Feasibility of One-pass Tillage Systems for Corn and Soybeans

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Introduction

Conservation tillage has many advantages in terms of efficiency, soil erosion control and cost savings. These have been documented in numerous studies. However, there is a continuing perception that, in cooler climates, reduced tillage and/or no-till lead to delayed planting, reduced plant stands and reduced yields in corn. These perceptions have slowed the adoption of conservation tillage systems in Indiana, particularly in the northern part of the state.

Chisel plowing is the most common tillage system for corn following soybean and continuous corn in Indiana. Farmers who chisel usually perform one or two passes of secondary tillage to obtain a suitable seedbed. Reasons for this include the rough soil surface and uneven residue distribution. Multiple passes of primary and secondary tillage comes at a high cost in fuel, labor and machinery. These practices often do not leave enough residue cover (30% or more to be rated as conservation tillage) for protection from soil erosion, especially following soybeans.

To fully explore a range of tillage system/crop residue relationships, a "one-pass" high clearance tillage implement was used in this study. We investigated timing of field operations, and equipment configurations in one-pass tillage systems that might permit sufficient residue cover for erosion control while resulting in satisfactory yields. Current two-pass or three-pass tillage treatments could be replaced with one-pass treatments that - if proven successful - could save farmers fuel, labor and machinery costs.

Site and Study Description

This study was conducted from 1999 to 2001 on a poorly-drained Sebewa loam soil at the Pinney Purdue Agr Center near Wanatah Indiana. Cultural practices other than tillage were held constant through the study.

Combination Tillage Tool Description

The Case-IH Combo-mulch Finisher 4400 combination tillage tool (see photo) had front disk gangs with adjustable depth and angle, plus 5 rows of 9-inch sweeps on 6.7-inch spacing; sweeps were mounted on either Vibra®Chisel or Vibra®Edge shanks. The Vibra®Chisel shanks are similar to the shanks on a conventional chisel plow while the Vibra®Edge are more like shanks found on a field cultivator. Leveling attachments included the use of 3-bar spike-tooth harrow with double rolling baskets or 5-bar spike-tooth harrow with a single rolling basket. Adjusting the gang angle and varying the depth achieved aggressive disk settings. Treatment descriptions are found in Table 1.

Combination tillage tool in soybean stubble.

Continuous Corn

Trends evident from the three-year averages found in Table 2 are:

- Single pass cultivation systems are successful in continuous corn.
- A single pass of the combination tillage tool with the Vibra®Chisel shanks in the fall followed by stale seedbed planting was at least as good as the same one-pass system in spring.
- All one-pass configurations of the combination tillage tool left sufficient residue to reduce soil erosion.
- Overall, the attachments used on the combination tillage tool did not result in substantial differences in residue cover or corn response.
- Aggressive disk settings on the combination tillage tool did not reduce residue cover in corn after corn.
- There appears to be no grain yield advantage for primary tillage before the combination tillage tool. The key advantages for using the combination tillage tool without prior chiseling include higher residue cover, fewer passes and less cost.
- There was a significant 12 to 17 bushel/acre yield advantage with the combination tillage tool, relative to no-till in continuous corn.

Corn following Soybeans

Some trends are also evident in the two-year averages for corn following soybeans (Table 3):

- One-pass cultivation systems are successful in corn following soybeans for grain production, but do not leave enough residue cover to adequately protect the soil from erosion.
- There appears to be no advantage for primary tillage before the combination tillage tool.

- Disengagement of the disk gang with Vibra®Edge treatment did not influence corn response following soybeans.
- Strip-till not only yielded higher than no-till, but also left enough residue to protect the soil from erosion.
- Fall operation of the combination tillage tool was superior to spring operation following soybeans.
- There was a significant 5 to 6 bushel/acre advantage with the combination tillage tool equipped with Vibra®Chisel shanks relative to no-till.
- In the stale seedbed systems the combination tillage tool with Vibra®Chisel shanks resulted in a 5 bushel/acre yield advantage relative to tandem disking. Therefore, a combination tillage tool may be preferable to disking in fall.
- No-till grain yields were 3.5% lower than the highest full-width tillage system.

Soybeans following Corn

The two-year averages for soybeans following corn (Table 4) suggest the following:

- All one-pass configurations of the combination tillage tool left sufficient residue to reduce soil erosion.
- There appears to be no advantage for primary tillage before the combination tillage tool.
- Some form of tillage improved soybean yields compared to no-till, although not all were significantly higher.
- There was a significant 5 bushel/acre advantage with 2 configurations of the combination tillage tool relative to no-till.
- The VE3BDR treatment and the conventional chisel followed by VE3BDR treatment, with perhaps the best seedbeds, yielded the highest.

Overall Conclusions for One-pass Tillage Systems

- Of the shank alternatives investigated, the Vibra®Chisel resulted in consistently higher levels of surface residue cover, and a tendency to higher yields of both corn and soybeans than the Vibra®Edge shanks.
- One-pass cultivation was as good as, or slightly better, than a two-pass system (chisel plowing plus secondary cultivation) in terms of yield, and superior in terms of residue cover.
- A system based on a combination tillage tool in fall followed by spring stale seedbed planting may be as good as conventional tillage for corn, and leave more residue cover. The combination tillage tool may also prove to be superior to fall disking for stale-seedbed planting systems.
- No significant differences in residue cover were observed among harrow attachments, or in disk settings on the combination tillage tool.
- Fall operation of the combination tillage tool was consistently as good as, or superior, to a single pass in spring.

Table 1. Tillage equipment abbreviation.

Equipment		Abbreviation
Shank:	Vibra®Edge	VE
	Vibra®Chisel	VC
Spike tooth harrow:	3-bar	3B
	5-bar	5B
Rolling basket:	Single	SR
	Double	DR
Example: VE3BDR = Vibra®Edge + 3-bar spike tooth harrow + double rolling basket		

Table 2. Continuous Corn, 1999-2001.†

Tillage Treatment (Ranked by yield)	Residue cover after planting	Grain yield at 15.5%
	%	Bu/a.
Fall VC5BSR, stale seedbed	47	150.6*‡
Spring VE3BDR, minimal disk	41	148.2*
Fall conv. chisel, VE3BDR	27	148.0*
Spring VE5B	48	147.3*
Spring VE5BSR	48	146.8*
Spring VC5BSR	47	146.8*
Spring VE3BDR	46	145.7*
Spring VE (no attachments)	43	145.5
Spring VE3BDR, aggressive disk	47	145.2
No-till with row cleaners	82*	133.2
LSD (5%)	7	4.9

†Average of 4 replications. ‡Means followed by an * are not significantly different from the highest mean in that column.

Table 3. Corn Following Soybeans, 2000-2001.†

Tillage Treatment (Ranked by yield)	Residue cover after planting	Grain yield at 15.5%
	%	Bu/a.
Fall VC5BSR, stale seedbed	23	159.9*‡
Fall VC5BSR, spring VE5BSR	13	159.6*
Fall strip-till 8 inches deep	36	158.9*
Fall Conv. chisel, spring VE5BSR	10	157.4*
Fall disk, spring VE5BSR	17	156.8*
Spring VE5BSR (raised disk)	18	155.4*
Fall disk, spring stale seedbed	19	155.1
Spring VE5BSR	22	154.6
No-till with row cleaners	67*	154.2
LSD (5%)	6	4.8

†Average of 4 replications. ‡Means followed by an * are not significantly different from the highest mean in that column.

Table 4. Soybeans Following Corn, 2000-2001.†

Tillage Treatment (Ranked by yield)	Residue cover after planting	Grain yield at 13.0%
	%	Bu/a.
Spring VE3BDR	45.6	55.5*‡
Fall conv. chisel, VE3BDR	23.5	55.0*
Spring VE3BDR, aggressive disk	45.0	53.2*
Spring VE (no attachments)	43.3	53.0*
Spring VE3BDR, minimal disk	38.6	52.8*
Spring VC5BSR	43.2	52.6*
Spring VE + 5-bar	40.9	51.4*
Spring VE5BSR	43.7	50.5
No-till	74.3*	49.2
LSD (5%)	11	4.7

†Average of 4 replications. ‡Means followed by an * are not significantly different from the highest mean in that column.

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