.

Yield results for the soybean crop differed little among tillage practices, with a range of less than one bushel per acre in average yields. Average yield for wheat differed by 9 bushels per acre, with ridge-till farmers reporting the highest wheat yields at 59 bushels per acre. No-till farmers reported the lowest wheat yield average (50.5 bushels).

Tables 1-3 suggests that youth, education, debt, rented land, large farms, high yields, and innovative tillage practices tend to appear together while traditional tillage is associated with older, high equity, small-farm operators.

Financial Performance

We asked the survey participants a number of questions regarding income and expenses for the 1992 production season. Their responses are reported in Table 4. Gross receipts varied substantially across farm type. This is expected since cropped acreage varied greatly among the tillage groups as did the percentage having livestock. Average gross receipts ranged from \$103,434 for the moldboard-plow group to \$185,004 for the ridge-till group. Net farm income, although still a function of farm size, is also expected to be strongly related to yield performance and input use efficiencies. No-till farmers reported the highest net farm income, averaging \$51,087. Moldboard plow farmers reported the lowest average net farm income (\$34,479). Adjusted gross income, as calculated for income tax purposes, includes both farm and nonfarm income. No-till farmers reported the highest adjusted gross income, with moldboard plow farmers reporting the lowest (\$47,248).

Net farm and adjusted gross income measures do not include all sources of production costs. Important omissions include charges for owned land, equity capital, and unpaid family labor. The rate of return measures are calculated with charges for these family-provided resources included. Thus, they are better measures of farm profitability than are net farm income or adjusted gross income. Ridge-till farmers had both the largest rate of return to investment (7.7 percent) and rate of return to equity capital investment (5.3 percent). This was followed closely by moldboard plow farmers (6.2% RRI and 5.3% RRE) and no-till farmers (6.5% RRI and 4.4% RRE). The mixed-system farmers had the lowest rates of return, both of which were negative.

Because these tillage systems use labor, machinery and chemicals in greatly different ways, there is much interest in the level of per acre costs for these inputs. Ridge-till farmers reported the lowest average expenditures per acre for both fertilizers and pesticides. This probably results because of their greater use of banding of herbicides and split applications of fertilizers. No-till farmers had the highest per acre expenditures for fertilizers and agricultural chemicals.

Expenditure for labor, fuel and machinery inputs may be substantially higher for farms with sizable livestock enterprises. The estimates of costs reported for these inputs in Table 4 are computed for farms that do not have a livestock enterprise. The moldboard plow and ridge-till groups had the highest total labor cost per acre, at \$51.84 and

\$53.86, respectively. The reduced-till group reported average labor costs that were about \$6.00 less per acre than the ridge-tillers. No-till producers reported a total per acre labor cost of \$35.62. Fuel costs per acre were \$8.58 for no-tillers, \$10.12 for ridge-tillers, \$10.18 for moldboard plow farmers and \$10.48 for reduced-till farmers. These relatively low labor and fuel costs for no-till reflect the low

number of trips over the field for this system. Machinery expense includes both costs of maintenance and repair in addition to expenditures for custom-hired machinery services. No-till farmers reported an average of \$13.03 for machinery expenses. Ridge-till farmers had the highest per acre machinery costs, averaging \$25.50. Finally, machinery investment per crop acre is reported in the last row of table 4. Moldboard plow farmers had the highest per acre investment, followed in decreasing order by ridge-tillers, no-tillers, reduced-tillers, and mixed system farmers.

Conclusions

These results suggest that there were differences in farms' performance in 1992 that were related to differences in tillage systems. Ridge-till is relatively new and little used by Ohio farmers, but its performance in 1992 was encouraging. Among the tillage systems examined, ridge-till farmers reported the highest average yields for the three major crops, corn, soybeans and wheat. Ridge-till farmers were also the most profitable group of farmers based on

Table 3. Crop mix and yields by tillage method.

Measure	Primary Tillage System				
	Ridge-Till	No-Till	Reduced-Till	Moldboard Plow	Mixed System
Crop	----- Percent of tilled acres -----				
Corn	37.7	29.8	28.2	23.8	28.1
Soybeans	31.3	36.6	31.5	29.0	32.9
Wheat	6.2	10.0	12.8	12.6	12.6
Hay	12.0	11.4	12.2	15.8	12.3
Others	12.7	12.2	15.3	18.7	14.1
Total	100.0	100.0	100.0	100.0	100.0
Crop	----- 1992 Yield -----				
Corn (bu/ac)	147.5	136.1	142.3	143.2	143.2
Soybeans (bu/ac)	43.1	42.8	42.4	42.3	42.3
Wheat (bu/ac)	59.1	50.5	53.9	56.2	53.5
Hay (ton/ac)	3.7	3.2	3.8	3.9	3.7

Table 4. Farm costs and returns by tillage method

Measure	Primary Tillage System				
	Ridge-Till	No-Till	Reduced-Till	Moldboard Plow	Mixed System
Total farm:					
Gross receipts	185,004	183,657	161,281	103,434	161,903
Net farm income	44,441	51,087	38,430	34,479	40,655
Adjusted Gross Income	56,853	70,103	57,552	47,248	56,054
Rate of Return to Invest. (%)	7.7	6.5	1.9	6.2	-3.4
Rate of Return to Equity (%)	5.3	4.4	-11.2	5.3	-5.2
Per acre expenses					
Fertilizers and lime	24.05	27.25	27.44	24.17	22.16
Herbicides and pesticides	14.73	23.31	20.08	16.43	18.40
Hired Labor ^a	13.25	1.99	5.70	3.03	1.60
Family Labor ^{a,b}	40.61	33.63	41.26	48.81	32.30
Fuel ^a	10.12	8.58	10.48	10.18	6.79
Machinery expense ^{a,c}	25.50	13.03	14.96	15.34	12.42
Machinery investment ^a	262.19	225.59	207.77	281.55	142.17

a Averages are calculated for farmers without livestock enterprises.

b Valued at \$6.00 per hour.

c Includes machine repair and custom hire

rates of return to investment and equity. However, because of their greater reliance on debt capital and leasing, ridge-till farmers had smaller net farm incomes than did no-till farmers.

No-till has been expanding rapidly on Ohio farms in the past two decades. While no-till farmers reported the lowest average yields for corn and wheat, their net farm income was the highest. One explanation for this seeming contradiction is that labor, fuel, and machinery expenses were relatively low for no-till farmers.

Use of the traditional moldboard plowing system has decreased, but it is still used on a substantial proportion of Ohio farms. Its disadvantages are relatively high operating expenses (labor, fuel, machinery repair), high machinery investment, and of course, high rates of soil erosion. Farms using reduced-till had about the same yield, expenses and net income as farms using moldboard plowing systems, but are expected to have less soil erosion.

These results need to be kept in perspective. They are for one year and do not capture the long run effects of year-to-year variability of each system. Also, performance of a system may be attributable, in large part, to the management abilities of its users rather than the system itself.

Ohio Farm Household Longitudinal Study
Dept. of Agricultural Economics & Rural Sociology
The Ohio State University
2120 Fyffe Road, Room 238
Columbus, OH 43210

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