

## **Management Factors: What is Important, Prices, Yields, Costs, or Technology Adoption?**

(updated November 2001 – data from 1990-1999)

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### **Defining Good Farm Management**

Economically, a well-managed farm is one that *consistently* makes greater profits than similarly structured *neighboring* farms. Because external macroeconomic factors, such as prices, often affect an entire industry, it is important to compare profits relative to other industry participants as opposed to profits in absolute levels. Thus, even during especially good or especially 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 than his neighbors for a number of reasons. Perhaps he tends to get higher crop yields. 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 he does a better job of using fixed assets such as land in planting intensity. Or, does the more profitable manager do 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 paper addresses questions such as these in an empirical study of Kansas farms from 1990-1999.

### **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 members of one of six regional farm management associations. The database is often referred to as KMAR, for Kansas Management, Analysis, and Research. Records from farms continuously enrolled from 1990-1999 comprise the principal data used in this study (over 1,000 farms). The KMAR data were augmented with data from other sources as needed (see Nivens, Kastens, and Dhuyvetter 2001 for additional detail).

Goals of this study involved quantifying the following basic management measures:

- a) In dollars per cropped acre, how much greater (less) was each farm's cropping enterprise *profit* than that of the average farm in that KMAR region that year? This measure of economic profits equals zero for the average farm in a region for a given year. Thus, negative values imply lower, and positive values higher, than average profits.

- b) 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? What was the average of that measure across all crops raised by that farm for each year, where the average was a weighted average (by number of acres of each crop), so that crops with larger acreages on a farm are given more weight in the yield performance measure? This index provides a measure of yield superiority, with negative values implying lower than expected yields and positive values higher than expected yields.
- c) As a percentage, how much higher/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? This index provides a measure as to whether or not a producer was low cost relative to other producers.
- d) For the important crops raised each year, as a percentage, how much higher/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? This provides a general measure of pricing superiority/inferiority (Is the producer a relatively good marketer?).
- e) As a percentage, how much higher/lower was the **planting intensity** for a farm in some year relative to what was expected in the region in that year? This provides a measure of a manager's ability to use fixed assets.
- f) As a percentage, how much higher/lower was the overall **government payments** compared to what was expected based on other farms in the region? Because government payments are primarily based on historical yields and acres, they cannot necessarily be "managed." However, differences in payments between farmers will impact profitability differences so this measure is included in the analysis.
- g) Relative to the average farm with in a region in a given year, how much larger or smaller, as a percentage, is the **size** of the farm in terms of total crop acres. This variable is included to determine if farms that are larger (smaller) than the average sized farm are more or less profitable – after accounting for the other management factors.
- h) As a percentage, how much higher/lower was the overall **risk** (farm income variability across years) compared to what was expected based on other farms in the region? This provides a general measure of how farm profitability is associated with risk.
- i) Compared to the average farm in the region that year, how far ahead or behind was each farm in adopting one important technology in Kansas – substituting herbicides for machinery and labor costs?

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, computed for each farm each year,

measured the tradeoffs between herbicides and tillage (and crop labor):<sup>1</sup>

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

The less-till index increases in value as herbicide expenditures increase relative to crop labor and machinery expenditures.<sup>2</sup> 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 statistically regressed on years, 1990-99, to estimate the typical rate of adoption over the years (refer to Nivens, Kastens and Dhuyvetter for additional detail). The index and related statistical models 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 each of the management measures described above such that they were "relative to their neighbors" (i.e., compared to the average for the region), the effect yield, cost, price, technology adoption, planting intensity, government payments, farm size, and risk had on profitability was established in a statistical model.

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<sup>1</sup> A farmer's involvement in less-tillage practices is not typically all-or-none. Often only a part of the farm is no-tilled, or only in some years, or only with some crops. Thus, it is difficult to label one farmer as a no-tiller and another as a conventional farmer. What is needed is some measure of the extent tillage is used that covers the continuum from moldboard plowing to 100% herbicide-based weed control and seedbed preparation. Then, the impact of that less-tillage measure on profitability could provide the answers needed. But, farm profitability is affected by more than the decision to reduce tillage; other management characteristics might be equally important, as might be luck or weather. To properly understand the relationship between no-till and profitability, it is important to identify the impact of less tillage on profitability – *after* other important profitability-determining factors are accounted for. After all, no-till adoption is essentially a management issue similar to marketing or cost control.

<sup>2</sup> Machinery operation expense is defined as the crop share (as opposed to livestock share) of: machinery repairs, gas-fuel-oil, farm auto expense, motor vehicle depreciation, and machinery-equipment depreciation; plus crop machine hire expense; plus an opportunity interest charge on crop machinery investment; minus machine work income. To that value is added the crop share of labor (operator, hired, and unpaid family labor).

## Results of the Farm Management Study

The first question to answer is, How persistent were the management measures: profits, yields, costs, prices, less-till adoption, planting intensity, government payments, and farm size? This was determined by averaging each of the management measure's annual values for a farm over the 1990-99 period and testing whether this average measure was statistically different from 0 (from the average or typical farm).

Statistical significance is important for establishing confidence in the results. Using the profit per acre variable as an example, consider farm A, which is assumed to have this annual profit stream over 5 years: {-80, 200, -50, 300, -270}. The average annual profit for farm A is \$20/acre. What would you expect farm A's profit to be in year 6? Although your best guess is \$20/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/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/acre. Now, 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/acre. On the other hand, it appears farm A's \$20/acre profits might chiefly be due to chance. In other words, the profits of farm B are persistent while the profits of farm A are much more random.

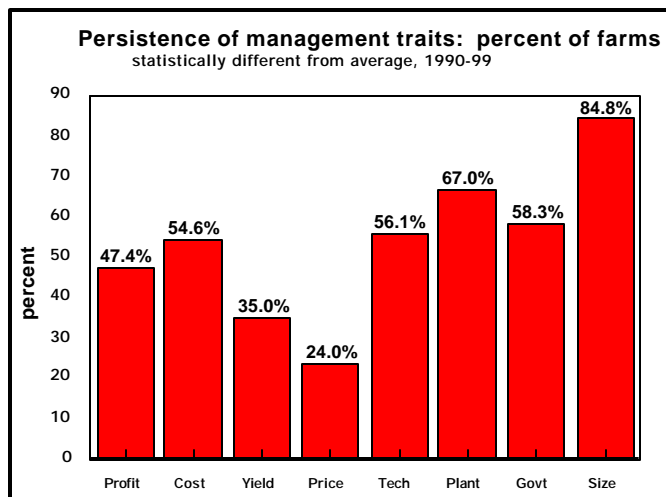


Figure 1

Based on around 1,000 farms tested, figure 1 shows persistence of management traits by reporting the percent of farms whose 1990-99 average management measure was statistically different from 0 (from the average farm in that region). With 67 percent of the farms statistically different from 0, planting intensity (Plant) is shown to be highly persistent among farmers. That is, producers tend to have consistently low or high planting intensity, not jumping about from year to year. The most persistent management measure is size, however this and government payments (Govt) often are not highly manageable on a day-to-day basis. Therefore, of the manageable factors the next most persistent measure is less-till technology adoption (Tech), followed by cost, where nearly 55 percent of the farms were persistently better or worse than their neighbors on average. A smaller number (35%) 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 price, where only 24 percent of the farms were significantly higher or lower than the average.

For farms wishing to differentiate themselves from their neighbors, figure 1 suggests which management aspects should be the easiest ones to 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 either increasing or decreasing planting intensity. 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 standard deviation for each measure. The standard deviation for a measure is approximately the level of that measure expected of the typical farm in the high third for that category. For example, the 30.0 shown in the Cost line indicates that farms in the high third cost-wise have costs that are 30.0 percent higher than their neighbors. Similarly, the typical low-cost (i.e., in the low third) farm would have costs 30.0 percent lower than their neighbors. The top third of farms yield-wise have 14.9 percent higher yields than their neighbors. Figure 1 showed that it probably would be difficult to become a superior price manager. Table 1 shows that even those who are good at pricing (one standard deviation above the average, i.e., the top third) get prices only 8.5 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 30% lower costs as it is to get 8.5% 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 focus on planting intensity, cost management, and yield, ahead of price (i.e., a 30.0% reduction in cost is more profitable than an 8.5% increase in price).

Table 1. Variability of management measures (standard deviation).

Measure	Standard Deviation
Profit (\$/acre higher profits than neighbors)	72.7
Cost (% higher cost/acre than neighbors)	30.0
Yield (% higher yield/acre than neighbors)	14.9
Price (% higher crop value than neighbors)	8.5
Tech (number of years ahead of neighbors in less-till adoption)	14.1
Plant (% higher planting intensity than neighbors)	23.4
Govt (% higher govt payments/acre than neighbors)	88.7
Size (% larger farm size in crop acres than neighbors)	78.6
Risk (% higher across-years income variability than neighbors)	67.3

Figure 2 depicts changes in less-till index values over time by Kansas Farm Management region. To some extent, index levels 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 and SW Kansas, followed closely by SE Kansas, displayed the fastest adoption rates. By 1995, NW Kansas was second only to NE Kansas in use of herbicides relative to tillage – after beginning in 1990, 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. Not surprisingly, profits associated with less-tillage adoption have generally been larger in western Kansas than in other regions (see the economics chapters of K-State’s *Kansas No-Till Handbook*).<sup>3</sup>

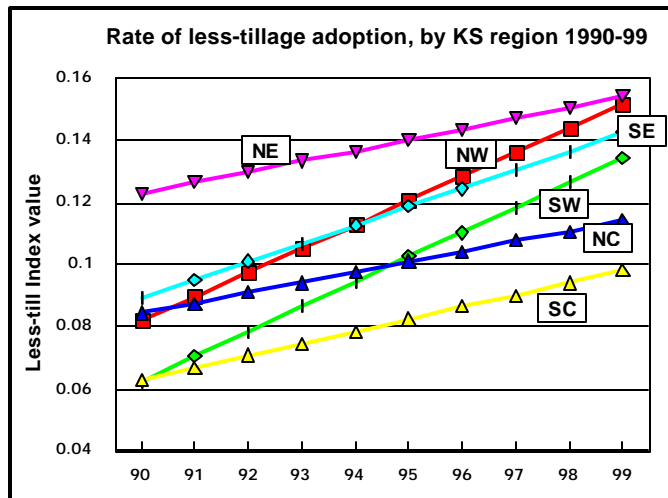


Figure 2

Table 1 shows that the fastest adopters of less-till are 14 years ahead of their neighbors. This does not imply that 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% no-till in only a year or two would likely reach the top end of the fast adopting third in that short time period.

Can the effects of management traits be quantified? For example, can we establish how much more profitable a farm manager was who was one standard deviation greater

(or worse) than the average of a management trait compared to if he were only 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 measure of relative farm size (the percent of acres greater or less than the regional average).

Figure 3 graphically depicts important results of the statistical model. It shows the impact on profit expected from a farm being one standard deviation above its neighbors for each factor expected to impact profit. The asterisks on the labels in the graph denote which factors had statistically significant

<sup>3</sup> In figure 2, measures of early adoption for individual farms are determined by the horizontal distance into the future or past where an individual farm’s index intersects the line for that region. For example, a farm in NE Kansas whose index value was 0.14 in 1991 was about 4 years “ahead” of its neighbors because the NE line did not reach 0.14 until 1995. On the other hand, a NE Kansas farm that had an index value of 0.14 in 1998 was considered to be 3 years “behind” its neighbors. Because of the overall slow adoption pace, farms which are principally no-till are calculated to be many years ahead of the average producers.

impacts on profits. According to the model, risk had the greatest impact on profit. That is, those farms willing to tolerate the greatest risk, causing them to be in the top third of farms based on across-years income variability, had over \$23/acre greater profits than their neighbors. Although perhaps difficult to manage for, farm size had the second greatest impact on profit, a strong indicator of economies of size in farming. That is, even after accounting for the other important differences in farm management, farms in the top third size-wise had nearly \$20/acre greater profits than their neighbors.

In figure 3, among the factors that are managed on a day-to-day basis, cost appeared to have the greatest impact on profit. Farms in the bottom third cost-wise had costs that were approximately

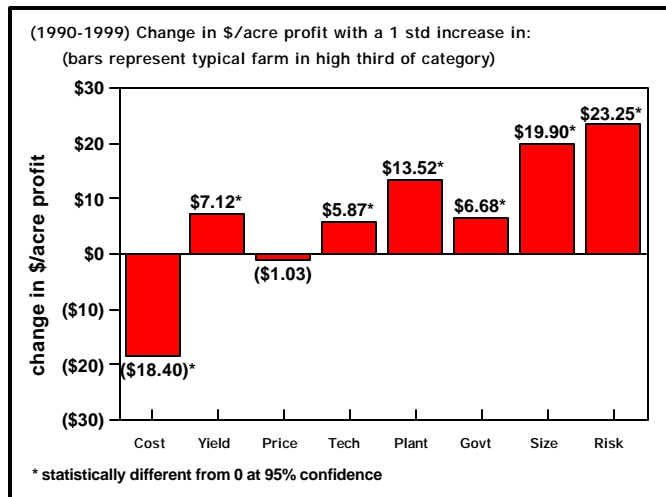


Figure 3

30% lower than their neighbors (table 1). Based on the model, having 30% lower costs would mean having more than \$18/acre greater profits than the neighbors (figure 3).

In figure 3, after cost management, planting intensity, yield, and less-till adoption follow in relative importance for improving profits. Of course, in farm management, it is not always easy to separate one management factor from another. For example, the western Kansas shift to less tillage in recent years paralleled a shift to increased cropping intensity (2 crops in 3 years rather than 1 crop in 2 years). Similarly, double-cropping

throughout Kansas has probably increased due to the time savings wrought by less tillage.

Interestingly, the 10-year study described in this paper has been conducted for a number of years, with the impact of less-till adoption on profits diminishing as more recent years are added and earlier years dropped. For example, though not perfectly comparable to the current study using 1990-1999 data, a study using 1987-1996 data showed that the fastest adopters of less-till were 17 years ahead of average farms during that time period (Nivens and Kastens, 1999). The resultant profit increase was \$16.27/acre (against a profit increase associated with being in the low cost category for that time period of \$20.57/acre). As agricultural technologies are adopted, farms are less able to differentiate themselves from their neighbors and associated profits disappear because they are bid into land prices and rents. 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. Late adopters must adopt to survive and never see the gains associated with the new technology.

In the statistical model underlying figure 3, price was the only factor whose impact on profitability was not significantly different from 0. That it happens to be negative is not particularly relevant because we have little confidence that it is anything besides 0. The results of table 1 and figures 1 and 3 confirm that farm operators who wish to improve profitability by improving management

might do well to focus less on price and more on planting intensity, costs, technology, and yields. 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.

## Summary

A study of about 1,000 farms in Kansas over 1990-1999 revealed that farmers are most able to differentiate themselves from their neighbors in terms of planting intensity, technology adoption, and costs, followed next by yields, and last by prices. Among those management factors, being a good cost manager was most important for increasing profitability, followed by planting intensity, yield, and technology adoption. Price management did not have a statistically significant impact on profit. Increasing the variability in farm income also would increase overall profit, however this is generally not a goal of producers. Increasing size and government payments would make a significant impact on profitability as well, however these are often outside the control of the current manager. In all regions of Kansas, farms have been expanding herbicide expenditures relative to machinery operation expenditures, indicating the adoption of less-till practices. Less-till adoption has been especially rapid in western Kansas, likely due to yield-enhancing moisture retention from less tillage. As a profit-maximizing management goal, increasing planting intensity ranked second in importance to being a low-cost operator. It ranked more important than managing for high yields and being ahead of one's neighbors in adopting less-till, both of which ranked more important than seeking high prices.

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