Impact of Shallow Vertical Tillage on Soil Disturbance and Crop Residue

K. Klingberg and C. Weisenbeck

University of Wisconsin – Discovery Farms Program,
Pigeon Falls, WI and Agronomic Consulting, Inc., Durand, WI

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Introduction

- Wisconsin farmers have begun using a new generation of vertical tillage implements designed to conduct shallow tillage and distribute crop residue better.

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- These machines cause minimal soil inversion.

- Main working component is a set of straight and/or wavy coulters, directing soil disturbance downward in slots, a couple of inches wide by a couple of inches deep.

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- Some corn producers have become interested in shallow vertical tillage because current high yielding hybrids have stalks that slowly decompose due to genetic enhancements for insect resistance.

- High levels of previous year corn residue in 1-pass no-till planting systems can lead to corn yield dip due to cool wet soils, slow seed germination and the physical challenges of planting into previous year(s) crop residue.




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- Many crop consultants and farmers recognize the value of conducting a small amount of tillage to size previous season residue, condition the seedbed, and incorporate livestock manure, lime or other nutrients.
- Some farmers are considering replacing their no-till planting system with a 1-pass shallow vertical tillage + plant system.
- Tillage is not “no-till”.

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Study

- Wisconsin farmers and their commodity groups have requested that the soil and water conservation impacts of vertical tillage implements be studied.

- The UW-Discovery Farms Program conducted a 1-year study on 14 crop fields on 5 western WI farms (spring 2010) to explore questions about soil and water conservation features of vertical tillage implements.

- Field data was collected on surface residue remaining and soil disturbance after 1-pass shallow vertical tillage operations.

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Methods

- Participating farmers used their own vertical tillage implement, operated at usual speed and depth (Fig. 1-3).

- All implements had 2 gangs of forward-facing non-concave blades, either straight or waved, along with rear attachments. Blades were spaced at 10 inches, with the back gang off-set from the front by 5 inches. These machines created slices of disturbed soil in the same direction of travel, every 5 inches.

Figure 1

Great Plains Turbo Till with rolling spike and reel (TT).

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Figure 2

Summers Supercoulter Plus with rolling spike and reel (SCP1).

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Figure 3

Summers Supercoulter Plus with rolling chopper (SCP2).

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- The line-transect method was used to estimate % crop residue cover.

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- Soil disturbance was evaluated using parameters of the NRCS Soil Tillage Intensity Rating (STIR).

- Trenches were dug perpendicular to tillage travel line to measure individual coulter tillage depth and width, as well as associated non- disturbance areas.

- 3 representative C-slope soils were used to compare NRCS RUSLE2 soil loss predictions for 3 tillage systems through a 6-yr corn and hay crop rotation.

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White pins = coulter depth, middle

Colored pins = associated width

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Results

- Soil disturbance and remaining surface residue after 1-pass shallow vertical tillage varied by field and farm based on soil type, machine blade / rear attachment characteristics and operating depth (Table 1).

- Deeper operation, aggressive machinery, and sandier soil resulted in more soil disturbance and less surface residue.

Table 1. Crop residue remaining and soil disturbance after 1-pass shallow vertical tillage

Farm	Soil	Implement *	2009 Crop	Residue (%)	Tillage Depth (inches)	Tillage Width (inches)
Go1	silt loam	TT	cgr	90	1.5	1.5
Go2	**loamy sand**	**TT**	**sb**	**75**	**2**	**2**
Go3	sandy loam	TT	cgr	90	1.5	2
Go4	silt loam	TT	cgr	94	1.5	1.5
Go5	silt loam	TT	cgr	90	1.5	1.5
Gr1	silt loam	TT	cgr	90	2.5	3
Cr1	**loamy sand**	**TT**	**cgr**	**70**	**2.5**	**2**
Cr2	loamy sand	TT	cgr	75	2.5	2
Ha1	loam	**SCP 1**	cgr	69	2.5	3 / 1
Ha2	f s loam	SCP 1	cgr	88	2.5	3 / 1
Ha3	silt loam	SCP 1	cgr	86	2.5	3 / 1
Ol1	silt loam	**SCP 2**	cgr	78	3	3 / 1
Ol2	f s loam	SCP 2	cgr	76	3	3 / 1
Ol3	silt loam	SCP 2	cgr	78	3	3 / 1

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* TT = Great Plains Turbo Till. * SCP 1 = Summers Supercoulter Plus with Turbo Till rear attachment.

* SCP 2 = Summers Supercoulter Plus with rolling chopper rear attachment

- In general, on silt loam soil, conservative 1-pass shallow vertical tillage created slices through the field such that every five inches of field width has a two inch wide by two inch deep coulter tilled area and three inches of width disturbed only by rear attachments. (Fig. 4,5).

Figure 4. Soil disturbance from SCP1 machine

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Conservative shallow vertical tillage can result in 40% of field coulter tilled to a two inch depth, while 60% remains untouched by coulters, disturbed only by rear attachments.

2” of 5” width disturbed by coulter + rear attachment.

3” of 5” width disturbed only by rear attachment.

Influenced by depth, speed and machine characteristics.

Figure 5. Soil disturbance from TT machine

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- Old Roots. 1-pass shallow vertical tillage maintained significant amounts of prior year corn plant roots, intact, anchored and still in place, post tillage. Regardless of soil type, 22,000 – 25,000 in-place corn roots per acre were observed.

Prior year – dead - root biomass has soil quality and soil & water conservation value:

Decomposing OM occupying undisturbed macropores.

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- 1-pass shallow vertical tillage did not bury much residue, yet residue was sized smaller to move through high residue planters, leaving 75 - 80 % of previous corn residue in place, after planting.

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- Tandem disks create complete lateral soil movement, compared to limited lateral soil movement and high residue maintenance for 1-pass shallow vertical tillage.

Tandem Disk Soil Disturbance

Shallow Vertical Tillage Soil Disturbance

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- NRCS - RUSLE2 soil loss model offers implements within its field operations database for shallow vertical tillage machines.
  - Referred to as Seedbed Conditioners, and are a combination of:
    - **coulter caddy +/-**
    - **Harrow (coil tine or rotary or spike) +/-**
    - **rolling basket.**
  - Conservation planners choose the seedbed conditioner combination most appropriate to the vertical tillage implement being used by the producer they are working with.
  - All of these implement components, plus others, are listed individually within the RUSLE2 field operations database and can be chosen to create an ala carte tillage operation - based on machinery characteristics, crop residue and soil disturbance.

Choosing RUSLE2 field operation for shallow vertical tillage implements

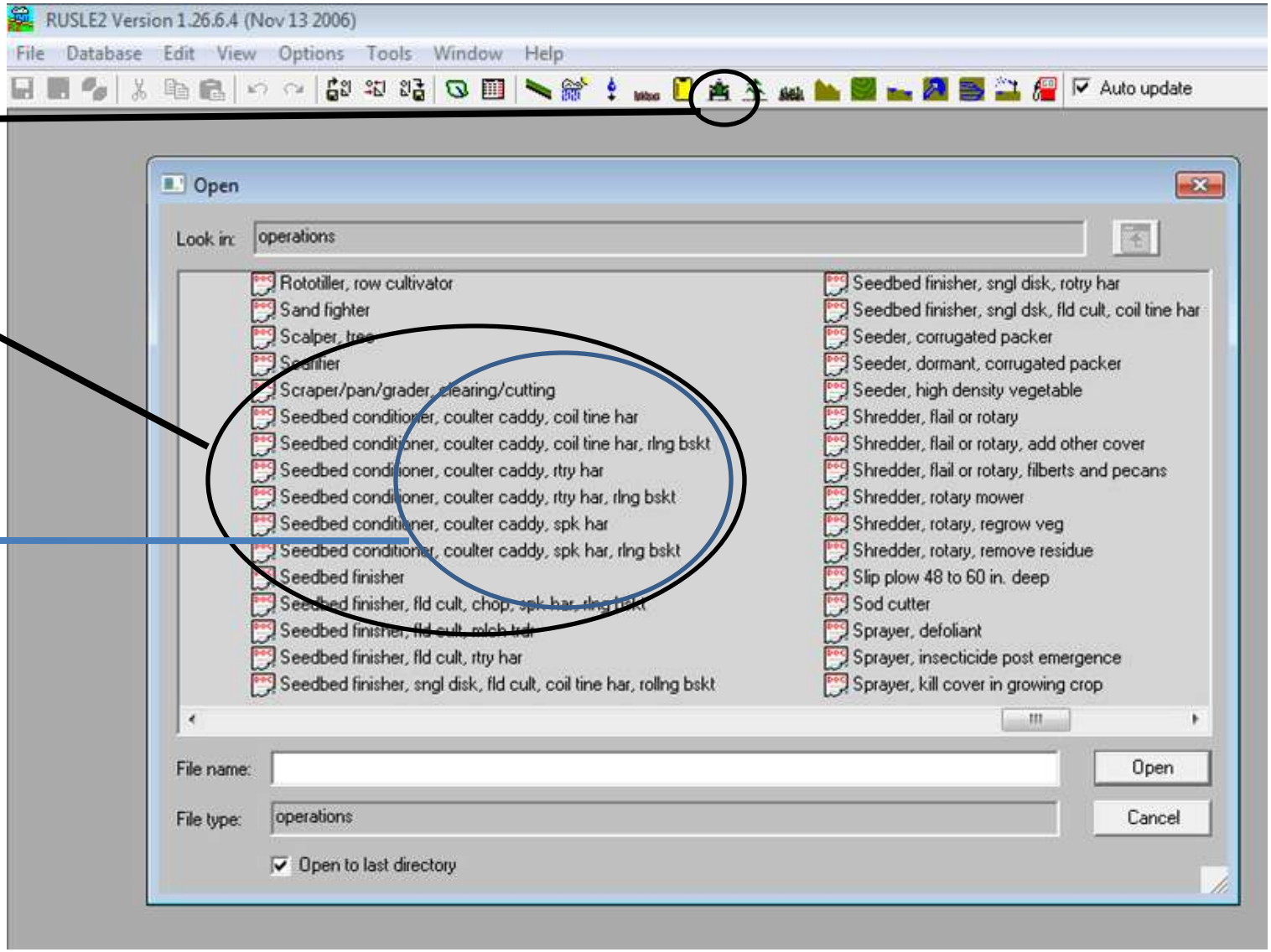
1. In RUSLE2, open "operations" (tractor on tool bar)

2. Scroll to "seedbed conditioner".

3. Pick coulter caddy + similar rear attach.

Coil tine, rotary or spike harrow.

With or without rolling basket.



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Using NRCS-RUSLE2 soil loss model to compare 3 tillage systems through a 6 yr corn and hay crop rotation, (Cgr – Csl – Alf / Gr – H – H - H) RUSLE2 predicts:

Table 3

Soil loss estimates for 3 tillage systems using RUSLE2 through a 6-year corn and hay crop rotation

Soil	T	No Till	Shallow	Disk + Field
			Vertical	Cultivate
		*******	(tons/ac/yr)	*******
BlC2	4	0.5	2.7	3.0
DdC2	5	0.9	4.8	5.3
ElC2	3	0.6	3.0	3.3

Vertical till and disk + field cult. systems <u>both</u> have 4-6 times more predicted soil loss than no-till.

Vertical till had <u>only</u> ~ ½ ton less predicted soil loss, compared to a disk + field cult. system.

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Conclusion

- It was interesting to observe how minimal soil and residue disturbance was after 1-pass shallow vertical tillage, compared to traditional implements with similar designs and characteristics.

Conclusion

- Two observations from within this project need additional study:
  - 1) Prior Year Roots. What is the soil quality and conservation value of maintaining intact prior year root systems after 1-pass shallow vertical tillage?
  - 2) Soil Loss Prediction. Is in-field soil loss really so closely comparable between shallow vertical tillage + planting systems and tandem disking + field cultivating + planting systems?

Conclusion

- In cropping scenarios where the desired rotation depends on very limited or no tillage in order to maintain conservation compliance, conservative 1-pass shallow vertical tillage might be an option, on a site specific basis.

- Conservative and shallow are key phrases when considering the use of these implements on cropland landscapes that have high soil loss potential.

- As soon as producers begin making 2 or more passes with vertical tillage implements prior to planting, similarities with tandem disking become more apparent as soil disturbance increases.

Future Research Needs

- Additional studies should be initiated to evaluate the impact / effectiveness of shallow vertical tillage for:
  - Minimizing soil loss
  - Water infiltration
  - Fertilizer, lime and manure incorporation
  - Use on tile drained preferential flow – critical sites

- An updated WI Crop Management Conference proceedings paper that accompanies this presentation is available. Send e-mail if interested: Kevan.klingberg@ces.uwex.edu

- Final factsheet for this project, Spring 2011.

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Kevan Klingberg

UW-Discovery Farms Program

Kevan.klingberg@ces.uwex.edu

Curtis Weisenbeck

Agronomic Consulting, Inc

cew@nelson-tel.net

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www.uwdiscoveryfarms.org