What Will Replace the Corn-Soybean Rotation?

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The first question we need to ask is why we would want to replace the corn-soybean rotation? It has been a relatively stable rotation for several decades in Illinois and Indiana, and continues to be important. Current acreage trends show that, due mostly to the relatively high corn price resulting from the use of more U.S-produced corn to produce ethanol for fuel, acreage is shifting quickly to more corn in Indiana (Figure 1). This trend is also favored by the fact that corn yields have been rising at about 2 bushels per year, faster than the ½ bushel per acre per year increases for soybean and wheat (Figure 2).

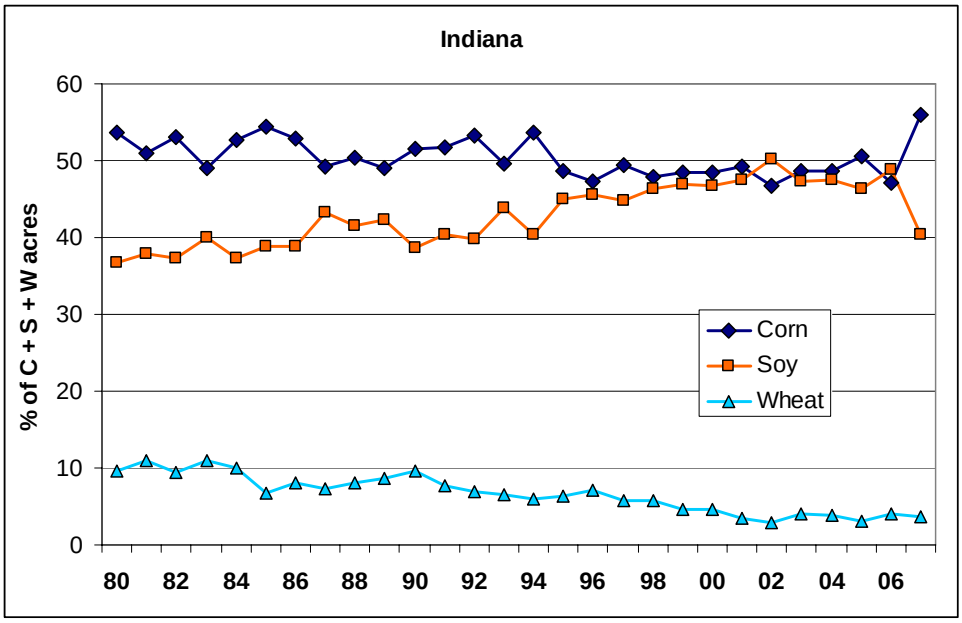

Figure 1. Area of corn, soybean, and wheat in Indiana, as percentages of total area of these three crops, from 1980 through 2007. Source: NASS.

Without the introduction of new crops on sizeable acreage or an unexpected reversal in corn acreage trends, there will have to be more corn following corn in Indiana, simply because there are no longer enough acres of soybean and wheat to serve as rotational crops for corn (Figure 3).

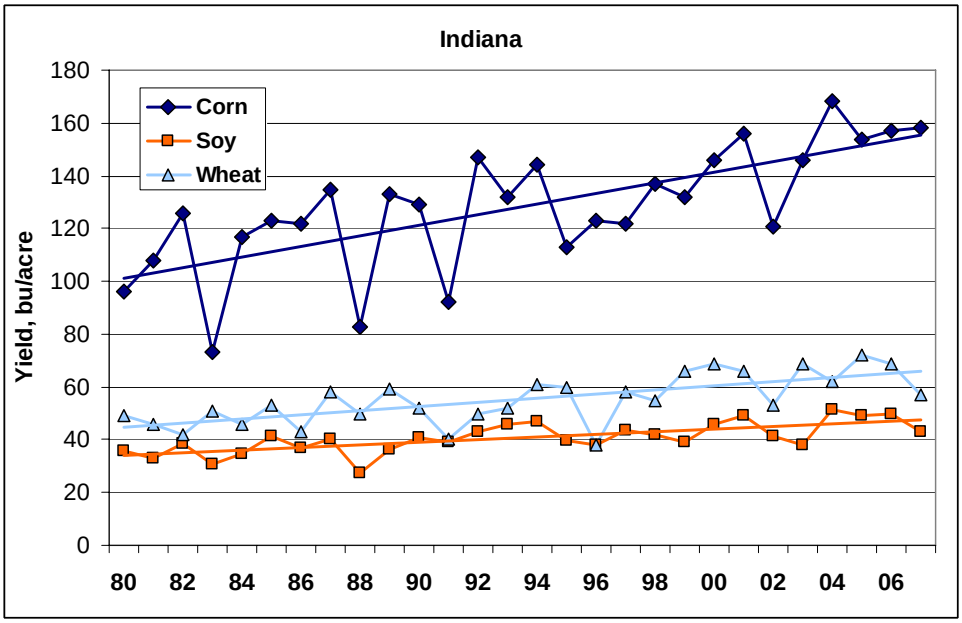

Figure 2. Yield trends of corn, soybean, and wheat in Indiana, 1980-2007. Source: NASS.

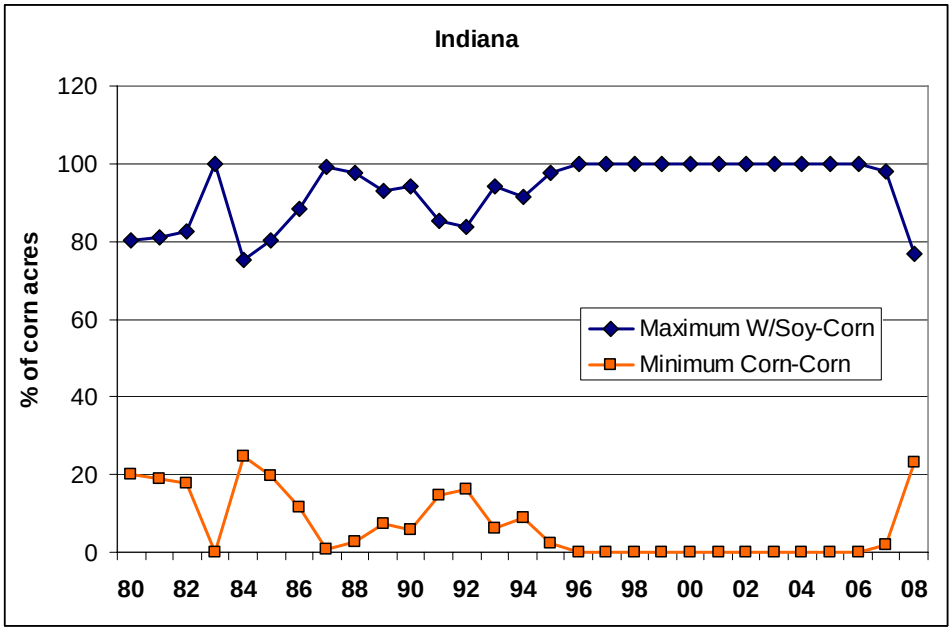

Figure 3. Maximum corn-following-wheat/soybean and minimum corn-following-corn acreage calculated for Indiana corn, 1980-2007. Previous crop includes all soybean acres plus 2/3 of wheat acres in the previous year, to include both double-cropped soybean after what and planting of corn after wheat. Estimates for 2008 assume an increase of 500,000 acres in corn from 2007 to 2008. Source: NASS.

Corn Following Corn

Although the current cropping pattern in Indiana does not "force" a lot of corn to follow corn, it is, and will continue to be, the system adopted by some producers on at least some of their land. It is likely that many producers will produce more corn following corn on their more-productive land, based on the impression that corn following corn does relatively better in more-productive fields.

One of the typical questions that producers ask about corn following corn (CC) is whether the yields will suffer compared to corn following soybean (SC), and if so, will this yield loss decrease or disappear over time? In work conducted over the past 9 years, there is no question that yields are more often higher in SC compared to CC, though in about 10% of the trials CC yielded more than SC (Figure 4).

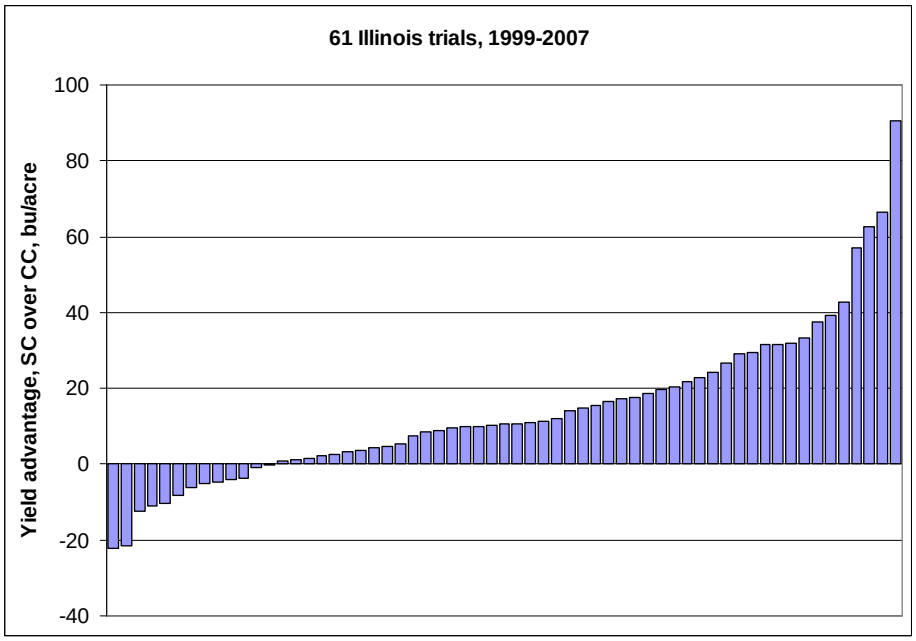

Figure 4. Yield advantage of corn following soybean compared to corn following corn in 61 trials at seven sites in Illinois. Data are from an N rate study where SC and CC were main plots in each trial.

The idea that continuous corn benefits from increasing numbers of years of corn growing in the same field is one that has gained some traction, though there are little data to support this contention. If we take the data shown in Figure 4 and break it out by year and by northern Illinois compared to southern Illinois, there is little evidence that the yield difference trends down over time (Figures 5 and 6). In northern Illinois, CC yielded an average of about 10% less than SC, but much of this difference came from four of 27 sites where the difference was more than 40 bushels. While this makes up a minority of sites, and it has not occurred in the past two years, we have no solid evidence that it will never happen again. It is possible that the use of corn rootworm-resistant Bt hybrids might decrease the incidence of this, but we do not know that for certain.

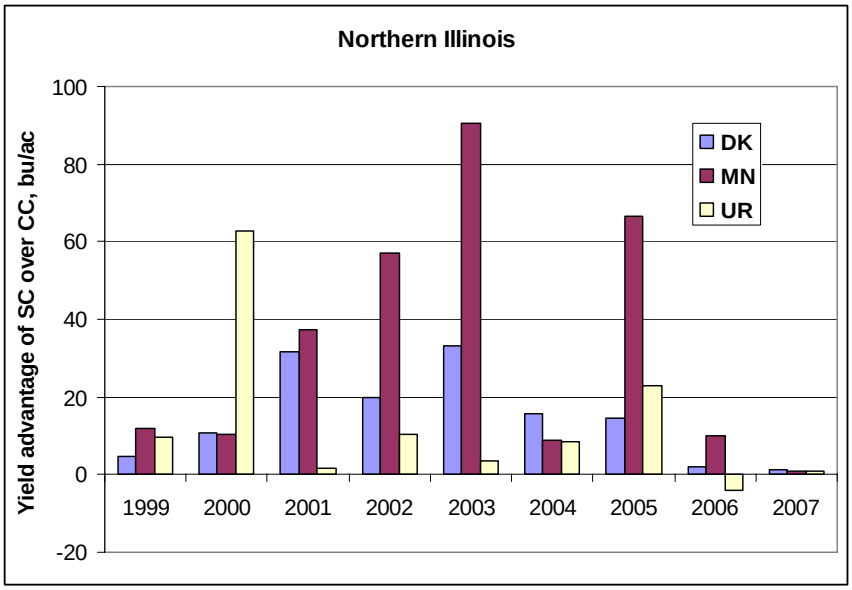

Figure 5. Trends in the yield advantage of corn following soybean compared to corn following corn over years at three northern Illinois locations (DeKalb, Monmouth, and Urbana). The average loss was 20 bushels per acre, or about 10%.

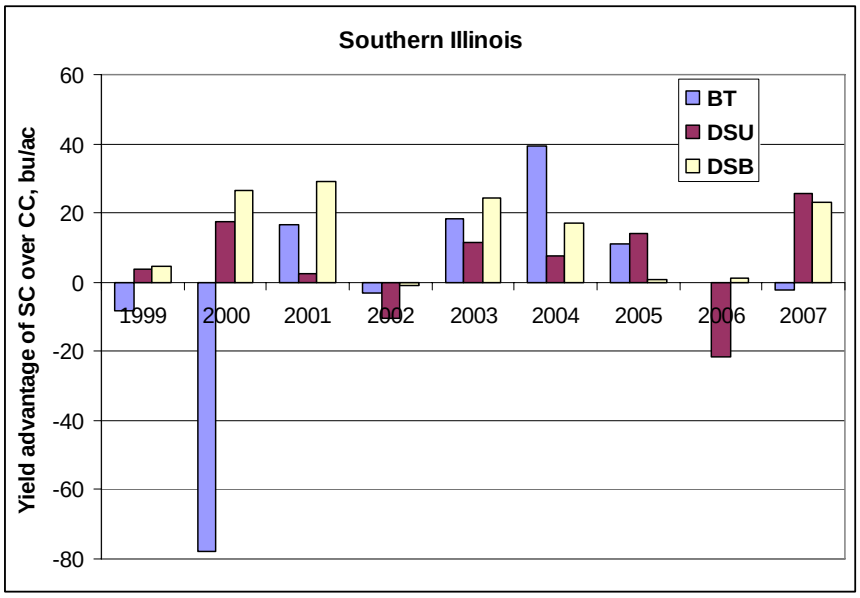

Figure 6. Trends in the yield advantage of corn following soybean compared to corn following corn over years at three southern Illinois locations (Brownstown, Dixon Springs upland, Dixon Spring bottomland). The average loss was 6 bushels per acre, or about 5%, but without the unusual advantage of CC at Brownstown in 2000, the difference was 7%.

It is interesting to note that the incidence of large yield losses from CC are less common in southern Illinois than in northern Illinois, and that the average yield loss from CC is less in these less-productive soils. The average yield of SC over the 27 sites-years in southern Illinois was 136 bushels per acre, compared to 196 in northern Illinois. The fact that the yield penalty was not closely related to soil productivity and, in fact, tended to be less in some less-productive soils and environments, there was no correlation between may mean that it is time to reconsider whether or not the placement of continuous corn should always be on the more-productive soils.

What management factors should we consider if we make a change to corn following corn? The first thought that many have is that CC needs more nitrogen fertilizer. While this has often been found to be true for rotation x N rate trials conducted in the same field (Figure 7), data drawn from a wide set of fields and used to formulate N rate guidelines for corn in Central Illinois indicate little difference in the N rate needed to maximize the return to N in these two rotations (see the N rate calculator at http://extension.agron.iastate.edu/soilfertility/nrate.aspx). This difference still exists in northern Illinois, where CC shows maximum return at an N rate about 40 lb more than in SC, and in southern Illinois, where about 20 lb more N is needed for CC. We think that some of the fields used to generate response data in central Illinois CC may be higher in productivity, and better able to provide N from soil organic matter, than do average fields.

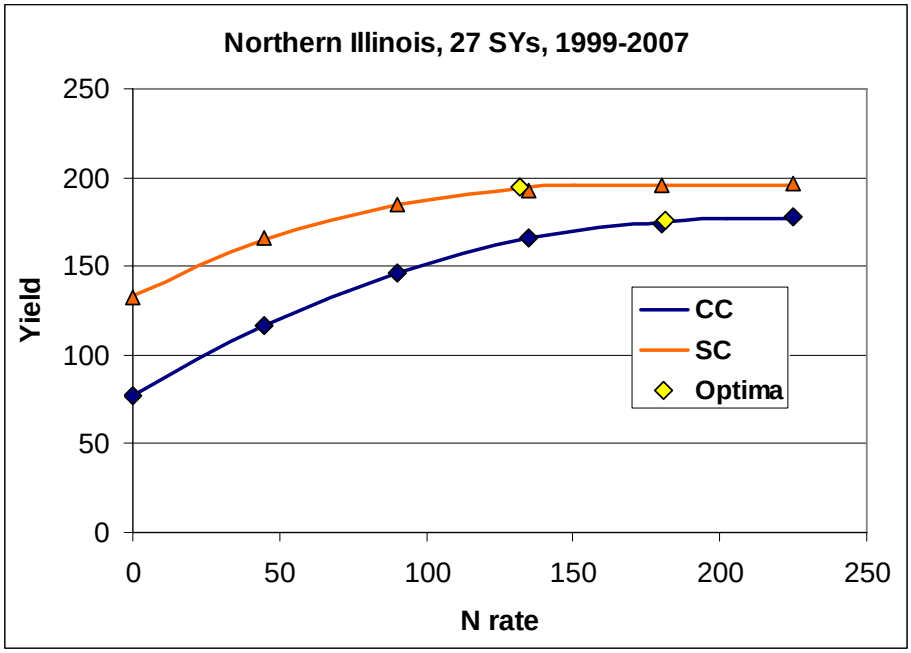

Figure 7. Response N rate of corn following soybean and corn following corn over 27 northern Illinois trials at three locations. Optima are the point where return to N is maximized based on a corn:N price ratio of 0.1.

We will also discuss other possible changes that might be helpful when switching to more corn following corn. Our research to date shows little consistent effect of changes in tillage, planting date, or plant population, though some of these might be expected to vary with different soils. Whether or not hybrids should be changed, or whether hybrids can be specified at “CC-friendly” remains a question, though the RWBt trait does seem to be of value.

Corn-Corn-Soybean

For those who will continue to grow 30% to 40% of their acreage in soybean, the question remains whether it's better to grow continuous corn on some acres and rotate the rest, or to use a corn-corn-soybean rotation on most or all fields. We have an experiment under way in Illinois in which we are comparing continuous corn with corn-soybean and corn-corn-soybean rotations. As we noted above, 2007 was a very good year for continuous corn in Illinois, and that showed in this study (Table 1). Over four years and three locations, corn following soybean yielded the same in both the 2-year and 3-year rotation, while the second year of corn in the CCS rotation yielded slightly (the difference was not statistically significant) more than continuous corn. Soybeans benefited from rotating with two years of corn instead of one, with yielding about 3 bushels more. Depending on production cost and crop prices, the CCS rotation might be a reasonable one, but any yield advantage to having 2/3 of acres in a CS rotation and the other third in continuous corn, compared to CCS on all acres, are modest. Results of this work in southern Illinois were similar, expect[[except?]] that the difference was not statistically significant and 2nd-year corn in CCS yielded about the same as corn following soybean, for reasons that are not clear.

Table 1. Yields in a corn-corn-soybean rotation experiment at three northern Illinois locations, 2004-07.

	DeKalb		Monmouth		Urbana		Average
Crop/Rotation	**2004-06**	**2007**	**2004-06**	**2007**	**2004-06**	**2007**	**2004-07**
Corn rotation							
Continuous corn	174	190	169	223	170	181	178
Corn-soybean	207	205	196	228	178	184	197
1st-year corn in CCS	207	215	195	224	174	181	196
2nd-year corn in CCS	191	196	172	224	170	184	184
Significance:	**	**	**	NS	NS	NS	*
Soybean rotation							
Corn-Soy	55.0	43.6	57.0	51.9	57.3	55.0	54.9
Corn-Corn-Soy	57.9	46.0	62.1	58.6	59.6	56.5	58.3
Significance:	*	NS	*	NS	NS	*	*

Corn-Soybean-Wheat

The last option we'll consider is a 3-crop rotation involving corn, soybean, and wheat. While wheat acreage in Indiana and Illinois has not been increasing, current wheat prices have stimulated more interest in the crop. Wheat also has the advantages of providing income during the summer and of providing a place to install tile, haul manure, or establish legumes after harvest, and it is very effective in limiting soil erosion.

About 10 years ago we initiated a study with continuous corn, continuous soybean, corn-soybean, corn-soy-wheat, and corn-wheat soy rotations, all with and without tillage, at two locations in western Illinois. Six-year averages showed that tillage produced consistently higher

corn yields. Corn yields were similar in CS, CSW, and CWS rotations, averaging almost 20% more than continuous corn (Figure 8).

In contrast, tillage slightly reduced the yield of rotated soybean. Continuous soybean yielded surprisingly well, within about 2 bushels of soybean rotated with corn. Soybean yield was increased slightly in the 3-year rotation with corn and wheat compared to the 2-year rotation with corn. Wheat yields were about the same whether wheat followed corn or soybean when tillage was done, but no-till yielded less than tillage when wheat followed corn (Figure 8).

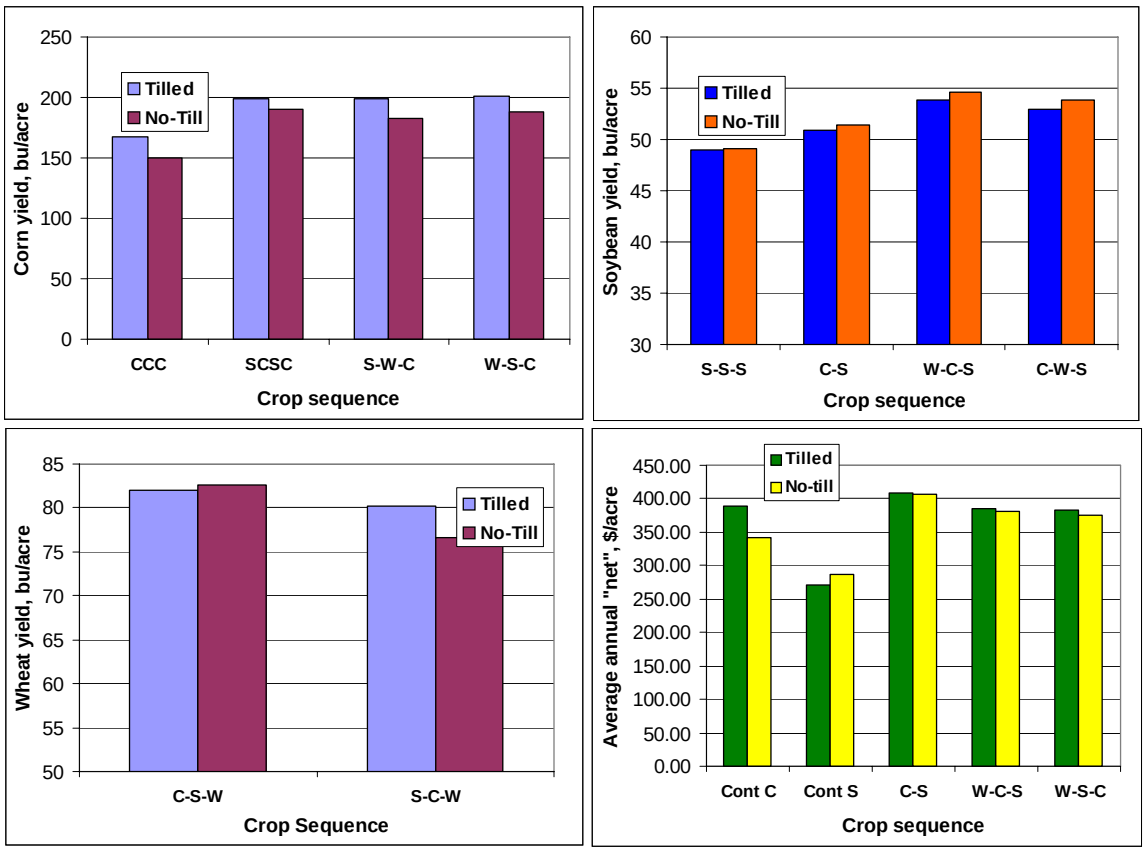

Figure 8. Response of corn, soybean, and wheat yields and net income for a crop rotation by tillage study at Perry, in western Illinois, from 2001 through 2006.

We calculated net return in these cropping systems using $3.75, $8.00, and $5.25 as the prices of corn, soybean, and wheat, and (variable) production costs modified from the Illinois FBFM records. Tillage was assigned a cost of $10 to $15 per acre, depending on rotation and crop. Using these costs and prices, the corn-soybean rotation was slightly more profitable than the 3-crop rotations, which produced a return about equal to that of continuous corn with tillage. No-till, continuous corn lost yield and income, while continuous soybean produced the lowest return of all the systems. Raising the soybean price to $10.00 and wheat to $6.00, and lowering corn to $3.50 per bushel made the 3-crop rotations about the same profitable as the corn-soybean rotation, and increased the return from continuous soybean above that from continuous corn. While these results will change as crop prices change, it appears that it is important to keep corn in the field as often as possible, as long as that can be done without loss of yield, and as long as its price remains relatively high compared to other crops we can grow.