Why Deep Zone Tillage/Vertical Tillage

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What is deep zone tillage (DZT)? Deep zone tillage is a type of reduced-tillage that combines strip tillage and sub-soiling. Unlike no-till, which relies on a heavy blanket of plant residue to protect the soil and which delays the warming of the soil and crop growth in Northern climates, DZT uses a 5-inch-wide tilled strip to simultaneously break up plow pans, warm the soil and prepare a seedbed. The field is prepared for planting using a zone builder, which consists of series of tools, mounted on two tool bars welded together into a single frame. A lead coulter cuts through the killed cover crop, followed by a narrow sub-soiling shank that breaks up the deep plow-pan, then a pair of opposing fluted coulters cut and prepare a narrow strip in the cover crop residue, and finally, rolling baskets help break up soil clods to prepare the narrow seedbed. Finger-like residue managers or additional coulters are usually mounted in front of the shoe on the planter provide a finished seed bed by removing any remaining residue or stones that may interfere with seeding. Most of the ground between the crop rows retains the heavy surface residue from the killed cover crop. The 5-inch-wide tilled strip is slightly raised (2-5 inch mound), warms faster than covered soils, and does not allow water to stand, or to build up enough speed to erode a slope.

What is wrong with conventional tillage? The extensive tillage practices used on vegetable farms in the Northeast are expensive, time consuming, fuel intensive, and result in problems with soil degradation, soil compaction, and soil erosion. Multiple tillage trips across the field are becoming cost prohibitive as fuel prices continue to rise. There is also a substantial investment in machinery and labor associated with tilling.

Between plowing, harrowing (several times), cultipacking or bedding, and cultivating (several times), we are literally working the life out of our soils. Constant tillage oxidizes soil organic matter (OM) away as CO_2. With conventional tillage, more organic matter is lost than can be replaced by incorporating crop residues and through the use of winter cover crops. Loss of OM reduces the reserve fertility in a field.

As the OM disappears, so do the earthworms, beneficial fungi and other beneficial organisms that depend on OM to survive. Many of these organisms provide the “glue” that hold the soil aggregates together to give us good soil structure. As the aggregates are broken down by tillage, and not replaced due to loss of OM and soil organisms, the soil air pores associated with the aggregates disappear too. This chain reaction leaves the soil devoid of oxygen and with an inability to hold water, nutrients and pesticides (which may run off and become pollutants). Obviously, plant root health suffers in such an environment, as do crop yields.

Loss of OM can also cause surface soil to plate or crust, making an almost impenetrable barrier, which reduces seed emergence and leads to water pooling, low oxygen conditions and even lower biological activity. The horizontal pressure at the bottom of a plow or harrow can produce sub-surface plow and disc-pans. Compacted plow pans often prevent root growth beyond 8-12 inches deep and lead to drainage problems, disease problems (think Phytophthora, etc.), reduce yields and additional tillage costs (i.e. subsoiling). A compacted soil depleted in

OM retains too little water during dry weather and floods during wet periods. Of all the problems associated with tillage, the most important problem is erosion, because soil lost, can not be replaced.

In 2006, one CT grower using conventional tillage actually resorted to building rock "bridges" every 100 yards or so across four-foot-deep erosion ditches, so that he could spray his sweet corn for insect pests, and then ended up rebuilding the bridges when they washed out. This type of soil loss makes it hard for future generations to acquire open land to grow our food. As land trusts and municipalities buy up the remaining open land in crowded New England towns, they often institute policies that prevent vegetable farmers using conventional tillage from renting land for fear of damaging the property. As urbanization spreads across New England, new neighbors along the farm boundaries object to the dust and noise. DZT is capable of reversing soil degradation and compaction problems, halting erosion, and even solving some of our urban/land value issues, and its faster and cheaper than conventional-tillage.

2008 Compaction and Organic Matter Survey. In 2008, I conducted a survey across CT to compare fields using reduced-till systems to those using conventional tillage. I surveyed 55 fields on 53 farms across the state; 46 conventionally-tilled fields and 9 reduced-till fields. While I was in the fields, I used a penetrometer to measure both surface (down to 6 inches) and subsurface (down to 18 inches) compaction (in p.s.i.), and took a soil sample and had it analyzed for percent OM, pH and macro and micro nutrients. I also recorded the depth that I encountered layers which were compressed to 300 psi because plant roots can not penetrate through soil that registers over that density. Multiple readings at 300 p.s.i. throughout a field can tell you the depth of your plow pan and thus, how much soil the plant roots can utilize. It can also tell you how deep to set the sub-soiling shank on the zone builder to put a slit through the plow pan, which improves drainage under the plants and allows for deeper root growth.

When we looked at farms where <u>most</u> penetrometer readings per field "maxed-out" at 300 p.s.i. (at least 6 of the 10 samples), it included 89% of the conventionally-tilled farms and only 33% of the reduced-till farms. This indicates that most conventionally-tilled fields have already formed an impervious plow pan, while most reduced-till fields have not. So, who should be looking for ways to break up their plow pans? Almost all conventional-till farmers! The average depth of plow pans (depth to 300 p.s.i. reading) were similar (11-12 inches) under both tillage systems.

For conventionally-tilled farms, 59% of the fields were low in OM (< 4% OM) and 41% were at moderate levels (4-8%). For reduced-till farms, 56% of the fields had moderate OM and 44% had high OM (>8%). The overall average for conventional fields was 3.9% OM, while reduced-till fields had 7.5% (almost twice as much). Perhaps the lesson from these results is that most conventionally-tilled farms could use more OM, and that OM levels in the reduced-till soils may be closer to the original (natural) levels before we started oxidizing it away through excessive tillage operations

Measuring Soil Health before Converting to Deep Zone-Tillage. A healthy soil is one that has optimum chemical, physical and biological attributes and is capable of sustaining crop productivity. Cornell's new Soil Health Test uses 12 different critical indicators to help measure and quantify a healthy soil. We used the new Soil Health Test to provide preliminary soil status data for 28 fields on 3 CT and 2 MA farms that were converting to DZT. Our goal is to re-test the soil on these farms in 5 years and detect some of the soil improvements that are expected to take place using DZT.

Even though all 5 growers that converted to DZT were very good farmers, all 28 fields had low OM levels and 64% of the fields were at very low levels (<2.5%). Ten of the 28 fields (36%) earned a red or unhealthy soil rating for organic matter, while 61% were rated yellow (medium soil health) and only one field rated green (healthy). A total of 24 out of 28 fields (86%) earned a rating of red, or unhealthy, for active carbon, which means that beneficial biological activity in those soils is very limited (the soil is a dead media instead of a healthy, functioning ecosystem). All the other fields were rated medium or yellow for active carbon. A plow pan was detected in all 28 fields between 9-13 inches deep. Eleven of the 28 fields (39%) earned a red rating for subsurface hardness, while 53% were rated yellow and only 7% were rated green. At least 2 of the 5 farms had most of there fields earn an unhealthy red rating in the following soil health indicators; potentially mineralizable nitrogen (reserve fertility), soil aggregate stability and phosphorus levels (P too high). Many fields also scored poorly in surface hardness.

Fortunately, the common management solution for all of these deficiencies is to reduce tillage, and by adopting DZT, these 5 growers are now on their way to healthier soils. What are you doing about the unhealthy soils on your farm?

Why not simply sub-soil fields? First of all, sub-soiling, followed by conventional tillage doesn't improve soil structure and just allows you to sink equipment deeper into wet fields. Secondly, a sub-soiler doesn't put the slit through the plow pan directly under the plant row the way DZT does, which facilitates deep rooting that can fully explore the soil profile for water and nutrients. It wasn't until one grower tried DZT for the first time, that it dawned on him why he still had a plow pan despite years of sub-soiling. With conventional tillage he would travel over his field another 8 to10 times with heavy equipment and re-compress the soil each year. With DZT you can prepare and plant the field with one or two passes. We saw this re-compaction first hand this past season on a CT farm with a bit of clay in his soils. This farmer also sub-soiled to start the season, but after plowing, harrowing and cultivating, we could no longer detect the soft slot left by the sub-soiler with the penetrometer.

Why use DZT? From a grower's point of view, perhaps the very best reasons for adopting DZT are because it is faster and easier to prepare a field for planting and you save money on fuel and equipment maintenance. The New England growers who have recently transitioned to DZT estimated that they cut field preparation time by 40 to 66% and reduced fuel consumption by 30 to 66%. The fuel delivery man on one of the farms actually complained that the farmer was not using near as much fuel as he used too. Now that is a complaint we would all like to hear! Less time preparing a field means more free time for other chores and fewer tractor hours, and since that is the most expensive piece of equipment on your farm, it pays big dividends to conserve tractor hours.

One farmer from a large NY farm did a breakdown of field preparation saving and found that he reduced his fuel consumptions from 100 to just 40 gallons per day (60% less), reduced his labor by 40% and saved a total of $50,803.60 or $46.18 per acre. He saved an additional $9.56 per acre on fertilizer with the new system, bringing his total saving (not including tractor hours savings) to $55.74 per acre. He figures he paid for his zone builder several times over the very first year.

This same NY grower also estimated that he improved his yields by switching to DZT by 13 boxes per acre (at $8/box that's an additional $104 per acre). One of the CT growers claimed that he increased his yield with DZT in a dry season (2007) by 50 bags per acre (50 bags more than he had ever yielded). He attributed this to the fact that the DZT preserves soil moisture

while planting during droughts so you get a better plant stand than in conventionally-tilled fields that take a week to prepare. He also had no problem with dry ear tips in 2007 while almost every grower in the state had dry tips that year, and he has experience the same problem during droughts with conventional tillage.

In the two wet seasons since then, he had a bumper crop in both years, while conventional-till growers really struggled with yields in 2009. He feels that DZT increases his yields in several ways during wet years. Fields that are moldboard plowed and/or harrowed absorb rain like a sponge and quickly turn into a quagmire that can result in stuck tractors, wasted time, delayed plantings and compacted soils. DZT fields with a heavy rye cover crop can usually be prepared and planted on time without putting a rut in the field. Even low fields that never get planted in wet years can usually be planted using DZT without tearing up the surface, resulting in increased acreage and yields compared with conventionally-tilled farms. Over 3 years breaking up the plow pan with DZT, we have watched one large, wet hole in one of his fields, turn from an unproductive piece of ground, with stunted or flooded-out crops, to a productive piece of ground that produces great crops. Another CT grower with a small farm noted, that because he didn't have to prepare a whole field at once using DZT, he could easily avoid the wet spots until they dried later in the season, and he claimed planting was faster because the rows were marked out by the zone builder. DZT also eliminates dead furrows. All the DZT growers noted that they were able to keep planting in a timely fashion this year, throughout the wet June and July, which resulted in some of the DZT farmers having corn to harvest when neighboring conventional-till farmers did not.

This year, 2 of the DZT growers who planted in fields highly infested with Phytophthora, experience much better drainage and far less damage from this destructive disease than they have in recent years, despite the exceptionally wet season. Far fewer rocks are pulled to the surface using DZT, almost eliminating the back-breaking chore of picking rocks before planting. Occasionally a large rock will get hooked by two or more sub-soiling shanks and get pulled to the surface. These large rocks are easily removed from the field with a front loader or bucket.

DZT stops soil erosion which can rob you of your most valuable resource. When combined with the use of cover crops, over time DZT reverses the deterioration of the soil, helps replace lost OM, improves soil drainage, increases soil water and nutrient holding capacity, eliminates compacted plow pans and surface crusting, allows beneficial soil organisms to thrive, creates more soil aggregates and pore spaces, and minimizes pesticide and nutrient runoff. Because of fewer trips across the field, growers say DZT reduces dust and noise when preparing fields near a crowded neighborhood, and completely eliminates dust-devils after field preparation. Growers find that they harvest much cleaner pumpkins and winter squash on the mulched surface than they ever could with conventional tillage, and one grower even acquired new rental land from a nearby municipality that will no longer rent to farmers that use conventional tillage. Could you really ask for more from a system that prepares your fields for planting?