Advancing No-till Soybean Production

(Final Report)

Purpose:

This three year study (2003-05) evaluated the use of minimal (shatter) tillage in no-till soybean production systems. No-till production has been adopted on approximately 50% of Ontario soybean acres. Some growers continue to report lower yields in no-till soybean fields compared to conventionally tilled fields. This problem is more frequently reported on heavier textured soils and during difficult growing seasons.

It has been suggested that a low level of pre-tillage prior to planting may improve the seedbed and increase yields while preserving the environmental and economic benefits of a no-till system. A light amount of tillage, approximately 7.5 cm (3 inches) deep may improve the seedbed by aerating, drying and warming the soil while managing previous crop residue.

A traditional disc or cultivator is not ideal for this operation since they cannot effectively handle the residue associated with a no-till system and would require several trips to achieve a level seedbed. These field trips are time consuming, costly, and impractical. A newly designed tillage tool called a RTS (Residue Tillage Specialist) was used in this project to evaluate the potential benefits of shatter tillage. The RTS can be operated at a high rate of speed, 18-20 km/h (12 mph) and be effective with a single pass. It also leaves the majority of residue on the soil surface and does not disturb all the soil, thus preserving most of the benefits of a no-till system.

This study also assessed the value of attaching tillage coulters to a John Deere no-till seed drill for soybean planting. John Deere drills are not equipped with standard coulters. Some producers have reported increased yields when attaching a coulter cart to their no-till John Deere drill. Coulters that operated in the seed row were attached to a 1560 John Deere drill and evaluated at two depths during planting.

Methods:

A Salford RTS (Residue Tillage Specialist) was operated a few days prior to soybean planting to prepare a lightly worked seedbed for planting. The Salford RTS is unique in design and function because the coulters are distributed over the whole equipment frame and not in gangs. They also utilize unique individual suspensions called Coil Tech Coulters. This makes it possible to run over rocky ground without damaging the equipment, as well as turning in the field without lifting the implement. The RTS was operated 1-3 days prior to planting at a speed of approximately 18-20 km/h (12 mph). The RTS was equipped with 4.5cm (1¾-inch) wavy coulters at 18cm (7 inch) spacing along with tine and rolling harrows at the rear (Figure #1). The coulters were operated at a depth of approximately 7.5cm (3 inches).

Figure 1. RTS (Residue Tillage Specialist)

Other treatments in the experiment involved equipping a no-till 1560 John Deere drill with a Yetter coulter cart. One 2cm (¾ inch) wavy coulter was positioned to run in front of each seed row (Figure #2). These coulters were tested at two operating depths: 4cm (1 ½ inches) and 9cm (3 ½ inches).

Figure 2. Yetter Coulter Cart attached to a 1560 John Deere Drill

Treatments evaluated:

1) Standard No-till JD1560 drill (no coulters).
2) Shatter harrow (Salford RTS) operated 1-3 days before planting. No coulters operated on drill.
3) No-till JD1560 drill utilizing in-row tillage (2 cm [¾ inch] coulters) set at planting depth (4 cm [1 ½ inches]).
4) No-till JD1560 drill utilizing in-row tillage (2 cm [¾ inch] coulters) set deeper than planting depth (9 cm [3 ½ inches]).

Over the three year study period, 40 field scale trials, each with two replications, were established in the following counties: Huron, Perth, Waterloo, Wellington, Middlesex, and Lambton. The majority of plots were planted into corn stalks, which is the most common crop rotation in Ontario. Five were planted into soybean stubble, one trial into mustard and one was planted into winter wheat stubble.

Results:

The following tables present the plant stand and yield data collected from these sites.

Table 1: Tillage System Impacts on Average Soybean Plant Stand. Results from 40 Site Years (2003-2005)

Treatment	Mean plants/ha (plants/ac)**	
No-till	409,675 (165,793)	a
Salford Residue Manager (RTS)	420,091 (170,818)	a
Drill Coulters Shallow (1.5")	416,005 (168,355)	a
Drill Coulters Deep (3.5")	410,964 (166,315)	a

**Values followed by the same letter are not significantly different at the 5% level.

The average population counts across all sites showed no statistical difference in plant stands between treatments. However, at a few sites an increase in plant stands was observed where the RTS was operated and a plant stand decrease resulted from operating the drill mounted coulters at 3.5 inches.

Table 2: Tillage System Impacts on Soybean Yield. Results From 40 Sites Over Three Years (2003-2005)

Treatment	Mean t/ha (bu/ac)**		Advantage kg/ha (bu/ac)
No-till	3.03 (45.1)	c	
Salford Residue Manager (RTS)	3.15 (46.9)	a	2.02 (1.8)
Drill Coulters Shallow (1.5")	3.05 (45.4)	c	0.34 (0.3)
Drill Coulters Deep (3.5")	3.09 (46.0)	b	1.01 (0.9)

**Values followed by the same letter are not significantly different.
Least Significant Difference (P = 0.05) = 0.4
Where the difference between two treatments is more than 0.4 bu/ac there is a less than 1 in 20 chance that it is due to random variation.

Summary:

Operating the RTS 1 to 3 days prior to planting showed a statistical yield advantage of 1.8 bu/ac across all the trials over the three years. This improvement represents a 4.0% yield increase compared to the straight no-till system. This is a sizable yield improvement, considering that previous tillage research conducted in Ontario has only demonstrated a 2 - 5% yield advantage to conventional tillage (fall moldboard plow) compared to a no-till soybean system. Fields ranged in their response to RTS tillage from 0 bu/ac to as high as 4.8 bu/ac.

Operating coulters attached to the John Deere drill deeper than planting (9cm [3 ½ inches]) also resulted in a statistical yield advantage. Coulters operated at this depth resulted in a 0.9 bu/ac advantage over the straight no-till operation. Operating the coulters attached to the John Deere drill at planting depth did not result in any statistical yield advantage over the straight no-till operation.

The four treatments in this trial can be ranked as follows: The highest yield occurred with the RTS unit run prior to planting, the second highest yield resulted from the deep operation of the drill mounted coulters, while the lowest statistical yield resulted from the straight no-till operation and running the coulters at planting depth. When operating coulters on a John Deere drill, this study would suggest that for maximum yield, coulters must be operated below planting depth. These results run contrary to the notion that coulters should be operated at planting depth on a no-till drill during planting. It should be noted that when running the coulters deeper than planting depth a reduction in plant stand can occur. Nevertheless, this reduction in plant stand did not affect yield, as soybeans are able to compensate for this reduction in stand by plant branching.

The spring of both 2003 and 2004 were relatively wet while the spring of 2005 was extremely dry. Interestingly, tillage treatments responded similarly for all three years. The previous crop did not have a statistically significant impact on the results of the tillage. The treatments behaved in a similar fashion regardless of year or previous crop.

Next Steps:

This study suggests that the 1-3 bu/ac yield difference between conventional tillage and no-till can largely be captured by a single one-pass springtime pre-tillage operation. Further studies will need to be undertaken to verify that the yield benefits of pre-tillage are similar to full conventional tillage, since a fall plow treatment was not part of these large scale trials.

Acknowledgements:

Special thanks to all those who participated in the project:
- The SCIA members that helped conduct the trials,
- The Heartland Regional SCIA which initiated this study,
- Salford Farm Equipment for providing the Salford Residue Manager (RTS),
- Middlesex Soil & Crop Improvement Association for making available their no-till drill,
- Podolinsky Equipment for providing a tractor at a reduced cost.

Project Contacts:

Stay tuned for future results and contact Horst Bohner, horst.bohner@omaf.gov.on.ca if you wish to be involved in 2006.