United States Department of Agriculture

No-Till Organic

(no, the title is not a misprint)

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Natural Resources Conservation Service Case Study
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Organic Management in Transition

Innovative farmers and researchers have been experimenting with organic no-till systems for over a decade but the vast majority of organic grain is currently produced using traditional tillage systems (sometimes referred to as “old school organic” practices). Joel Gruver, director of Western Illinois University’s Organic Research program and research technician/farm co-manager Andy Clayton are leaders in the development and evaluation of new organic production systems that integrate less tillage, intensified cover cropping, and precision agriculture technologies. Joel and Andy harvested their first organic no-till soybean plots at Western Illinois University's Allison Farm in 2009.

Resource Setting

The Allison Farm is a 77 acre organic research and demonstration farm located in SW Warren County, 18 miles northwest of the main campus of Western Illinois University. The entire farm consists of flat black poorly drained soils (mapped as Sable silty clay loam and Muscatine silt loam). One unusual characteristic of the farm is that Mr. Allison (who farmed the land from the 50’s to 80’s) never adopted conventional farm chemical inputs.

The University began renting the farm as a "Chemical Free" research site in 1989 and early research focused on the mapping of chemical, physical, and biological properties. In 1997, the farm began transitioning to certified organic production and the entire farm has been certified organic since 2009. Cover crop research has been a major focus since 2007.

Changing Directions

Throughout most of the history of agriculture, tillage was the principal means of controlling vegetation as well as other important objectives such as seed bed preparation, sizing of residues, incorporation of amendments and alleviation of compaction. More recently, heightened concern about soil erosion combined with the advent of new technologies (e.g., more effective herbicides and no-till planting equipment) has led to major reductions in tillage on many US farms; but tillage remains a critical tool on most organic farms, including the Allison Farm.

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Steel can be very effective…in steel vs. vegetation, steel usually wins. However, an important downside is that tillage tends to stimulate the germination of new weeds. In addition, mechanical weed control is less effective when soil conditions are excessively moist, and when weeds are growing in the crop row. Methods of controlling weeds that survive early cultivation are sometimes limited to hand rogueing. At the Allison Farm, Joel and Andy have to decide each season how much time can be spent hand rogueing. A few hours of rogueing per acre to clean up a field is generally a good investment. In contrast, a field where the effectiveness of cultivation was compromised by wet weather or improper setting of cultivation equipment may require > 10 hours per acre to remove all weeds. In these cases only certain weeds (e.g., select broadleaves) are targeted for hand rogueing.

Improving Returns

Organic no-till soybean plots were harvested at the Allison Farm in 2009-2012 and 2015-2016 (See Table 1). In all years except for 2012, (an extreme drought year) no-till plot yields were comparable to or greater than conventional tillage plot yields. (the slight difference of 1.4 bushel/acre in 2009 is not significant) This result is counter intuitive to many organic producers as they have always viewed tillage (field prep and post-plant cultivation) as critical for crop establishment and weed control. Tillage can be an effective weed control strategy, but it can crash hard during seasons with weather conditions that interfere with cultivation and/or promote weed growth. In 2016, weed pressure was higher in all soybean plots with tillage than in any of the no-till soybean plots, necessitating significant hand rouging of weeds in all tillage plots.

With organic No-Till into cover crops:

Better weed control. Weed germination in no-till plots is generally very low compared to tilled plots. Suppression of weed germination is likely related to allelopathy (inhibitory compounds released from cover crop biomass) as well a lack of factors that stimulate weed germination (elevated oxygen, light, soil temperature, and nutrient availability).

In addition, weeds that do emerge in no-till plots tend to lack the vigor of the emerging crop (and the vigor of weeds in tilled plots). This low vigor is probably partly due to alleopathic effects of the cover crop but also due to less favorable growing conditions (e.g., lower N availability, lower soil temperatures).

One potential trade-off is that the soybean plants in the no-till plots also get off to a slower start compared to a tillage environment. The cash crop is probably affected by many of the same influences reducing weed growth. After about 30 days however, the soybean plants begin growing vigorously and rapidly develop a canopy, and tend to out compete the weeds.

Greater consistency. After 6 years of testing, no-till soybean yields at the Allison Farm have only came up short once, the drought of 2012. The main issue in 2012 was moisture depletion by the cereal rye which increased soybean drought stress relative to adjacent tillage plots where cover crops were terminated much earlier. In the lower wetter parts of the no-till soybean field (“wet holes”), yields were actually quite good in 2012. Despite the less vigorous crop growth in most of the no-till field, weed pressure was low and relatively little weed “seed rain” occurred. This is very different than the negative legacy (multiple years of high weed pressure) that typically occurs when poor crop growth in tilled field is accompanied by high weed seed production. (It should be noted that no-till soybean plots were not planted at the Allison Farm in 2013 and 2014 because the fields slated for no-till research were not deemed to have acceptable stands of cereal rye to plant into).

With conventional organic:

In tilled fields with a large weed seed bank, it is common for dozens of weeds to emerge per foot of row if no weed control occurs. In 2016, weed counts in a comparison of mechanical weed control practices ranged from 0.3-3 weeds per row foot. This is AFTER normal pre-plant tillage, blind cultivation and row-crop cultivation. Joel notes that with weed pressure this high, even 95% weed control leaves enough weeds to significantly compromise crop yields. By way of comparison, weed germination in no-till plots in 2016 was < 1% of weed germination in tillage plots.

New insights come with new challenges

While Joel and Andy have successfully integrated cover crops and reduced tillage in many plots over the last decade, not all of their results have been positive or consistent. For example, attempts at organic strip-till corn have resulted in high in-row weed pressure and the lowest corn yields on the farm. Radishes have done a good job of scavenging nutrients at the Allison Farm but release of these nutrients has proven to be a moving target, and not always in sync with the needs of following cash crops.

Summary

By applying novel ideas to organic research, Joel and Andy have been able to increase yields, reduce weed pressure, and reduce labor requirements. This is significant not only in terms of research, but its practical application to *organic **AND** conventional* producers who may be looking at cover crops and alternative tillage methods in crop production.

The transferability of these skills between organic and conventional producers are significant, and demonstrates the value of the research, *and more importantly*, its findings, to large and varied audiences. Through their efforts, Joel and Andy have been able to demonstrate that new approaches can yield positive results, and that conservation pays.

No-Till Soybeans in 2016

Table 1: Summary of organic No-till Soybean Yields at the Allison Farm

Year	Field #	Cover Crop Drilled Rate & Date	Soybean Company & Variety	Soybean Drilling Date	Soybean Drilling Rate	Method of Crimping Rye*	No-Till Soybean Average Yields	Conv.-Till Comparative Yields** (fld & plant date)	Notes
2009	2B West	Aroostook Rye @ 60 lbs/a on 8/14/08	BRH 34A7	June 6th	250k/a	Culti-mulcher 1 week prior to drilling beans	**53.8 bu/a**	55.2 bu/ac (fld 2B W/June 5th)	Weed free field
2010	1B	Aroostook Rye @ 98 lbs/a on 9/30/09	BRH 34A7	June 7th	230k/a	1 pass drill	**44.4 bu/a**	37.0 bu/ac (fld 1B/July 4th)	Very wet spring (Too limited on time to crimp)
2011	1A	Rymin Rye @ 100 lbs/a on 9/16/10	BRH 34A7	June 8th	220k/a	15' metal drum crimper after drilling beans	**42.9 bu/a**	33.0 bu/ac (fld 1A control/June 8th)	Very wet spring
2012	3-4	ARF (bin-run) Rye @ 124 lbs/a on 10/8/11	BRH 34A7	May 10th	220k/a	2 pass drilling & 15' metal drum crimper	**34.6 bu/a**	61.2 bu/ac (fld 3-3/June 7th)	Severe drought
2015	4-4	Aroostook (bin-run) Rye @ 65 lbs/a on 9/8/14	BRH 34A7	May 28th	218k/a	2 pass drilling & culti-mulcher	**61.0 bu/a**	57.7 bu/a (fld 4-1,4-2/June 3rd)	Very wet summer (Yields from 4 out of 5 reps)
2015	4-4	Aroostook (bin-run) Rye @ 65 lbs/a on 9/8/14	BRH 39C4	May 28th	213k/a	2 pass drilling & culti-mulcher	**65.1 bu/a**	N/A	Very wet summer (Yields from 4 out of 5 reps)
2016	3-3	Fridge Triticale @	BRH 34A7	May 31st	197k	Culti-mulcher	**70.8 bu/a**	58.5 bu/a	June was very dry and

		76 lbs/a on 9/17/15				just prior to drilling		(fld 3-2/June 3rd)	stunted the growth of the soybeans
2016	3-3	Fridge Triticale @ 76 lbs/a on 9/17/15	BRH 39C4	May 31st	235k	Culti-mulcher just prior to drilling	**70.2 bu/a**	58.2 bu/a (fld 3-2/June 3rd)	June was very dry and stunted the growth of the soybeans

*** Triticale was used as the cover crop, instead of rye, for the study in 2016.**

**** Conventional-till soybeans used as a comparison were not planned to be planted the same day as the no-till soybeans. Instead, they were planted at the time when soil conditions were suitable and after at least one good flush of weeds in the spring.**