

## *A Study of Economics Using Farm Management Data*



■ Soybeans relay-planted into wheat.

*Do no-till producers generate more profit than those using conventional tillage? Are farms that are ahead of neighboring farms, in terms of less tillage adoption, more or less profitable? This chapter answers those questions in an analysis of financial records of Kansas farms over time.*

### **DEFINING GOOD FARM MANAGEMENT**

Economically, a well-managed farm is one that consistently makes greater profits than similarly structured neighboring farms. External economic factors, such as prices, often affect an entire industry, so it is important to evaluate profits compared to other producers in the same time period as opposed to profits in absolute terms. Thus, even during especially good or bad times for the industry as a whole, individual management differences can still be identified. However, because random, localized events, such as weather, often mask differences or similarities in management, it is important to observe profit differences among farms that persist over time.

In the context of crop production management, an operator could be more profitable for a number of reasons. Perhaps he tends to get higher crop yields than his neighbors. Or perhaps he is a better marketer and consistently gets higher crop prices. Maybe he does a better job of controlling costs than his neighbors. Or, maybe the more profitable manager does a better job of determining when and how to adopt new agricultural technologies, such as less tillage.

Other questions also arise. Are profitable operators especially good at one thing? Or, are they better than average at a number of tasks? How easy is it to be better than average at cutting costs or increasing crop prices? How are profits

impacted by having input costs that are 10% lower than average? This chapter addresses questions such as these, based on a study of Kansas farms from 1989 to 1998.

### **DESCRIPTION OF THE STUDY**

The Department of Agricultural Economics at Kansas State University maintains an historical economic database of financial records from Kansas farms that are or have been members of one of six regional Farm Management Associations. Records from farms continuously enrolled from 1989 to 1998 comprise the principle data used in this study (over 1,000 farms).

This study intended to quantify the following basic management measures:

- In dollars per cropped acre, how much greater (or less) was each farm's cropping enterprise profit than that of the average farm in that Kansas Farm Management region that year?
- For each major crop (wheat, corn, grain sorghum, soybeans, alfalfa) raised each year, what was a farm's yield as a percent of the county average for that year?
- As a percentage, how much higher or lower were crop input costs for a farm in some year relative to what was expected in the region for similar cropping programs in that year?
- For the important crops raised each year, as a percentage, how much higher or lower was the overall crop value compared to what was expected based on other farms in the county raising the same crop mix and having the same crop yields? In short, is the producer a good marketer?
- Compared to the average farm in the region that year, how far ahead or behind was each farm in substituting herbicides for machinery and labor costs? In short, is the farm using "less tillage?"

The tillage technology index used in this research is referred to as “less-tillage” to avoid being confused with the terms “reduced-tillage” or “no-till.” The measure was computed for each farm for each year and measured the trade-offs between herbicides and tillage (and crop labor). The index was:

$$\text{less-till index} = \frac{\text{herbicide expense}}{[\text{herbicide expense} + (\text{crop labor and crop machinery operation expense})]}$$

The less-till index increases in value as herbicide expenditures increase relative to crop labor and machinery expenditures. With 0 herbicide expense the index equals 0 and if labor and machinery costs were 0 the index would equal +1. The index value would tend to be small and likely never even 0.5 because crop labor and machinery operating costs typically exceed herbicide costs. The less-till index is an intermediate step in determining how far ahead (or behind) a farm is, relative to its neighbors, in terms of less-tillage adoption.

For each Kansas Farm Management region, the less-till index was used to estimate the typical rate of less tillage adoption over the years. The index made it possible to determine: (a) if a region’s reliance on herbicides over tillage was greater or smaller relative to other regions; (b) if a region was adopting less-tillage faster or slower than other regions over the time period studied; and (c) how far ahead or behind was each farm, on average, compared to the average farm in that region. After quantifying the management measures described above, the effect of yield, cost, price, and technology adoption on profitability was established.

### PERSISTENCE IN MANAGEMENT

How persistent were the five management measures: profits, yields, costs, prices, and less-till adoption?

This is to say, year in and year out, is a given farm consistently better (or worse) than average for that management measure? Data from 1989-1998 were used to determine statistical significance. To understand persistency and statistical significance, let’s look at an example of profits on two farms. Farm A has the following annual profit stream over 5 years: {-\$80, \$200, -\$50, \$300, -\$270}. The average annual profit for farm A is \$20 per acre. What would you expect farm A’s profit to be in year 6? Although your best guess is \$20 per acre you would not have much confidence in that prediction. With the large variability displayed in

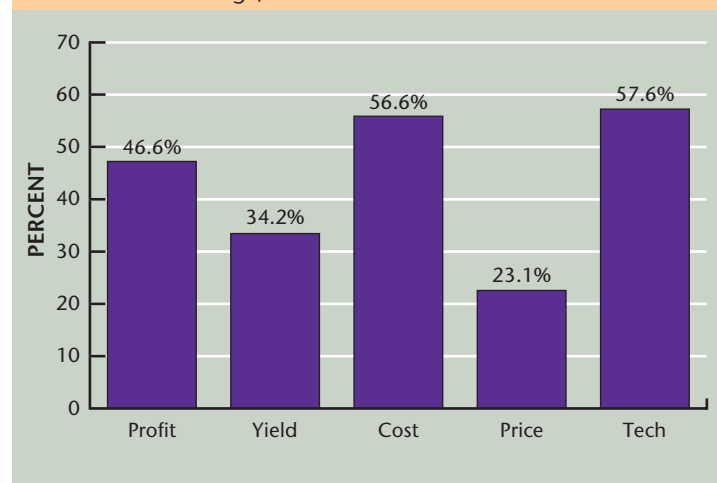
farm A’s profits, it can easily be shown that its \$20 per acre profit is not statistically different from 0.

Now consider farm B whose profit stream is {-\$5, \$30, \$20, \$25, \$30}. Like farm A, farm B’s average profit is also \$20 per acre. However, it is much easier to have confidence in a \$20 prediction for year 6. In this case, the \$20 average is statistically different from 0. Thus, farm B’s profits are said to be substantially more persistent than farm A’s. It is much easier to believe that farm B’s manager has the management skills necessary to make positive profits of \$20 per acre. On the other hand, it appears farm A’s \$20 per acre profits might chiefly be due to chance.

Based on about 1,000 farms tested, Figure 1 shows persistence of management traits by reporting the percent of farms whose 1989-98 average management measure was statistically different from 0 (from the average farm in that area). With nearly 60 percent different from 0, less-till technology adoption is shown to be highly persistent among farmers. That is, producers tend to be consistently fast or slow adopters, not jumping in and out of tillage systems from year to year. The next most persistent management measure is cost, followed by profit, where nearly 50 percent of the farms were persistently better or worse than their neighbors on average. A smaller number (34 percent) of farms were significantly better or worse at yields than their neighbors. This should not be too surprising given that crop yields are so weather dependent. The least persistent management measure is prices, where only 23 percent of the farms were significantly higher or lower than average.

For farms wishing to differentiate themselves from their neighbors, Figure 1 suggests which management aspects should be the easiest ones to

**FIGURE 1.** Persistence of Management Traits: Statistically different from average, 1989–1998



focus on—those with the greatest persistence. For example, it should be relatively easy for a farm to set itself off from its neighbors, presumably to make more profit, by being an especially early or especially late adopter of the less-tillage technology. We know that because so many farms have demonstrated they can do it. On the other hand, the low persistence on price management suggests it will be especially difficult for a farm to become better at achieving higher prices than its cohorts. But, the appropriate effort expended to achieve higher prices depends on the potential payoff, which is discussed later.

How variable are the management measures? Table 1 reports the average value in the high third and low third of each measure. For each measure the middle third centers near zero. The table shows a seemingly wide range of profitability for the high-profit and low-profit group. The least-cost third of farms have costs per acre that are around 25 percent lower than average costs. The top third for crop yields have 16 percent higher yields than average. Figure 1 showed that it would likely be difficult to become a superior price manager. Table 1 shows that even those who are good at pricing (the top third) get prices only 8 percent higher than average. In general, each value in Table 1 is expected to have the same likelihood of occurrence. That is, it should be as easy to get 25 percent lower costs as it is to get 8 percent higher prices. If we assume that the typical price just breaks even, then it is certainly more profitable to be a superior cost manager. Like Figure 1, Table 1 suggests that producers should generally focus on cost and yield ahead of price. (i.e., a 25 percent reduction in cost is more profitable than an 8 percent increase in price.)

### ADOPTION OF LESS-TILLAGE IN KANSAS

Figure 2 depicts changes in less-till index values over time by Kansas Farm Management region. To some extent, index levels in Figure 2 indicate crop mixes in regions. For example, the less-till index

value is highest in NE Kansas, where soybeans, sorghum, and corn (crops that typically require herbicides) largely dominate over wheat. In SC Kansas, where wheat largely dominates, the index value is lowest throughout the time period. The slopes, or steepness, of the lines in Figure 2 are of more interest than the levels as they indicate the speed of less-till adoption. NW Kansas, followed closely by SW and SE Kansas, displayed the fastest adoption rates. By 1998, NW Kansas was second only to NE Kansas in use of herbicides relative to tillage — after beginning in 1989, along with SW and SC Kansas, near the study’s index lows. The fast adoption rates in western Kansas correspond to the ongoing transition from wheat-fallow cropping systems to wheat-row crop-fallow systems in that area (displayed in Chapter 5, Figure 5). Not surprisingly, that is where the research reported in Chapter 5 was most likely to find profits associated with reduced- or no-till.

Table 1 shows that the fastest adopters of less-till are 14 years ahead of their neighbors. That does not imply it would take an average producer 14 years to catch up with the fastest third. For example, a farm that went from average tillage practices to 100 percent no-till in only a year or two would likely reach the top end of the fast adopting third in that short time period.

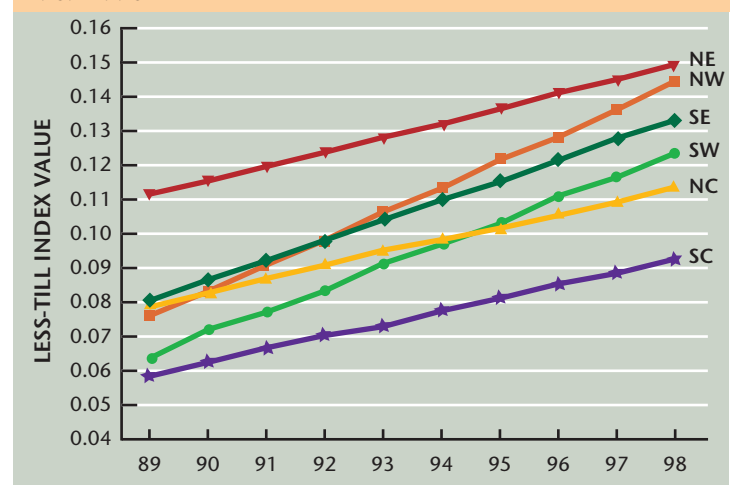
### ARE MANAGERS GOOD (OR BAD) ACROSS THE BOARD?

Figure 1 shows persistence across time for each of the different management traits. Are farms also persistent across traits? That is, are low-cost farms also high-yield farms, etc.? Table 2 addresses that issue. High profit and rapid adoption of less-till are seen to be highly related in the left data

**TABLE 1. VARIABILITY OF MANAGEMENT MEASURES: AVERAGE VALUE IN HIGH AND LOW THIRDS**

Measure	High Third	Low Third
Profit	+\$76/acre	-\$79/acre
Yield	+16%	-16%
Cost	+31%	-2.5%
Price	+8%	-8%
Less-till technology adoption	+14 years	-13 years

**FIGURE 2. Rate of Less-tillage Adoption, by Kansas Region 1989-1998**



column of the table. That is, over half (50.9 percent) of the most profitable farms (those in the top third, profit-wise) were also among the most rapid third of less-till adopters. Further, only 14.7 percent of those in the high profit group were slow adopters (in the slowest third). Had less-till adoption been only randomly associated with profitability we would expect these values to be about 33.3 percent. Based on that, other values in the profit column suggest that high profit is next most associated with high yields, followed by low cost, and last by high prices.

Looking across the less-till adoption row it appears that rapid adoption of less-till is associated with both higher yields and lower costs. That is, good yield or cost managers tend to be rapid adopters of less-till. Interestingly, slightly more than a third (35.6 percent) of those in the high-yield category are also in the low-cost category. Apparently, acquiring high yields depends on using superior combinations of inputs rather than merely using more inputs.

### HOW MUCH ARE MANAGEMENT TRAITS WORTH?

Can the effects of management traits be quantified? For example, can we establish how much more profitable a farm manager was who was in the top third of a management trait compared to the average? To accomplish this, a statistical model was constructed that measures the effect each management trait has on profitability, holding all other traits constant. Although the only technology-adoption variable explicitly considered was

less-till, other technologies might also be important in explaining profitability. Consequently, because technology adoption can often be measured by farm size (larger farms tend to be those which adopt new technologies), our statistical model also included a variable of excess crop acres (the percent of acres greater or less than the regional average).

Table 3 reports the impact of the various management values on profit per acre. The left side of the table reports how marginal changes in management affected profitability for the farms in this study. A 1 percent increase in yields resulted in farm profits rising by \$0.68 per acre. Also, being one year ahead of the average farm in a region in terms of less-till adoption results in increased profits of \$0.97 per acre. A 1 percent increase in farm size is associated with a \$0.19 per acre increase in profit, indicating economies of size in crop production. In the statistical model underlying Table 3 price was the only factor where effect on profitability was not significantly different from zero. That it happens to be negative is not particularly relevant because we have little confidence that it is anything besides zero.

The left side of Table 3 does not address whether it is easier to get a 1 percent increase in yields or a 1 percent reduction in costs. One way to examine this is to look back at Table 1 at the values associated with being in the top third of a management category rather than at its mean. Roughly, it should be as easy to be in the top third of one category as another. Thus, the right side of table 3 reports the effects of those larger changes

**TABLE 2. PERSISTENCE ACROSS MANAGEMENT TRAITS (EXPECTED VALUE IS 33.3 PERCENT AT RANDOM)**

This Percent is in the... ↓	-----Of those in the...-----			
	Highest Third of PROFIT	Highest Third of YIELD	Lowest Third of COST	Highest Third of PRICE
<b>YIELDS:</b>				
Highest Third	46.2%			
Lowest Third	20.2%			
<b>COSTS:</b>				
Lowest Third	41.3%	35.6%		
Highest Third	24.0%	29.8%		
<b>PRICES:</b>				
Highest Third	36.4%	35.6%	27.3%	
Lowest Third	23.4%	30.9%	40.6%	
<b>LESS-TILL ADOPTION:</b>				
Fastest Third	50.9%	43.1%	36.3%	33.5%
Slowest Third	14.7%	22.9%	31.8%	31.3%

**TABLE 3. IMPACT ON PROFIT PER ACRE OF MANAGEMENT TRAITS**

-----Marginal-----		-----Best Third-----	
This Change ↓	Results in This Change in Profit/Acre	This Change ↓	Results in This Change in Profit/Acre
	A 1% Increase in Yields		\$0.68*
A 1% Decrease in Costs	\$0.78*	A 25% Decrease in Costs	\$19.50*
A 1% Increase in Prices	-\$0.11	An 8% Increase in Prices	-\$0.88
A 1% Year Increase in Speed of Less-Till Adoption	\$0.97*	A 14 Year Increase in Speed of Less-Till Adoption	\$13.58*
A 1% Increase in Farm Size above avg.	\$0.19*		

\*Statistically different from 0 at the 95% confidence level.

on profits. For example, going from a farm with average yields to the average of those in the top third implies 16 percent higher yields, which implies \$10.88 per acre higher profits. Clearly, being in the lowest third cost-wise is the most important management trait, followed next by speed of less-till adoption, and then by being in the top third yield-wise. The effect of being in the top third price-wise, at \$-0.88 per acre, was not statistically different from 0.

The results of tables 1-3 confirm that producers who wish to improve profitability by improving management might do well to focus less on price and more on costs, technology, and yields. It was especially surprising to see that being ahead of average in terms of less-till adoption had that much impact on profits.

Interestingly, completing this study's analysis using only 1987-96 data showed that the fastest adopters of less-till were 17 years ahead of average farms during that time period. The resultant profit increase was \$16.27 per acre (against a profit increase associated with being in the low cost category for that time period of \$20.57 per acre.) As agricultural technologies are adopted, farms are less able to differentiate themselves from their neighbors and profits disappear because they are bid into land prices. Being one year ahead of one's neighbors in terms of speed of technology adoption is especially important when a technology is quite new (assuming it is not a passing fad). After the newness has worn off, the benefit of being one year ahead of one's neighbors is smaller. Of course, there is likely diminishing returns to specific areas of management. That is, farms that

are already superior in all areas except price may need to focus on improving price.

## CONCLUSION

A study of 1,000 farms in Kansas over 1989-1998 showed that producers in all regions of Kansas have been expanding herbicide expenditures relative to machinery operation expenditures, indicating the adoption of less-till practices. Relative to the other regions, less-till adoption in western Kansas has been especially rapid due to yield enhancing moisture retention from less-tillage. Of farms in the top third of profits, 50 percent were also in the most rapid third of less-till adopters, indicating a strong relationship between farm profitability and early adoption of less-till. As a profit-maximizing management goal, being ahead of one's neighbors in adopting less-till ranked second in importance to being a low-cost operator. It ranked more important than managing for high yields, which ranked more important than seeking high prices.

## SUMMARY

- High profit and rapid adoption of less tillage are highly related among farms included in the Kansas Farm Management Association.
- Rapid adoption of less tillage is associated with both higher yields and lower costs.
- It is most profitable to focus on costs and technology adoption first, then yields, and lastly on prices.
- As agricultural technologies are adopted, profits disappear because they are bid into land prices. Being one year ahead of others in the speed of adopting a new technology is especially important when a technology is new.