RESIDUE MANAGEMENT – HORIZONTAL VS. VERTICAL TILLAGE

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Introduction

Agricultural machinery manufacturers are providing more equipment options for crop growers to manage crop residue and provide the soil conditions to increase the potential for maximum productivity. With higher crop yields and improved crop varieties with respect lodging and pest resistance, managing crop residue becomes more challenging. Much of the tillage equipment can be grouped into vertical or horizontal tillage. Many manufacturers are marketing vertical tillage equipment with a wide range of characteristics. Based on the performance characteristics of the equipment on the market, vertical tillage has several definitions.

Setting Tillage Goals

When a crop grower is considering the purchase and operation of tillage equipment, tillage and residue management goals should be identified. Some questions to answer when identifying these goals are:

1. What quantity and distribution of surface residue do you want to have after the operation?
2. What quantity of residue is present before the operation?
3. What is the condition of the crop residue-partially standing corn stalks or flattened-chopped residue?
4. What are the soil characteristics–shallow or deep soil, compacted areas and depth?
5. What volume of soil do you want to loosen–horizontal in a uniform layer or vertical in non-uniform layer across the width of a machine?
6. What tillage depth should you consider?
7. What soil surface roughness or smoothness is desired?
8. What is the root pattern of the preceding crop–signs of soil compaction due to tillage or wheel traffic?

Once the tillage goals are identified from the answers to these questions, tillage equipment can be identified and adjusted to meet these goals. Following are some general guidelines to consider:

1. If compacted conditions exist, the tillage depth should be 2 inches below the compacted layer. Dealing with compaction will usually require vertical tillage.
2. If a smooth soil surface is desired, horizontal tillage can be used or vertical tillage with very little soil inversion or a leveling attachment may be useful.
3. If large quantities of crop residue need to be buried, some soil inversion will be needed.
4. If crop residue needs to be sized smaller, some cutting coulters or disks may be needed.
5. If strips of soil must be cleared of crop residue for better soil warm-up, some form of strip or zone tillage may be needed.

These are just a few scenarios that can be considered to meet the tillage goals. Becoming familiar with the equipment on the market and its operating characteristics will minimize potential errors and problems resulting from incorrect soil conditions.

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Horizontal Tillage

Horizontal tillage has been described as a broadcast tillage which creates horizontal layers of soil having layers of different soil densities. Historically, the moldboard plow has been known to produce the dense, compacted plow layer which influenced root patterns. Chisel plows with sweeps with a width greater than the shank spacing will create a horizontal layer. Other tillage machines creating horizontal layers include field cultivators and soil finishers.

Although some of these tillage machines do not create a very dense layer, the change in soil density influences the root pattern. As the root initially develops in and adjusts to the upper-less dense layer, the roots may grow in a horizontal pattern when it reaches the slightly denser layer.

With horizontal tillage, mechanical weed control is more effective reducing the need for chemical weed control. More crop residue is buried with horizontal tillage which may be a problem in soil conditions susceptible to soil erosion due to wind or water. The soil at the soil surface is more uniform with regard to surface roughness and density, which results in better planter performance and more uniform emergence.

The density changes in layers leads to changes in the rate of water movement into the soil profile. When a rainfall event occurs, the water can move more rapidly through the less dense surface layer than through the denser layer below. Some conditions may lead to greater risk of sufficiently high water content in the soil just above the dense layer for short periods of time to impact root development.

Vertical Tillage

Vertical tillage frequently involves deeper tillage and tool spacing such that soil disturbance depth between the tillage shanks or tools is less. The most common implements in this group are subsoilers, rippers, and chisel plows with straight or twisted shovels. Many combination tillage machines having disks or coulters in front of deep tillage shanks followed by tillage tools to modify residue cover and influence surface roughness condition are readily available on the US farm equipment market.

Several machines referred to a vertical till machines have very different characteristics. Two short line manufacturers have a vertical till attachment for chisel plows. On the chisel plow shank, the shovel is replaced with two fluted coulters, to till about an 8-inch wide strip of soil to a depth of 3 to 4 inches. The coulters have a diameter of about 17 inches and are spaced 6 inches apart. These coulters obviously will not address compaction problems beyond 4 inches but do provide a strip of loosened soil with less surface residue which may enhance planter performance over no-till. Two these manufacturers are Wil-Rich and Yetter.

Another family of tillage implements described as vertical tillage machines has a rolling soil engaging tools. These shallow tillage machines create little or tillage beyond 3 inches and can be used to reduce the roughness of the soil surface. Examples of this equipment are Aerway and Phoenix rolling tillage machines.

Numerous studies have been conducted evaluating the performance these vertical tillage machines primarily dealing subsoiling. Very few studies have identified vertical tillage as a specific treatment. One study was conducted in Iowa.

In a vertical tillage study, Van Dee (2004) reported research comparing conventional, no-till and vertical till system in corn. The conventional system consisted of spring disking and field cultivation. The no-till consisted of planting directly into soybean stubble. For the vertical till, he used a spiked rolling harrow making a single pass. Although this was a 1-year report, small differences in corn yield were observed.

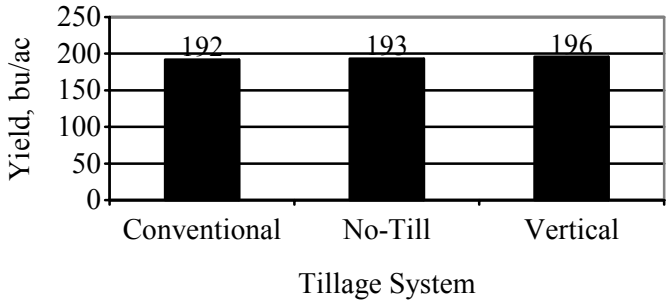

Figure 1. Iowa tillage study in one year of corn.

The traditional vertical tillage machines are designed primarily to address soil compaction issues beyond six inches. They create a soil environment to allow good root development beyond the six inch depth. Since most vertical tillage machines do not till the complete soil surface, most vertical systems will require herbicide weed control. With more surface residue and the potential for a rougher soil surface, proper planting will require more attention to ensure high and uniform emergence rates. If surface roughness is excessive, a soil leveling attachment is needed or a separate leveling operation may be needed.

Summary

Setting goals for the tillage system and learning about the performance of the tillage implement on the market will increase the potential of a successful tillage. Getting to know the soil conditions with respect to compaction and depth and studying the rooting patterns of previous will prove to be very useful. The plant's roots can provide a great deal of information to identify problems if they exist. Vertical tillage can provide a solution to these problems, but there is a large variety of this tillage equipment on the US market.

References

Smith, D. 2006. Tillage road map. AgWeb.com. Accessed 12/23/2006.

Van Dee, K. 2004. Vertical tillage study. Iowa State Univ., Southeast Research and Demonstration Farm, ISRF04-34.