■ No-till corn after corn.

CHAPTER FIVE

Yield & Economic Comparisons: *University Research Trials*

In a competitive industry, such as agriculture, where producers are typically price takers, one of the best ways for producers to increase profits is by adopting production practices or technologies that reduce per-bushel costs of production. In general, reducing per-bushel costs can come about either by increasing crop yields or by decreasing production costs per acre. Thus, an understanding of the economics of no-till can be gained by comparing yields and costs among various tillage systems.

This chapter analyzes the economics of production differences across tillage systems in university research trials. Relevant questions are: Does no-till increase crop yields? Is chemical weed control more or less expensive than the tillage it substitutes for?

In much of the Great Plains, conventionally tilled wheat, either summerfallow or continuous, has been the mainstay cropping system for many years. It has not been without problems, however. Tillage, although designed to destroy moisture-robbing weeds in semiarid regions, also causes moisture loss itself, and hence can reduce yields. Further, tillage (especially during the long fallow period in summerfallow programs and on highly erodible land) may lead to increased soil erosion, diminishing the soil's long-term yield potential.

Changes in government farm legislation over the last decade have focused on reducing soil erosion by making those producers with excessive erosion ineligible for government program payments. Thus, failure to consider alternative farming practices may jeopardize a producer's profitability by reducing this important income source for Kansas farmers.

Reducing tillage in the Great Plains has several potential benefits.

1. If more soil moisture is conserved where it is otherwise limiting, higher yields should result, increasing crop revenue.
2. Herbicides may be less expensive than tillage, thereby decreasing costs.
3. It may be possible that management and other fixed costs can be spread over more acres with reduced tillage, further reducing costs.
4. Machinery investment per acre may be reduced, which could lower the risk associated with rapidly changing production technologies.
5. Reduced tillage may ensure government program payments by making it easier to meet farm program residue requirements.

Increasing cropping intensity, often made possible by no-till, also has potential benefits.

1. The fixed cost of land investment can be reduced by being spread over more crop acres.
2. Adding row crops to wheat farms may reduce planting and harvesting bottlenecks by spreading fixed machinery and labor costs over multiple "seasons" within a year.
3. Harvesting different crops at different times may reduce the risk of total crop failure.
4. Adding crops may reduce price risk.
5. Increased acres in growing crops or crop residue may mean less erosion, ensuring government program payments as well as long-term land productivity.

Research Background

Several cropping system studies conducted by K-State are briefly discussed in this chapter. Perhaps because no-till benefits were expected to be largest in drier climates, the majority of no-till research in Kansas has focused on western Kansas. At least that is where available economic analyses are the most complete.

The research studies involve different years, locations, and underlying assumptions (especially regarding the economics, e.g., whether a land charge has or has not been included). Consequently, comparisons should chiefly be made within a study, and less emphasis placed on comparisons across studies. To enhance relevance for the current policy environment, where government payments are no longer tied to cropping decisions, economic results reported here do not include program payments.

PROFITABILITY OF TILLAGE AND CROPPING SYSTEMS

What does the research show regarding profitability? Figure 1 shows that, in Garden City from 1987-93, systems that increased cropping intensity improved profitability over summerfallow wheat systems, regardless of the tillage system. Conventional-till (CT), reduced-till (RT), and no-till (NT) wheat-sorghum-fallow (WSF) systems increased profits over conventional, reduced, and no-till wheat-fallow (WF) systems. The most profitable tillage in the wheat-sorghum-fallow rotation was reduced tillage prior to the wheat and no-till prior to the sorghum (RT/NT). The no-till continuous sorghum system (SS), excluding wheat entirely, had nearly double the profits of wheat-fallow programs. However, the returns were less than the wheat-sorghum-fallow rotation, indicating that increasing cropping intensity to 100 percent (a crop each year on every tillable acre) was not optimal. In this study, high sorghum yields relative to wheat yields were instrumental in providing the results.

The returns did not include a land charge but it should be pointed out that the average cash rent in southwest Kansas during these years was $23.85 per acre, which means the wheat-fallow rotation would not have been profitable without government payments. Of course, without government payments land values and rents would fall accordingly.

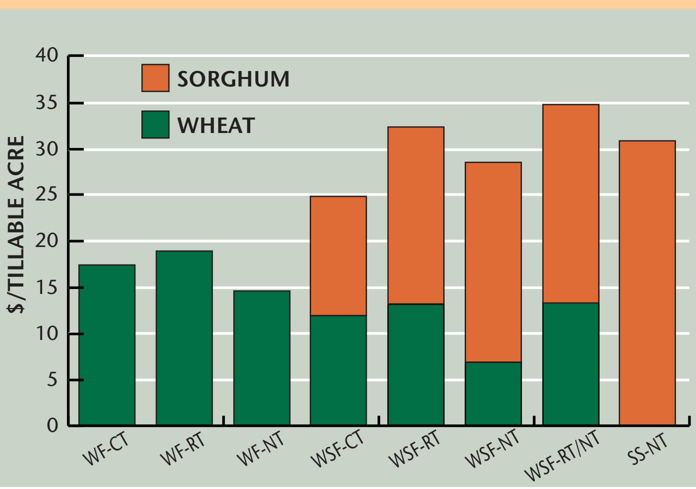
Figure 2 shows cropping system returns from 1991-95 in Tribune. Increased profitability associated with increased cropping intensity was not as apparent as it was in the Garden City study. That is, wheat-sorghum-fallow systems were similar to wheat-fallow systems in profitability. Continuous no-till wheat (WW-NT) was slightly more profitable than no-till wheat-fallow (WF-NT) but only half as profitable as reduced-till wheat-fallow (WF-RT). In this study, high wheat yields relative to sorghum yield was an important factor in the results.

A long-term study in Hays (1976-86) showed wheat-sorghum-fallow to be around $10 per acre more profitable than either wheat-fallow or sorghum-fallow, confirming the benefits to increased cropping intensity (Figure 3). Because this study includes a charge for land, all returns are much lower than those shown in the previous studies mentioned. Conventionally tilled continuous sorghum (SS) and continuous wheat (WW) were especially unprofitable here.

KEY TO CODES IN FIGURES IN THIS CHAPTER:

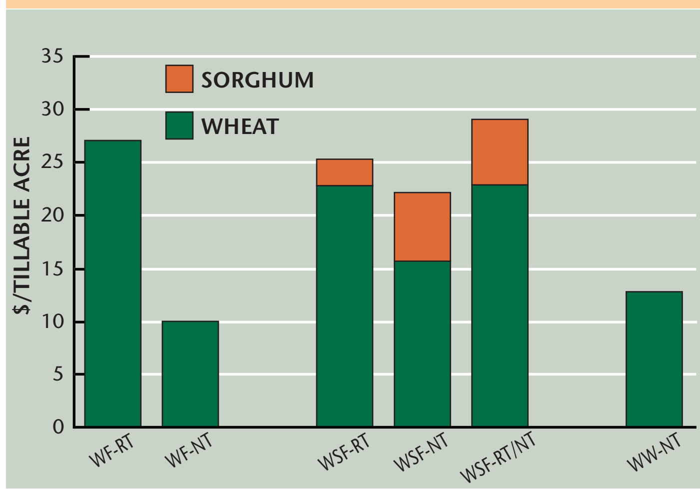
WF =	Wheat-Fallow	**WW** =	Wheat-Wheat
WSF =	Wheat-Sorghum-Fallow	**CT** =	Conventional-Till
SF =	Sorghum-Fallow	**RT** =	Reduced-Till
SS =	Sorghum-Sorghum	**NT** =	No-Till

FIGURE 1. Economic returns per tillable acre: Garden City, 1987-93



Source: Dhuyvetter & Norwood

FIGURE 2. Economic returns per tillable acre: Tribune, 1991-95

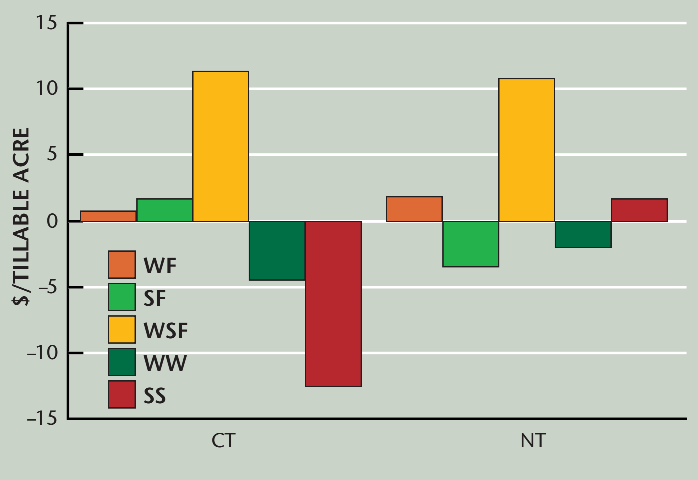


Source: Dhuyvetter & Schlegel

A similar study at Tribune over 1973-85 confirmed the reduced profitability associated with such conventionally tilled continuous cropping programs (Figure 4). Compared to Hays, however, the Tribune study showed even larger increases in returns associated with tillage reduction. This is not surprising considering that conserving moisture should be more important in lower-rainfall areas.

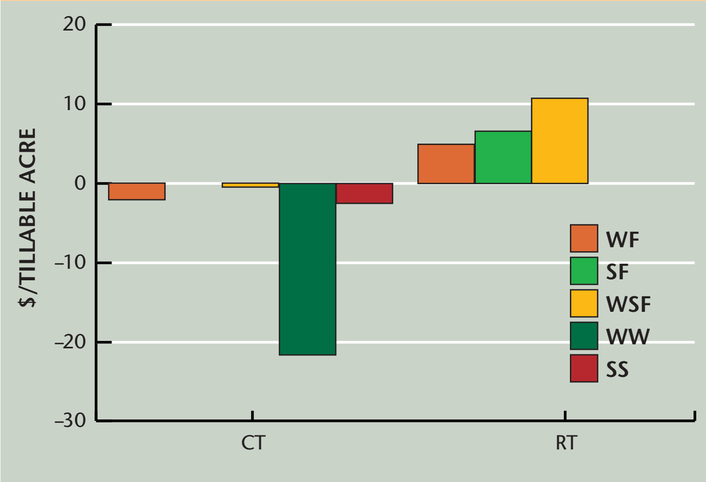
The research from western Kansas strongly supports increased cropping intensity. Clearly, summerfallow wheat is losing acres to more intensive systems, typically involving spring-planted crops. Figure 5 shows acres of dryland crops harvested in western Kansas in recent years and confirms this expected trend. Since 1993, crops such as sorghum, corn, and sunflowers, appear to be increasingly substituted for summerfallow wheat. The values below the years indicate the number of summerfallow wheat acres planted for each acre of all other dryland crops combined. In 1996, insufficient winter moisture and frost caused many wheat acres to be destroyed and planted to sorghum, especially in southwest Kansas, leading to an extreme summerfallow wheat-to-other-crops ratio of 1.03. The 1997 and 1998 ratios, at around 2.5 and 1.9, respectively, show that the trend starting in 1993 is continuing.

FIGURE 3. Economic returns per tillable acre: Hays, 1976-86



Source: Williams, Llewelyn, and Barnaby

FIGURE 4. Economic returns per tillable acre: Tribune, 1973-85



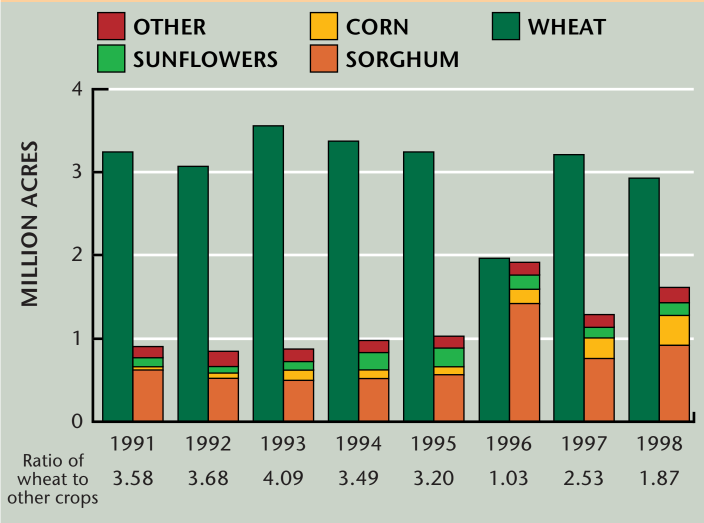
Source: Williams et al.

Research shows an economic advantage to increased cropping intensity, but it is more mixed on the economics of no-till vs. conventional tillage in western Kansas. As a general rule, there is little economic incentive to reducing tillage, either reduced-till or no-till, in a wheat-fallow rotation. However, in a more intense cropping rotation, research indicates that reducing tillage can be profitable in western Kansas.

ALTERNATIVE DRYLAND CROPS

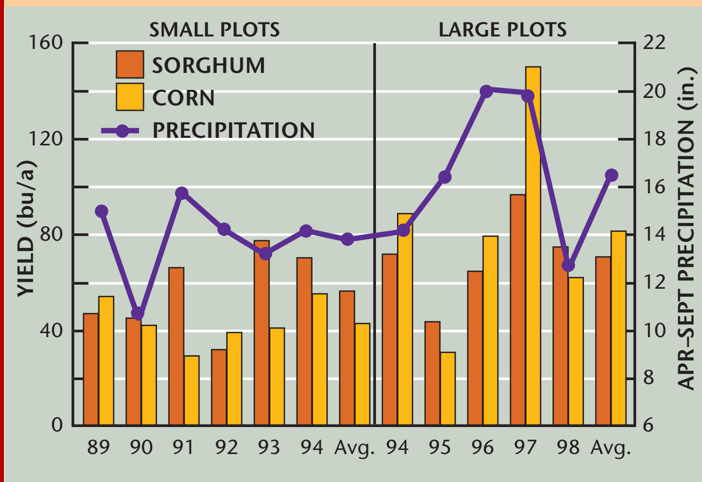
Regardless of tillage choice, many Kansas farmers, especially in the western part of the state, are growing more summer crops and are interested in which summer crops might be most profitable. Figure 6 shows corn and sorghum yields within a wheat and fallow rotation in Tribune when the research was conducted on either small or large plots. Research conducted on small plots typically is more controlled than research on larger plots. However, larger plots generally are more representative of farm yields because there is less of a "border effect." This is especially true of dryland crops such as corn and sorghum where hot dry winds can have a large effect on yields in small plots.

FIGURE 5. Dryland acres harvested in western Kansas



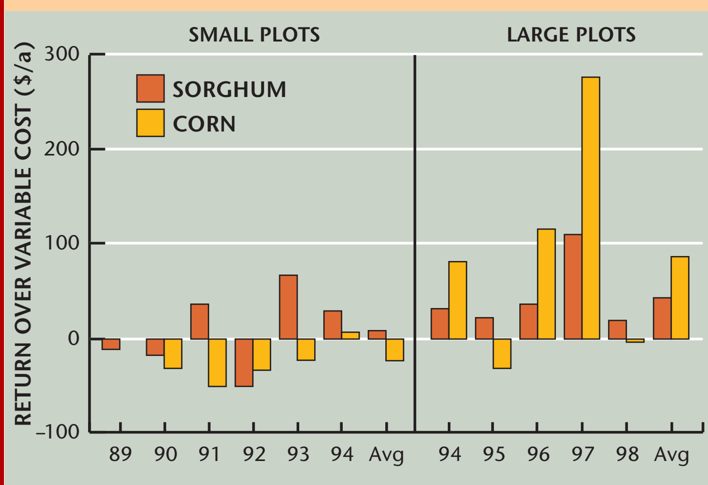
Source: Kansas Agricultural Statistics, Farm Facts.

FIGURE 6. NT corn vs. sorghum yields: Tribune, 1989-98



Source: Schlegel

FIGURE 7. NT corn vs. sorghum returns/planted acre: Tribune, 1989-98



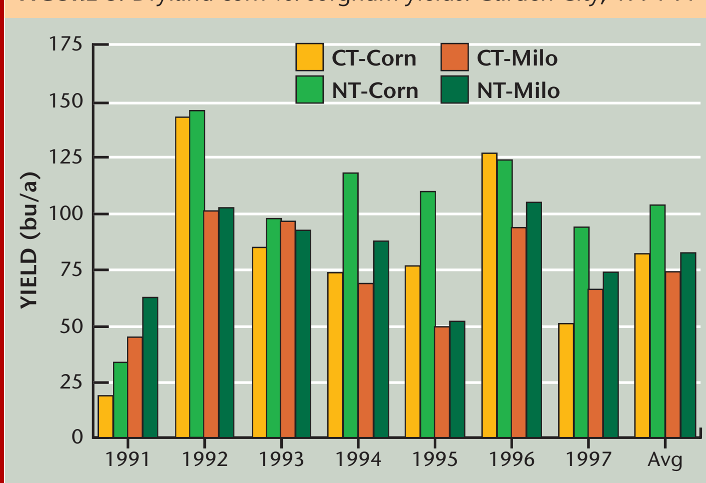
Source: Dhuyvetter & Schlegel

In the small plot research conducted from 1989-1994, sorghum typically yielded more than corn, and especially so in 1991 and 1993 (Figure 6). On average, sorghum yields were around 13 bushels per acre greater than corn, suggesting a potential sorghum advantage. However, in the large plot research conducted from 1994-1998, corn yields were greater than sorghum yields in three of the 5 years and averaged 12 bushels per acre greater. Since much of the small plot versus large plot research was conducted in different years it is difficult to say if yield differences are due to a "year effect" or a "plot-size effect." In particular, April-September rainfall during 1994-98 averaged about 2.75 inches more than during 1989-94.

After considering production costs that were approximately $17 per acre higher for corn than for sorghum, Figure 7 shows the corn and sorghum net returns associated with the yields shown in Figure 6. The typically higher market price for corn over sorghum roughly offsets the higher production cost of corn. Therefore, as a general rule, whichever crop yields the highest in a particular year typically will be the more profitable crop. In the small plot research, sorghum returns were higher than corn returns in four of 6 years, and averaged around $30 per acre higher for the six-year period. However, in the large plot research, corn returns were higher than sorghum returns in three of the 5 years, and averaged around $45 per acre higher for the entire 5 years.

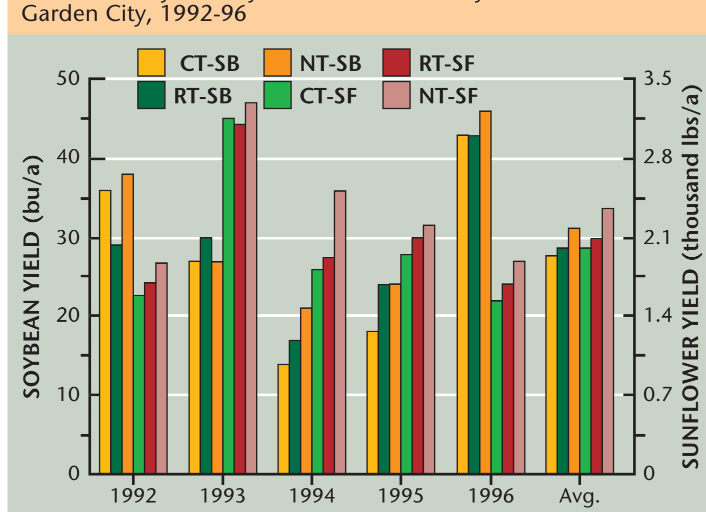
Figures 8 and 9 show dryland yields of corn versus sorghum and soybeans versus sunflowers grown in a wheat-row crop-fallow rotation in Garden City using various tillage methods. Corn out yielded sorghum by about 20 bushels per acre

FIGURE 8. Dryland corn vs. sorghum yields: Garden City, 1991-97



Source: Norwood

FIGURE 9. Dryland soybean and sunflower yields: Garden City, 1992-96

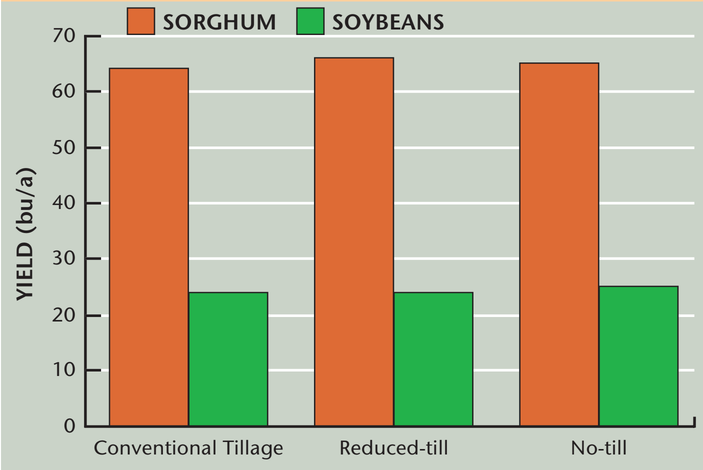


Source: Norwood

over the length of this study. In dry years like 1991, however, sorghum yielded more since it is a more drought-tolerant crop. No-till typically resulted in higher yields than conventional-till, and this difference was larger for corn than sorghum, once again reinforcing the critical importance of conserving moisture for summer crops, especially corn. Dryland yields of soybeans averaged about 30 bushels per acre and sunflowers averaged almost 2,400 pounds per acre from 1992-1996. In both cases, yields with no-till were generally greater than with conventional- or reduced-tillage.

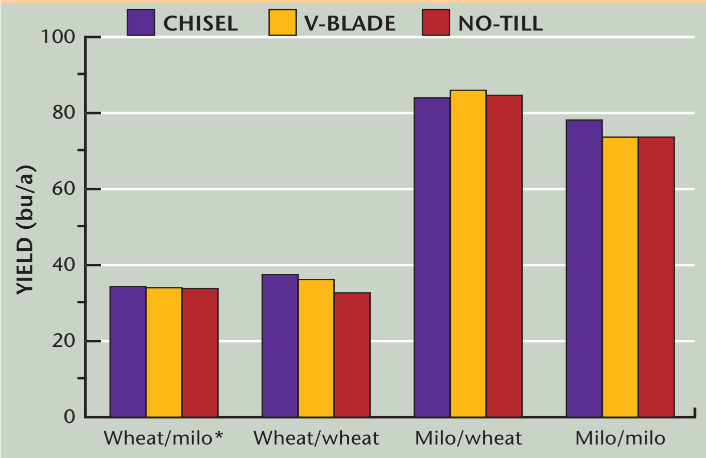
Figures 10 through 16 show crop yields across tillage systems for locations in central and eastern Kansas. The figures, which report tillage research spanning 20 years, reveal that, yield increases

FIGURE 10. Grain sorghum and soybean yield versus tillage: Belleville, 1975-81



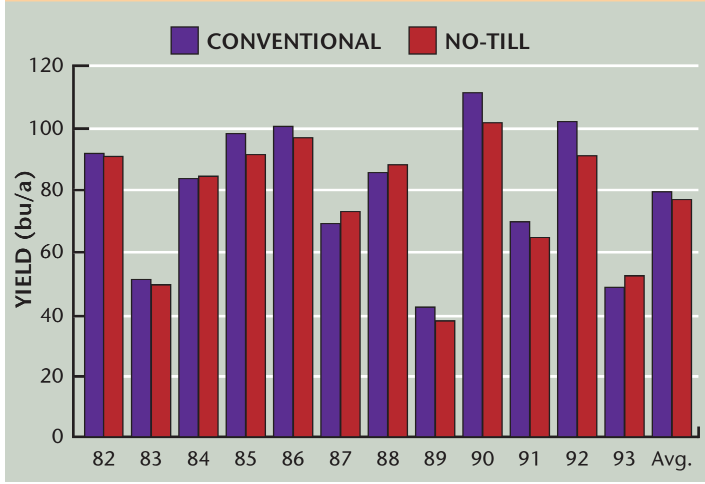
Source: Raney, Russ and Powell

FIGURE 11. Comparison of tillage and rotation: Harvey County, 1986-95



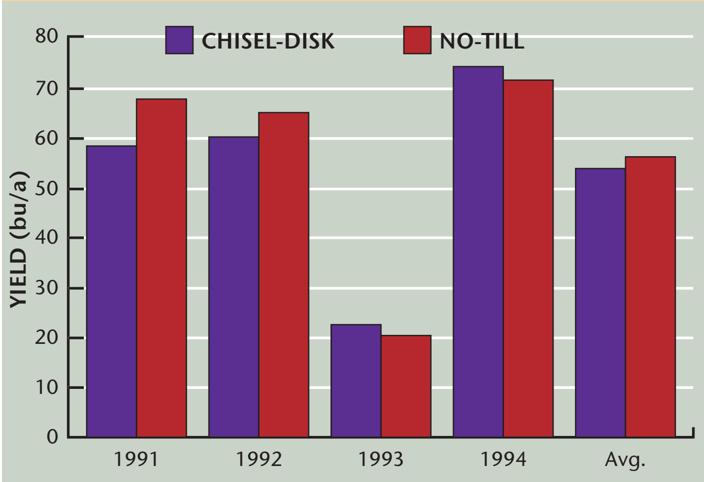
Source: Claassen

FIGURE 12. Comparison of conventional and no-till planting on sorghum yield: Manhattan, 1982-93



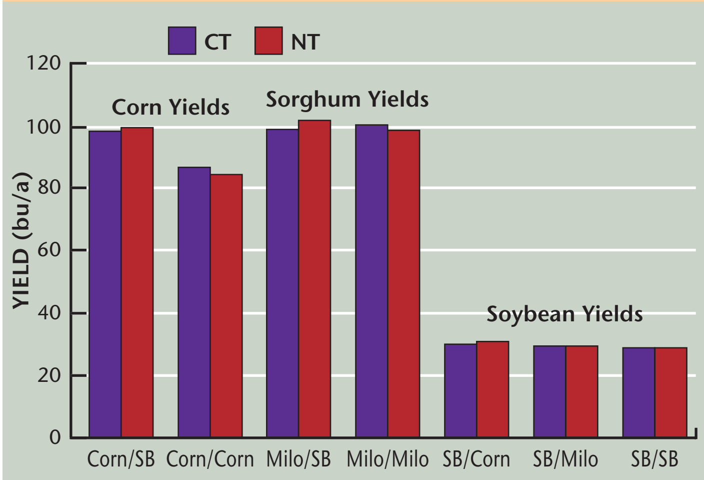
Pierzynski, Whitney, and Lamond

FIGURE 13. Comparison of chisel-disk and no-till planting on sorghum yield: Ottawa, 1991-94



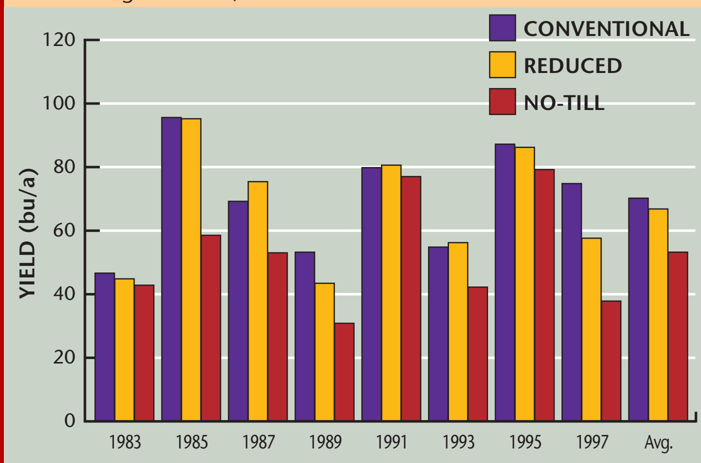
Source: Janssen

FIGURE 14. Comparison of conventional and no-till planting on corn, grain sorghum, and soybean yield: Powhattan, 1975-84



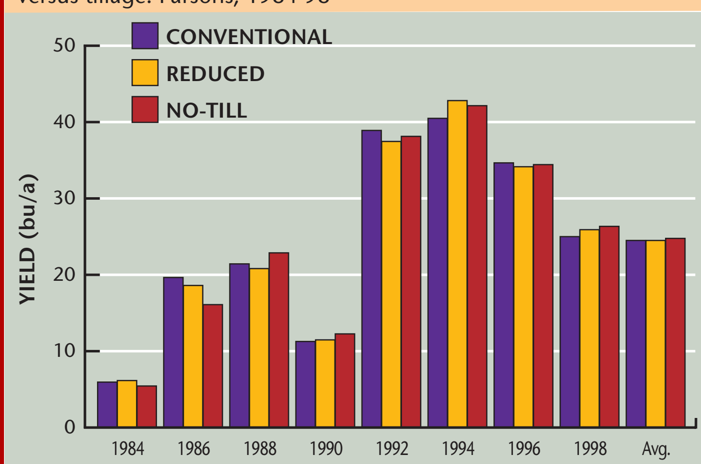
Source: Lundquist et al.

FIGURE 15. Grain sorghum yield (in rotation with soybeans) versus tillage: Parsons, 1983-97



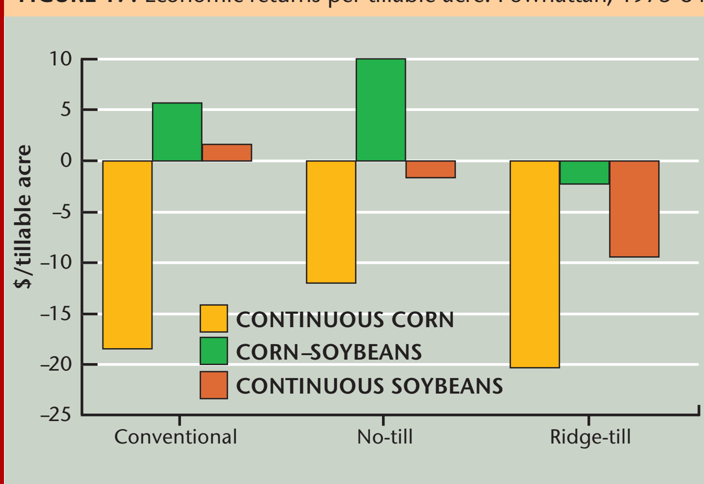
Source: Sweeney

FIGURE 16. Soybean yield (in rotation with grain sorghum) versus tillage: Parsons, 1984-98



Source: Sweeney

FIGURE 17. Economic returns per tillable acre: Powhattan, 1975-84

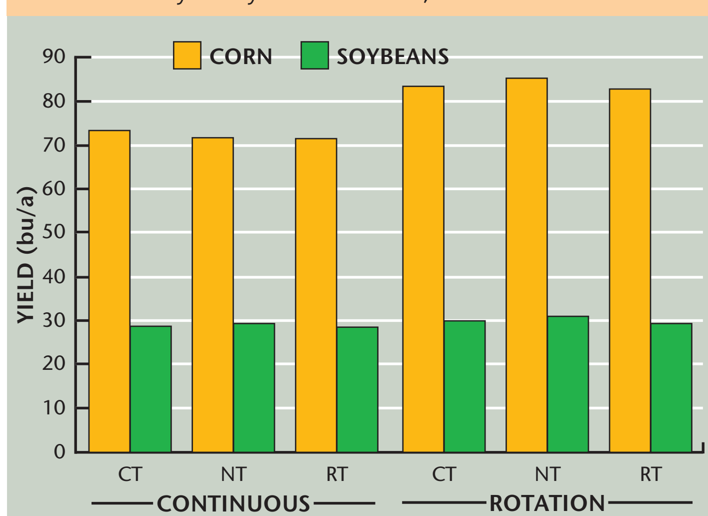


Source: Williams, et al.

from no-till appear smaller in central and eastern than those observed in western Kansas. In some cases, no-till yields are less than conventional- or reduced-till yields (e.g. sorghum in southeast Kansas—Figure 15). If economics are closely tied to yields, it should not be surprising to find slower rates of no-till adoption in central and eastern Kansas than in western Kansas.

Figure 17 shows the economics of continuous corn, corn-soybeans, and continuous soybeans with conventional, no-till, and ridge-tillage for northeast Kansas. In both the continuous corn and the corn-soybean rotations, no-till was more profitable than either conventional, or ridge-tillage. With continuous soybeans conventional tillage was the most profitable. It should be noted however, that this result may not hold with current technology (e.g., Roundup Ready soybeans). The returns in Figure 17 are based on the yields shown in Figure 18. It can be seen that there are small yield differences between the various tillage systems, but there is a slight interaction between rotation and tillage. For example, no-till corn yields are slightly lower than conventional tillage in a continuous corn rotation, but no-till corn yields are better than conventional tillage in the corn-soybean rotation. Thus, similar to the western Kansas data, it is important to consider both the rotation and the tillage method (i.e., the cropping system) when analyzing the economic returns.

FIGURE 18. Comparison of conventional, no-till and ridge-tillage on corn and soybean yield: Powhattan, 1975-84



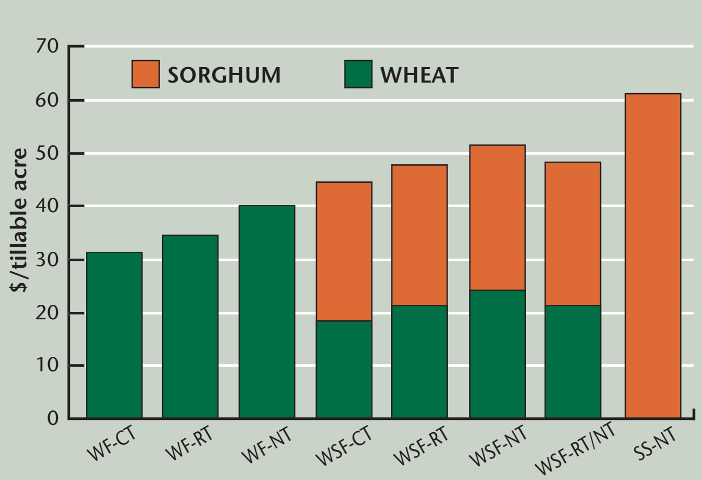
Source: Williams, et al.

COSTS

Production costs are related to the level of risk involved in a cropping system. With higher costs, producers must be able to finance or otherwise bear them — even if projected crop sales are expected to offset those higher costs. Also of interest, is how production costs are divided between the crops involved in cropping systems. In central and eastern Kansas, production costs associated with tillage systems are an especially important issue because yields do not appear to vary significantly across tillage. Thus, any profitability associated with no-till would have to come primarily through cost reduction.

Figure 19 displays the annual variable production costs associated with the Garden City study.

FIGURE 19. Annual variable production costs: Garden City, 1987-93



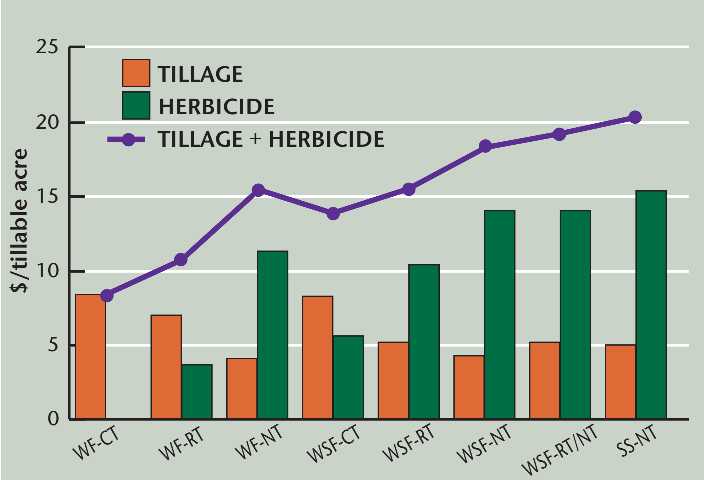
Source: Dhuyvetter & Norwood

Clearly, the costs per tillable acre rise in cropping systems other than conventionally tilled summerfallow wheat. Continuous sorghum, which had the third highest economic returns in Figure 1, had costs that were nearly double those of conventional-till summerfallow wheat.

Figure 20 breaks out the tillage and herbicide costs for the crops in the Garden City study. The tillage/herbicide trade-offs are readily apparent. In this study, herbicide costs rise more than tillage costs fall. For example, going from conventional- to reduced-till in wheat-sorghum-fallow, tillage costs are reduced by about $3 per acre but herbicide costs increase by about $5 per acre. The adoption of no-till often requires higher yields or increased cropping intensity to be profitable. That is not a foregone conclusion, though, if less tillage is coupled with increased cropping intensity. For example, two lower-yielding crops in 3 years (i.e., wheat-sorghum-fallow) may provide more production than one higher-yielding crop in 2 years (i.e., wheat-fallow). Where higher yields are both needed and expected in a reduced tillage system, producers should only cautiously reduce herbicide costs. If profits depend on higher yields, reduced herbicide usage might jeopardize profits by jeopardizing yields.

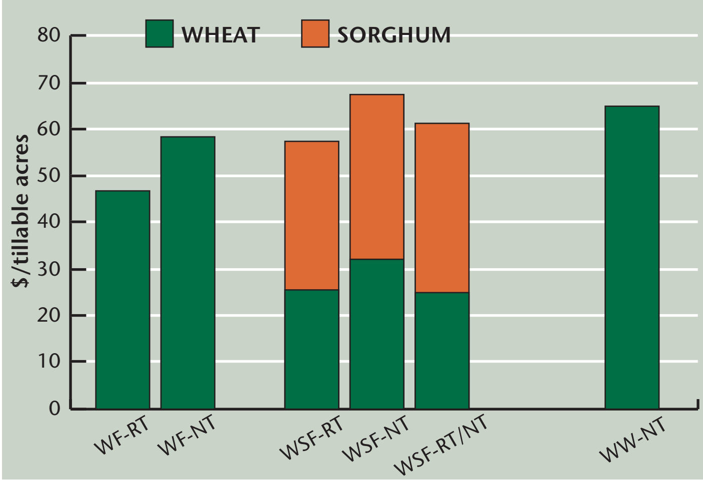
Figure 21 shows production costs from the Tribune study. There, costs were more similar across cropping systems than in the Garden City study. Somewhat surprisingly, total annual variable costs do not increase much when going from no-till wheat-fallow to no-till wheat-sorghum-fallow—even though two crops are raised in 3 years rather than one crop in 2 years. Similarly,

FIGURE 20. Tillage versus herbicide expense: Garden City, 1987-93



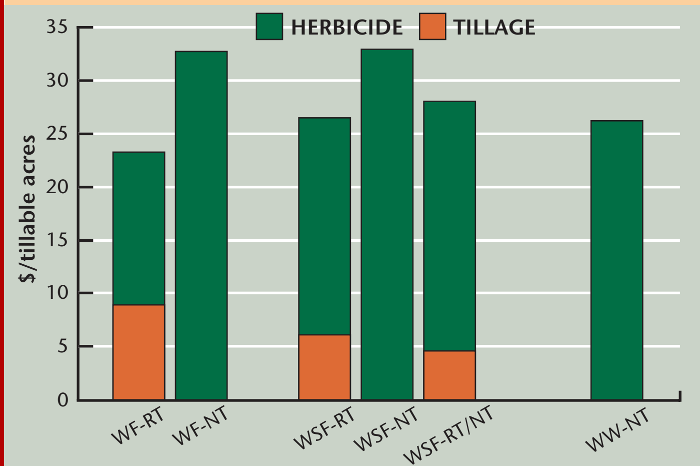
Source: Dhuyvetter & Norwood

FIGURE 21. Annual variable production costs: Tribune, 1991-95



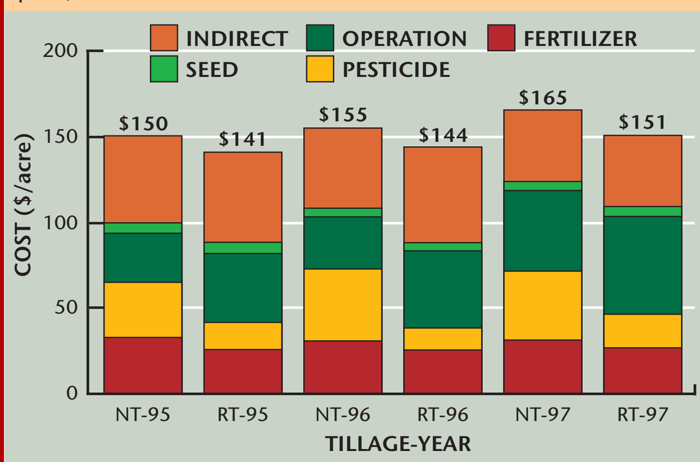
Source: Dhuyvetter & Schlegel

FIGURE 22. Tillage versus herbicide expense: Tribune, 1991-95



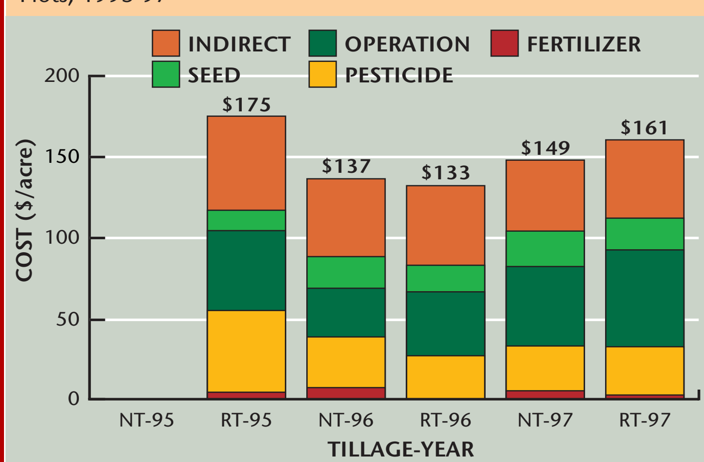
Source: Dhuyvetter & Schlegel

FIGURE 23. Cost breakdown of Riley County sorghum plots, 1995-97



Source: Christian

FIGURE 24. Cost Breakdown of Riley County Soybean Plots, 1995-97



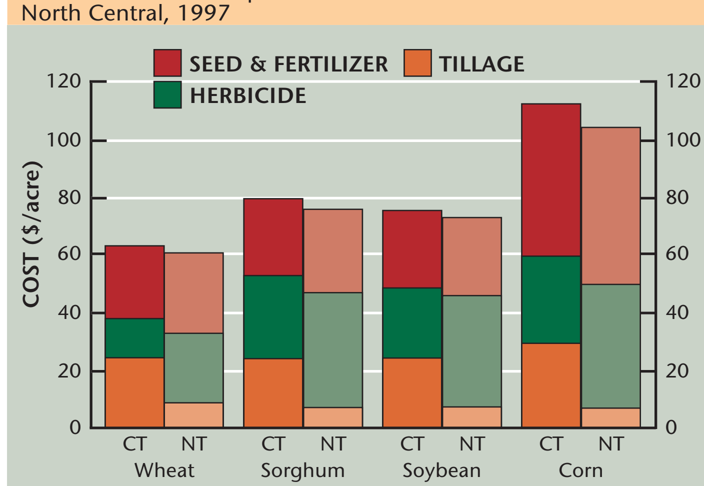
Source: Christian

Figure 22, which examines only the tillage and herbicide costs, shows that herbicide costs for the no-till wheat-fallow program are around $7 per acre higher than for the no-till continuous wheat program. Rotations with more fallow acres require increased herbicide usage to control weeds during the fallow period. In more intensive crop rotations, the crops themselves help keep weeds in check. However, Figure 22 generally suggests that including some tillage lowers weed control costs over complete no-till.

Figures 23 and 24 display total costs and a breakdown of those costs for reduced till (RT) and no-till (NT) plots in Riley County. For 1995-97 sorghum plots, costs are about $10 per acre lower for reduced-till than for no-till (Figure 23). Differences in costs are ambiguous for soybeans, however (Figure 24). Although operation (machine) costs are higher with reduced-till than no-till for sorghum, increased pesticide (herbicide and insecticide) and fertilizer costs with no-till are even greater.

Figures 25 and 26 compare the expected costs associated with conventional tillage and no-till for north central (Figure 25) and northeast (Figure 26) Kansas. These costs were constructed using the Kansas Farm Management Guides for crop inputs (e.g., seed, fertilizer, herbicide and insecticide) and custom rates for planting, tillage, and harvest as reported by Kansas Agricultural Statistics. For each of the crops examined, total costs were similar across CT and NT, with a slight edge going to NT. The figures show clearly that cost differences between CT and NT principally involve tillage/herbicide trade-offs.

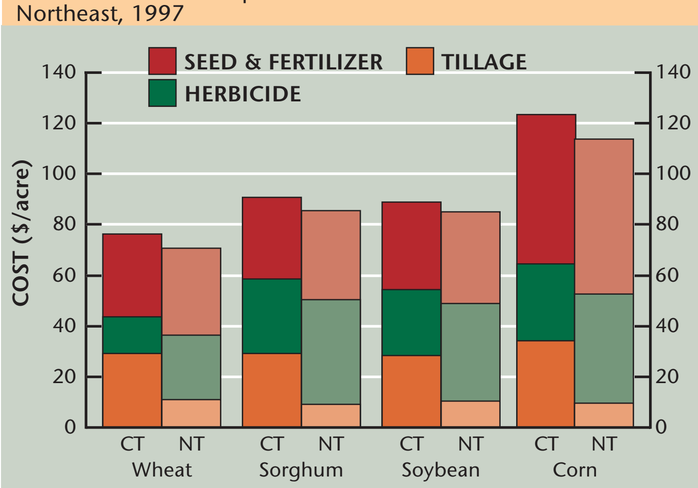
FIGURE 25. Cost comparison of conventional and no-till: North Central, 1997



Source: K-State Farm Management Guides and North Central Kansas custom rates.

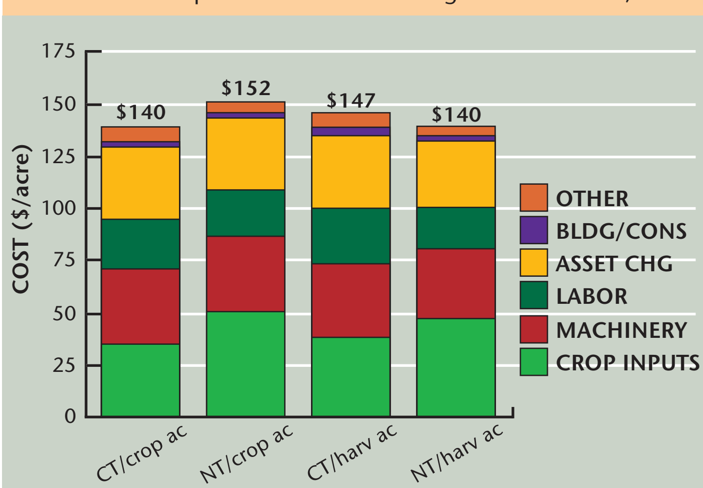
Figure 27 compares the costs of seven totally no-till farms in the North Central Kansas Farm Management Association in 1996 with the average cost of all other crop farms in the association that year. The first and second bars of the figure show that total crop input costs, on a per-crop-acre basis, are $12 higher for no-till than for conventional tillage (assumed to be the tillage operation for those members who were not exclusively no-till). Crop input (fertilizer, seed, and chemicals) costs were notably higher for no-till. However, when the costs are computed on a per-harvested-acre basis (third and fourth bars of the figure), the edge went to no-till, at $7 per acre less than conventional-till. The no-till farms tended to crop more intensively, typically double-cropping soybeans, which ultimately reduced land costs per harvested acre. As previously mentioned, this suggests it is more appropriate to examine no-till in a cropping systems framework, rather than looking at only individual crops.

FIGURE 26. Cost comparison of conventional and no-till: Northeast, 1997



Source: K-State Farm Management Guides and Northeast Kansas custom rates.

FIGURE 27. Comparison of no-till vs. tillage: North Central, 1996



Source: NC Farm Management Association

CONCLUSION

Wheat-fallow has traditionally been the dominant strategy on nonirrigated acres in western Kansas but there has been a trend toward planting more summer crops. The current farm bill allows producers to plant whatever crop they want regardless of their historical base acres. Additionally, government program payments are fixed and declining, which increases the need for producers to find cropping systems that can increase returns and decrease risk relative to the traditional wheat-fallow rotation. Increasing cropping intensity by including a spring crop such as sorghum or corn into a wheat-fallow rotation can increase returns and possibly reduce financial risk. In central and eastern Kansas the benefits to no-till have not been as large as in western Kansas. There, yields and costs appear relatively flat across alternative tillage systems.

In general, this chapter depicts a mixed bag for the profitability of no-till in Kansas. When coupled with increased cropping intensity, reduced tillage in western Kansas led to increased crop yields and increased profits. In central and eastern Kansas, yields and costs with no-till appear similar to those with more conventional tillage methods, suggesting marginal economic gains to no-till, at best. On the other hand, these results suggest there is no economic disadvantage to less tillage (with a possible exception of Southeast Kansas). One northeast Kansas study (Figure 17) and one north central Kansas research project (Figure 27), however, hinted that it is important to study no-till economics in a cropping system rather than in a single-crop framework. Chapter 7 in this handbook examines no-till on a total system framework.

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SUMMARY

- Research in western Kansas shows an economic advantage to increased cropping intensity when used in conjunction with less tillage.
- Corn will be more profitable than sorghum under dryland conditions in western Kansas in normal or good years. Sorghum will be more profitable in dry years.
- Yields of dryland corn, sorghum, soybeans, and sunflower in western Kansas were higher in no-till than reduced-till or conventional-till.
- In central Kansas, yields of wheat, grain sorghum, and soybeans have generally been unaffected by tillage systems.
- In east central and southeast Kansas, no-till can have a detrimental effect on yield on claypan soils with poor internal surface drainage.
- If economics are closely tied to yields, it should not be surprising to find slower rates of no-till adoption in central and eastern than in western Kansas.
- Cost differences between conventional-till and no-till primarily involve tillage/herbicide trade-offs.
- It is important to consider both the rotation and tillage system when comparing economic returns.