

## Cropping Systems Research at ISU: More than the Sum of the Parts

Rick Exner, Dec., 2005

### *Background*

Lengthening the crop rotation and/or transitioning to a sustainable system like organic brings both economic rewards and challenges. Can weeds be controlled? Will the crops have adequate fertility? Will yields and prices received justify the production costs? These questions can best be answered in field-scale, long-term studies.

### *Objectives*

- 1) LTAR (Long-term agroecological research) at the Neely-Kinyon Farm: compare production, economics, and other characteristics of a conventionally-managed corn-soybean system to several longer rotations managed organically.
- 2) Crop Rotation Study at the ISU Marsden Farm: evaluate production, economics, and other characteristics of a conventionally-managed corn-soybean system (broadcast herbicide, fixed nitrogen rates) to several longer rotations managed with banded herbicides and testing-based nitrogen applications.

### *Results*

- 1) LTAR: Organic systems have been more profitable than the conventional corn-soybean system. Despite increased labor requirement, the organic system profits are more sensitive to compost cost than labor cost.
- 2) Crop Rotation Study: Three years of economic results show the longer rotations with reduced inputs are economically competitive. Three years of production data suggest the longer rotations are gradually reducing the need for purchased N. The number of foxtail and velvetleaf seeds in the soil is declining, in part for an unexpected reason.

PFI field days in 2005 have provided opportunities for two cropping systems research projects at ISU to showcase their findings. One of these projects is completing its eighth year, while the other is only finishing year four, but both are demonstrating that the whole of a system is more than the sum of its parts. That might not surprise you, but some of the findings may.

Kathleen Delate, director of ISUs Organic

Table 1. Average yields by crop and rotation, 1999 – 2004, Greenfield LTAR

Rotation/Crop	– bu or T/acre –
<b>Corn-soybean</b>	
Corn	155
Soybean	41
<b>Corn-soybean-oat/alfalfa (organic)</b>	
Corn	141
Soybean	42
Oat	95
<b>Corn-soybean-oat/alfalfa-alfalfa (organic)</b>	
Corn	142
Soybean	43
Oat	94
Alfalfa	2.8

Data from Delate, Chase, and Turnbull.

Agriculture program, has a long history with the Neely-Kinyon Research Farm, in Greenfield. Since 1998, Kathleen's LTAR (Long-Term Agroecological Research) project has compared a corn-soybean, conventional cropping system to several longer rotations under organic management. These systems are evaluated in plots large enough to work with standard field equipment, and each crop in the different rotations is grown each year.

One obvious question, at least at the beginning, was yields. As Table 1 shows, soybean yields in the organic system are holding their own with those in the conventional, corn-soybean system, and organic corn yields are not far behind conventional corn. In fact, there are years in which yields flip-flop and the organic corn yields more. The concerns with the organic systems would typically be fertility and weeds. Crop nutrient needs in the organic systems have been managed through composted swine manure and the nitrogen-fixing alfalfa crops. Weeds have been managed through timely field operations, including some hand labor – and through the rotations themselves.

As you might expect, organic premiums do not hurt the alternative rotations at all. Table 2 shows returns by rotation and by crop within rotation before figuring in the costs for land, labor, and management. Of course “individual mileage may vary,” but these results do show what organics can do for the bottom line.

In a paper covering the years 1999-2001 of the study, Delate et al.<sup>1</sup> observed that the organic rotations were more profitable than the conventional corn-soybean system even without the organic premiums. And although more labor was required in the organic systems, they remained more profitable than the conventional system even at high rates of wage labor. What the organic systems were most sensitive to was the cost of compost.

Table 2. Average returns to land, labor and management, 1999 – 2004, Greenfield LTAR  
Rotation/Crop – \$ per acre –

<b>Corn-soybean</b>		
Corn		116
Soybean		109
Rotation		113
<b>Corn-soybean-oat/alfalfa (organic)</b>		
Corn		361
Soybean		435
Oat		130
Rotation		309
<b>Corn-soybean-oat/alf-alfalfa (organic)</b>		
Corn		400
Soybean		448
Oat		124
Alfalfa		208
Rotation		295

Data from Delate, Chase, and Turnbull.

<sup>1</sup> Kathleen Delate, Michael Duffy, Craig Chase, Ann Holste, Heather Friedrich, and Noreen Wantate. An economic comparison of organic and conventional grain crops in a long-term agroecological research (LTAR) site in Iowa. At <http://extension.agron.iastate.edu/organicag>

Closer to the middle of the state, a crop rotation experiment led by Matt Liebman has completed four years at the ISU Marsden Research Farm, west of Ames. The three rotations included in the study are: corn-soybean; a three-year corn-soybean-triticale/red clover sequence; and corn-soybean-triticale/alfalfa-alfalfa. Crop outputs are priced the same across rotations.

The researchers were fairly cautious about reducing inputs, but by 2005, the late spring soil nitrate test was recommending less fertilizer N, and the yields of corn and soybeans in the three- and four-year rotations actually surpassed those in the corn-soybean rotation. Table 3 shows average yields over 2003-2005.

Table 4 shows that at the Marsden Farm the two-year and four-year rotations have performed best on average, trailed slightly by the three-year corn-soybean-triticale/red clover rotation. Several factors combine to make the results of this crop rotation study slightly different than those of the LTAR. Row crop yields have been excellent in central Iowa the past three years, favoring the corn-soybean rotation. A different set of grain prices were assumed (see Table 5), and of course organic premiums were not part of the picture. Moreover, when LTAR takes away the premium, the organic rotation still performs well in part because it is truly low input. While the three- and four-year rotations at the Marsden Farm are trending toward lower inputs, they still are based on testing-based nitrogen and banded herbicides in row cropping years. Based on tentative 2005 prices, for the first time both the three-year and the four-year rotations outperformed the two-year crop rotation.

Table 3. Average yields by crop and rotation, 2003-2005, ISU Marsden Farm.  
Rotation/Crop — bu or T/acre —

<b>Corn-soybean</b>	
Corn	199
Soybean	52
<b>Corn-soybean-triticale/red clover</b>	
Corn	207
Soybean	56
Triticale	63
<b>Corn-soybean-triticale/alfalfa-alfalfa</b>	
Corn	207
Soybean	56
Triticale	64
Alfalfa †	4.6

† One full year plus seeding year cutting.  
Data from Liebman and Chase.

Table 4. Average returns to land, labor and management, ISU Marsden Farm, 2003-2005.  
Rotation/Crop — \$ per acre —

<b>Corn-soybean</b>	
Corn	176
Soybean	170
<b>Rotation †</b>	173
<b>Corn-soybean-triticale/red clover</b>	
Corn	220
Soybean	207
Triticale	54
<b>Rotation</b>	160
<b>Corn-soybean-triticale/alfalfa-alfalfa</b>	
Corn	228
Soybean	211
Triticale	42
Alfalfa	286
<b>Rotation</b>	192

Data from Liebman and Chase.

† Greater \$ with Roundup-Ready soybeans.

If the message from the LTAR is that organics represents an attractive economic option for producers who are compatible with that style of farming, perhaps a “bottom line” message of the Marsden study is that even conventionally-oriented growers may be able to benefit from enhanced conservation with a painless transition to longer rotations. Additionally, because herbicides were banded and were used less often than in the corn-soybean system, herbicide use has been reduced 71% and 78%, respectively in the three- and four-year rotations. If nitrogen prices continue to rise, cropping systems that need less energy input per crop output will only look better. And somewhere in the future, systems that protect soil and water may be rewarded as much as those that contribute most to agricultural exports.

Mardsen Farm		Greenfield LTAR	
2003-2005 Avg. Prices †		1999-2004 Avg. Prices	
Corn	\$2.04	\$2.00	Conventional Corn
		\$3.48	Organic Corn
Soybeans	\$6.03	\$5.65	Conventional Soybeans
		\$13.28	Organic Soybeans
Triticale	\$2.04	\$1.85	Organic Oats
Triticale Straw	\$35.00	\$50.00	Organic Oat Straw
Alfalfa	\$84.33	\$100.00	Organic Alfalfa

† Based on tentative 2005 prices.

[Sidebar] *Disappearing Weed Seeds*

The Marsden Farm study is revealing new information about weed dynamics. Farmers may not realize that they have lots of little helpers out there. They do know that even a few weeds can produce enough seeds to thoroughly infest next year's crop. What keeps weed numbers from exploding? A number of scientists working on the Marsden Farm study is finding that the answer is "seed predation." Who's eating the weed seeds? To some extent, insects such as crickets are responsible. But the champion consumers of weed seeds turns out to be – mice and other rodents.

In fact, in 48 hours rodents removed up to 39 percent of velvetleaf seeds and 58 percent of giant foxtail seeds from cards left in the field, according to graduate student Andy Heggenstaller. So although the cropping systems study's three- and four-year rotations are producing tremendous numbers of velvetleaf and giant foxtail seeds, especially in the soybean years, the overall soil seedbank for those weeds has actually declined since the study began in 2002.

In the fall and spring, these beneficial rodents spend most of their time in the forage legumes and small grains, whereas the summer finds them active in the row crops. Seed predation increased with greater distance from the edge of the plots. Professor Brent Danielson suspects that is because the most abundant rodent, the prairie deer mouse, happens to shun the edges of fields. Finally, the four-year rotation at Marsden appears to support more mice than the two-year or three-year rotations. The researchers do not yet know what draws these beneficial rodents to, say, corn or soybeans in the four-year rotation as opposed to the same crops in the two-year rotation. It's another example of the system being more than the sum of its parts.

