IS VERTICAL TILLAGE A PRACTICE FOR WISCONSIN SOILS?

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Introduction

The interest in "vertical tillage" management has increased throughout the grain production region of the US in the past several years. The perception exists that certain traditional tillage practices create compacted layers and may reduce soil quality relative to crop production. These layers basically restrict root development into the soil; whereas vertical tillage systems "open up" the soil to better root growth down into the soil. Many companies now promote their tillage equipment as vertical tillage implements. However, it is likely that the practice means different things to different people. It has been suggested that vertical tillage could be conducted shallow, at a depth of 3 to 4 inches using tools that are equipped with specialized disks or harrow attachments or deep to depths well beyond 12 inches using subsoiling-like knives that create slots and do not invert the soil.

Perhaps it is easier to describe what is understood to not be vertical tillage (i.e., horizontal tillage). Such practices are those that shear the soil horizontally using a moldboard plow, field cultivator, or similar tools designed to cut and lift the soil often across the full tillage width. A chisel plow equipped with sweeps could be considered a horizontal tillage tool, while the same implement with straight points would provide vertical tillage. The principal effect is that there is a downward force associated with their operation that compresses the soil underneath as it cuts and lifts the soil, thereby creating a tillage pan. According to Dr. Randall Reeder, an agricultural engineer at The Ohio State University, negative factors associated with horizontal tillage practices include surface soil compaction, poorer root growth, increased erosion potential, and greater energy requirement to prepare a seedbed.

An abstract from a patent application for a vertical tillage tool by a prominent US company provides the following description. *"A vertical tilling implement to be pulled behind an agricultural vehicle having a number of gangs of fluted-concave disc blades, rolling baskets, and wheels connected to a main frame. As the vertical tilling implement is pulled, the fluted-concave disc blades move the soil in a direction lateral to the side of the blades as well as up. Meanwhile, the rolling bars aid in leveling the seedbed and crushing the remaining large pieces of soil. The vertical tilling implement reduces the amount of subsoil compaction and cuts through heavy residue making it ideal for use in the fall or in the spring."*

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The University of Delaware Extension has described vertical tillage as an intermediate tillage method between no-till and full-width tillage with a chisel plow. Note that they consider chisel plowing to be a conventional tillage practice, while others consider it vertical tillage. The interpretation is likely related to the type of point used on the chisel plow. They summarized the benefits of vertical tillage to include:

1. The preservation of a large percentage of crop residue on the surface.
2. The creation of tilled slots that encourages downward root growth leading to better rooting.
3. A method to break up surface compaction without plowing.
4. Promote the drying out and warming the surface in the spring allowing for earlier planting than full no-till.
5. Control slug problems.
6. Shallow incorporation of fertilizers, soil amendments, and cover crop seedings.
7. Incorporation of surface-applied manures to conserve the ammonia fraction of the manure.

Research

A relatively small number of studies have been published that purposely compare crop response between defined vertical tillage systems and other practices; however tillage studies have been conducted that essentially provide such a comparison of these systems. No publications were found in the refereed literature. A study was conducted by the author that compared fall chisel plow and strip-till, spring field cultivator, and no-till at Lancaster, Wis. in first-year corn after soybean. The original objective of the research was not to evaluate vertical tillage with other systems. The fall chisel and strip-till treatments could be considered vertical tillage; one pass in the spring with a field cultivator a horizontal tillage method; and a no-till treatment (with row cleaners). Although the chisel and strip-till treatments produced higher yields than the field cultivator, the resulting silage and grain yields were not significantly affected by tillage type. Of course other considerations may favor the tillage selection on specific soils, including the effect on total cost or production, equipment availability, and addressing soil conservation issues. A more detailed report can be found in the 2006 proceedings of this conference.

A second tillage study conducted by the author compared what would be considered two vertical tillage methods and a horizontal tillage practice in both corn and soybean at the Arlington Agricultural Research Station in 1998 and 1999. The site had a very low initial soil test K level of about 60 ppm K and included K fertilizer treatments, however for the purposes of this paper only the results of the highest K treatment were considered. More information on the project can be found in the 2000 Proceedings of this conference. The tillage treatments were fall subsoiling to a depth of about 16 inches with a straight shanked tool, fall twisted-shovel chisel plowing, and no fall tillage, but a single pass with a field cultivator, that was also run over the fall-tilled plots. The yield results for these two years are shown in Table 2. Yield of corn or soybean was not affected by any of the tillage treatments in either year.

Table 1. Effect of tillage on corn silage and grain yield, Lancaster, WI, 2004 and 2005.†

Tillage	Silage yield (ton DM/a)		Grain yield (bu/a)	
	2004	2005	2004	2005
Fall chisel	9.6	10.1	203	195
Field cultivator	9.0	10.2	198	183
Fall strip-till	9.5	10.1	200	187
No-till	9.1	9.6	195	186
Pr>F	0.25	0.55	0.52	0.62
LSD	NS ‡	NS	NS	NS

† Wolkowski (2006). ‡ NS = not significant.

Table 2. Effect of tillage on corn and soybean yield, Arlington, WI, 1998 and 1999.†

Tillage	Corn yield (bu/a)		Soybean yield (bu/a)	
	1998	1999	1998	1999
Fall chisel	223	206	57	47
Fall subsoil	218	201	54	51
Spring field cultivator	223	204	53	45
Pr>F	0.15	0.44	0.38	0.31
LSD	NS	NS	NS	NS

† Adapted from Wolkowski (2000). ‡ NS = not significant.

A study evaluating deep subsoil tillage with a straight-shanked tool to a depth of 20 in. was conducted in southern Minnesota by Jodi DeJong-Hughes, a University of Minnesota Regional Extension Soils Specialist and Jane Johnson, a NRCS Soil Scientist in 2003 and 2004. This study examined the use of the practice in an on-farm strip trial that was replicated eight times in a ridge-till system on a loam soil. The deep tillage was conducted on alternate sets of rows in the fall and then the ridge-till practice was applied over the entire field the following year. Yield measurements were taken from both upland and depressional areas in the field. This study did not show a yield response to deep vertical tillage and as a result they concluded that there would be considerable profit loss because of the added expense of the deep tillage (Table 3).

Table 3. Effect of deep tillage on corn and soybean yield, Elrosa, MN 2003 and 2004.†

Tillage	2003 corn yield (bu/a)		2004 soybean yield (bu/a)	
	Upland	Depression	Upland	Depression
Ridge-till	183	156	32	14
Ridge-till with deep tillage	185	155	33	17
Significance	NS	NS	NS	NS

† Jodi DeJong-Hughes, personal communication. NS= Probability of significant exceeds 5%.

Another Midwestern study conducted at the Iowa State University Southeast Research and Demonstration Farm examined shallow vertical tillage in 2004 on corn. This one-year study was reported by Superintendent Kevin Van Dee. Tillage systems included what was termed conventional (spring disking followed by a field cultivator), no-till, and spring vertical tillage using a Phoenix harrow; a tool with a rolling set of tines. The results of this evaluation are shown in Table 4. The reported values are the average of four measurements; however statistical analysis was not reported and it is therefore not possible to conclude much from the study.

Table 4. Effect of tillage on corn stand and yield, Crawfordsville, IA, 2004. †

Tillage	Stand (x 1000)	Yield (bu/a)
No-till	32.2	193
Disk/field cultivator	32.6	192
Phoenix harrow	32.2	196

† ISU SE Research and Demonstration Farm, Pub. ISRF04-34.

Summary

Clearly every producer wants to create a seedbed that promotes rapid and uniform crop emergence, while having a soil condition that permits deep and extensive rooting. Poor, uneven stands with limited root development are a recipe for disaster. Producers should be encouraged to carefully evaluate the purpose and reasoning for selecting tillage practices. If not doing so they stand to lose operational efficiency, increase their cost of production, and potentially increase soil loss from their land. They may find that no one system will work in every part of the rotation, or for that matter on every field. Vertical tillage describes a practice that should offer a good seedbed and root zone and still maintain adequate crop residue for soil conservation purposes. Many producers are likely unknowingly using vertical tillage methods already and most will continue to fine-tune their practices over time. One could argue that a well-managed no-till system offers some of the same benefits as vertical tillage if traffic is managed to reduce compaction and the soil is allowed to naturally develop vertical pores from earthworm activity, root traces, and voids between soil aggregates. Whether using a modern vertical tillage tool with concave or other specialized coulters, strip-tillage, or a chisel system it is still important that producers strive to avoid compaction by staying off wet soils, limiting load, and controlling traffic.