Relative Cost Efficiency of No-Till Farms

Abstract

The objective of this study was to examine the relative cost efficiency of no-till farms in central Kansas. Data from the Kansas Farm Management Association (KFMA) for farms that have adopted a no-till production system and for farms with a conventional or reduced tillage system were utilized in this study. Overall or cost efficiency was significantly higher for the no-till farms. The no-till farms were also larger, produced more feed grains and oilseeds, produced less wheat, had higher operating profit margin and asset turnover ratios, and more efficiently utilized their labor and capital inputs.

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Introduction

For the counties in the United States participating in the 2006 Crop Residue Management Survey, the adoption of no-till production has increased from 7.4% of planted acres in 1990 to 31.5% of planted acres in 2006 (Conservation Technology Information Center, 2006). Another way of looking at this increase is to note that two-thirds of the farms surveyed have still not adopted a no-till production system. Given this fact, examining the relative cost efficiency of a no-till system would be of interest to both farms that have adopted a no-till system and to those considering the adoption of a no-till system.

The objective of this paper was to examine the relative cost efficiency of no-till farms in central Kansas. Cost efficiency was measured using an overall efficiency index. Comparisons of farm size, financial ratios, technical and cost efficiency, income shares, and cost shares between no-till farms and farms with a conventional or a reduced tillage system were made.

Data and Methods

Table 1 presents the average and standard deviation of the variables used to compute overall efficiency as well as variables pertaining to farm size, farm type, and tillage system. The data were obtained from the Kansas Farm Management Association (KFMA) databank. Information pertaining to the variables available in the KFMA databank can be found in Langemeier (2003) and on the KFMA web site (KFMA, 2008). To be included in this study, a farm had to have continuous data from 2003 to 2007 and be located in central Kansas. Economists working with KFMA farms in central Kansas have been designating farms as no-till or mixed tillage for the last several years. Thus, this study focused on this region of Kansas. To be designated as a no-till farm, a farm had to utilize a no-till production system for all of their crops.

On average, the farms had a gross farm income of $304,894, a value of farm production of $288,493, and a net farm income of $58,102. Total hectares included crop, pasture, and farmstead hectares and averaged 726. Approximately 84 percent of the farm operators' time allocated to the farm operation was devoted to producing crops. The less tillage index was computed by dividing herbicide and insecticide cost by total crop machinery cost which included repairs, fuel, auto expense, machinery and equipment depreciation, crop machine hire, and an opportunity interest charge on crop machinery and equipment investment. The less tillage index was used by Nivens, Kastens, and Dhuyvetter (2002) to examine the adoption of reduced tillage practices. A farm that has reduced tillage would have relatively higher chemical

Table 1. Summary Statistics for 312 Central Kansas Farms.

Variable	Average	Std. Dev.
Farm Characteristics		
Gross Farm Income ($)	304,894	215,962
Value of Farm Production ($)	288,493	204,521
Net Farm Income ($)	58,102	53,832
Total Economic Cost ($)	341,079	208,450
Total Hectares	726	448
Percent of Labor Devoted to Crops	0.8381	0.1785
Less Tillage Index	0.1222	0.0924
No-Till Farms	0.2340	0.4240
Outputs		
Crop	330,774	259,619
Livestock	71,287	114,341
Inputs		
Labor	1.42	0.76
Livestock	27,798	56,760
Seed	21,684	21,595
Fertilizer	48,053	38,319
Chemicals	20,220	17,680
Capital	230,139	148,804
Input Prices		
Labor	41,864	7,800
Livestock	0.830	0.000
Seed	0.846	0.000
Fertilizer	0.781	0.000
Chemicals	0.953	0.000
Capital	0.816	0.009

costs, relatively lower machinery costs, and a higher less tillage index. The average less tillage index was 0.1222. Approximately 23% of the farms were designated as no-till farms.

Data on total economic cost, outputs, inputs, and input prices were needed to estimate efficiency indices. Total economic cost was computed by summing cash costs, depreciation, an opportunity charge on unpaid operator and family labor, and an opportunity interest charge on net worth. The number of operators on a farm and average family living expenditures were used to compute the opportunity charge on unpaid operator and family labor. Outputs were computed by dividing crop income by a weighted average crop price, and livestock income by a weighted average livestock price. Relative crop income and livestock income shares served as the weights, in the price computations. Crop and livestock prices were indexed using an index value of 1.00 for 2007. Similarly, all of the input prices, except the price of labor, were indexed using an index value of 1.00 for 2007. Labor price was computed by dividing labor cost, which includes hired and unpaid operator and family labor, by the number of workers on the farm. The input level for labor represents the number of workers. All of the other input levels were computed by dividing input cost by input price. The chemical, livestock, and capital inputs represent an aggregate of several inputs. The chemical input included herbicide and insecticide. The livestock input included dairy expense, feed purchased, veterinarian expenses, and livestock marketing and breeding expenses. The capital input included repairs, fuel, organizational fees and dues, property taxes, insurance, machine hire, conservation expenses, interest expense, cash farm rent, depreciation, and an opportunity interest charge on net worth.

An overall efficiency index was computed for each farm using linear programming (Fare, Grosskopf, and Lovell, 1985; Coelli et al., 2005). The overall efficiency indices ranged from zero to one. Farms with an overall efficiency index of one were producing on the cost frontier and at the most efficient scale of operation. More specifically, these farms were producing at the lowest cost per unit of aggregate output. Farms with a lower overall efficiency index could lower per unit cost by reducing inefficiency. The overall efficiency index for each farm was decomposed into technical and allocative efficiency indices. A farm that was technically efficient was using the best available technologies and producing on the production frontier. A farm that was allocatively efficient was using the optimal mix of inputs.

Efficiency indices as well as farm size, farm type, financial performance, income shares, and cost shares for the no-till farms and the mixed tillage farms were compared. Financial performance was measured using the operating profit margin ratio (net farm income plus interest expense minus unpaid operator and family labor divided by value of farm production) and the asset turnover ratio (value of farm

production divided by total farm assets). Income shares were computed by dividing gross income for a particular group of enterprises (e.g., feed grains) by gross farm income. Similarly, cost shares were computed by dividing input cost for each input (e.g., labor) by gross farm income. To determine whether a specific efficiency index or farm characteristic was statistically different between the two groups of farms, t-tests and a 5 percent significance level were used.

Results

The average overall efficiency index was 0.624. Using this level of efficiency, cost per unit of aggregate output could be reduced by 37.6 percent, on average, if all of the farms were overall efficient. The average technical and allocative efficiency indices were 0.866 and 0.722, respectively. Based on these results, allocative inefficiency seemed to be a larger source of overall inefficiency than technical inefficiency.

Table 2 contains a summary of farm characteristics, income shares, and cost shares by tillage group. This table also indicates whether each variable was significantly different between the two groups of farms. Gross farm income, value of farm production, net farm income, and total hectares were significantly different between the two groups of farms. On average, the no-till farms were larger than the mixed tillage farms. More importantly, the operating profit margin ratio, the asset turnover ratio, and the overall efficiency index were significantly higher for the no-till farms. At least a portion of this improvement in performance exhibited by the no-till farms could be due to the fact that these farms were larger. Technical efficiency was significantly higher for the no-till farms. In contrast, allocative efficiency was not significantly different between the two groups of farms. The average percent of labor devoted to crops was not significantly different between the two groups of farms. However, the less tillage index for the no-till farms was significantly higher.

The income share comparisons can be used to examine differences in enterprise mix between the two groups of farms. The no-till farms generated more income from feed grains (e.g., corn and grain sorghum) and oilseeds (e.g., soybeans and sunflowers), and less income from small grains (e.g., wheat) than the mixed tillage farms. Beef and dairy income were not significantly different between the two groups of farms.

The cost share comparisons can be used to examine differences in input mix between the two groups of farms. The no-till farms used relatively less labor and capital, and relatively more seed and chemicals. Given the difference in the mix of crops produced and the substitution of chemicals for fuel associated with a

Table 2. Characteristics of No-Till and Mixed Tillage Farms in Central Kansas.

Variable	No-Till	Mixed Tillage	Difference Significant
Number of Farms	73	239	
Farm Characteristics			
Gross Farm Income ($)	378,016	282,560	yes
Value of Farm Production ($)	360,109	266,618	yes
Net Farm Income ($)	74,432	53,114	yes
Operating Profit Margin Ratio	0.1256	0.0881	yes
Asset Turnover Ratio	0.3729	0.3001	yes
Technical Efficiency	0.863	0.867	no
Allocative Efficiency	0.773	0.706	yes
Overall Efficiency	0.664	0.611	yes
Total Hectares	817	699	yes
Percent of Labor Devoted to Crops	0.8625	0.8306	no
Less Tillage Index	0.1617	0.1101	yes
Income Shares			
Feed Grains	0.2125	0.1683	yes
Hay and Forage	0.0311	0.0442	no
Oilseeds	0.1440	0.0914	yes
Small Grains	0.2277	0.2959	yes
Beef	0.1628	0.1707	no
Dairy	0.0084	0.0331	no
Cost Shares			
Labor	0.1904	0.2577	yes
Livestock	0.0638	0.0666	no
Seed	0.0658	0.0570	yes
Fertilizer	0.1258	0.1254	no
Chemicals	0.0823	0.0575	yes
Capital	0.5860	0.7035	yes

no-till production system, the results with respect to seed and chemicals were not surprising. Anecdotal evidence supports the difference in labor use between the two groups of farms. Many farmers indicate that they have adopted a no-till production system so that they could more efficiently utilize labor. The result with respect to capital was at least partially due to the difference in farm size between the two groups of farms. Previous research suggests that larger farms use capital more efficiently than smaller farms (Langemeier and Bradford, 2006).

Conclusions

The objective of this study was to examine the relative cost efficiency of no-till farms in central Kansas. Data for KFMA farms that have adopted a no-till system and for KFMA farms with a conventional or a reduced tillage system were utilized. In addition to having higher efficiency indices, the no-till farms were larger, had a higher level of financial performance, produced relatively more feed grains and oilseeds, produced relatively less wheat, and more efficiently utilized their labor and capital inputs.

Results of this study have implications on the future adoption of no-till production systems. The no-till farms had significantly higher overall efficiency indices which translate into lower per unit costs. Another possible advantage of a no-till system that was evident by the results of this study was related to crop mix flexibility. The no-till farms in central Kansas have used the no-till production system to add feed grains and/or oilseeds to their rotations. The combination of lower per unit costs and added crop mix flexibility will certainly attract the attention of farms that currently have conventional or reduced tillage systems.

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