# Soil Compaction And Fall Tillage

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With the early start of corn harvest, and in some cases a short wait before soybean harvest revved up, fall tillage got underway early this fall. We don't keep statistics on tillage like we do for harvest progress, but in some areas, especially east-central Illinois, many of the harvested corn fields have already been tilled.

Soil in good condition is, by volume, about half mineral (and organic) material and about half pore space. Soil at field capacity (the amount of water held against gravity, typically about 20 percent to 25 percent of the soil volume) has about half the pore space filled with water and the other half with air. Soil compaction takes place when we compress the soil, forcing some of the air out. Mineral matter and water aren't "compressible," so they are unaffected. Dry soils don't compact much because dry mineral matter is strong enough to protect pore space. Saturated soils have a lot of water and little air in the pore space, so they also don't compact much. Moist soils are the easiest to compact.

Most soil compaction results from driving heavy equipment over soils that are at or somewhat above field capacity. Heavy rains can help puddle the surface and result in some "surface compaction" or crusting, but they don't contribute to deep compaction. Soils in the spring, including at planting time, are often at or near field capacity, and for a time after a rain they are above field capacity.

With the removal of water by the crop and normally dry weather in the fall, soils at harvest are often dry enough to limit compaction. That was not the case in 2009, when soils were wet at harvest. Adding that compaction to spring tillage or planting-time compaction in both 2009 and 2010 means that soils in many Illinois fields this fall are more compacted than they have been for some time.

Because the physical resistance to penetration increases greatly as soils dry out, it can be difficult to get a meaningful measure of the amount of soil compaction. If soils are relatively moist, a simple tile probe can often be used to locate layers in the soil that resist the probe. Dry soils, though, provide a lot of resistance to penetration even when they aren't compacted much. This year, it may be enough to recall soil conditions at harvest in 2009 and at planting in 2009 and 2010 to assess the likelihood that compaction is an issue. Some of the standing water we saw in May and June might have stood a little longer in the more compacted areas of fields, but with so much rainfall it was hard to tell if compaction had a direct effect. In general, more poorly drained areas will have the most compaction.

Repeated cycles of freezing and thawing can help relieve compaction – the water volume in the pore space expands during freezing and contracts during thawing. This works on the surface of the soil, where soils typically freeze and thaw often during the winter and early spring. But at depths greater than six inches or so, soils go through only a few freeze-thaw cycles in most years. And below a foot deep, soils often freeze and thaw only once or twice during the winter. This past winter, many soils froze and stayed frozen until they thawed, with no repeated cycle at all. There was thus little relief from deeper compaction through "natural" processes.

Though heavy equipment is the main cause of deep compaction, large tractors are usually needed to help relieve compaction by pulling implements that penetrate soil into the deeper, compacted zones. Deep tillage can't fully restore soil pore space to its "precompacted" state, but it can introduce space for air to enter the soil, which over time helps increase pore space. It also helps break up the physical barrier that compacted soil produces as it dries out.

Several types of equipment can be run deep enough to penetrate the compacted zones. The most basic are "deep rippers," which typically consist of five or seven heavy standards on a heavy toolbar and can rip to a depth of 12 to 18 inches. Either straight points or sweeps can be used, with sweeps requiring more horsepower, and typically a little shallower, but providing more "soil shatter," which is helpful in relieving compaction. Ripper standards with a narrow cut and straight points can be operated without disturbing much surface residue; fields following such "minimum residue disturbance" (MRD) implements can qualify as no-till.

Because the deep-ripping operation is expensive in terms of equipment wear, fuel, and time, it has been common practice to use these implements only when standing water or other signals point to the need to use them in individual fields or part of fields.

Other implements used to relieve compaction include combination disk-rippers, which typically have a front gang of straight coulters with an adjustable angle to bury more or less residue, a row or two of heavy ripping standards, and a rotating cage or tine harrow for leveling. These tend to bury more residue and to leave soil surfaces more level than do deep rippers. Some also use heavy disk harrows, often with large, notched blades that they use to penetrate to depth and with gang angles that adjust to cover the desired amount of residue.

Whatever implement is used to relieve compaction, there are a few basic principles to remember during such operations:

• Running implements to depth to relieve compaction does little good if soils are not dry enough. Soils shatter well only if they're somewhat below field capacity. Running heavy equipment over the field pulling a heavy implement causes some compaction even when soils are dry enough-and it causes a lot of compaction when soils aren't dry enough to shatter well. So it's not difficult to cause as much compaction as you relieve. While it has been relatively dry in most of Illinois for the past month, water use by the corn crop ended early this year, and soils without active crop roots and with corn residue after harvest dry slowly, especially as temperatures drop. So it pays to check to see if soils are actually as dry as we think they are and that they are breaking up at the depth of tillage. As a hint, ripping to relieve compaction when soils are dry enough takes a lot of horsepower; if the implement pulls easier than you expected, it's possible that it is running in soil wetter than was thought.

• Tillage operations can only relieve compaction to the depth at which they're operated. A heavy axle load can cause compaction to a depth of 18 inches or more, so you can cause a net increase in compaction if it's too wet or you're running too shallow. While implements like the offset disk or disk harrow are often blamed for causing compaction, their real drawback is that they usually aren't run deep enough to relieve compaction to the desired depth. The moldboard plow often has a similar limitation, though the "modified mini-moldboard" can, if operated to a depth of 12 inches or so, effectively relieve compaction.

• Primary tillage needs to leave some residue on the surface to minimize soil loss before next spring. This is especially important on slopes, where much soil loss occurs through water runoff. On flatter soils, wind erosion can be substantial, and having surface residue can effectively decrease the amount of soil picked up and blown off the field.

While we typically consider corn fields that will go back into corn in 2011 as having the highest priority for relieving compaction, there have also been questions about the need for deep tillage following soybean harvest in 2010, in preparation for corn in 2011. While soybean fields often have a mellower surface in the fall than corn fields, deeper compaction that was caused during the 2009 season is still present, and at minimum soybean stubble fields should be checked for compaction this fall. With so much less residue than in corn fields, soybean fields need as much residue as possible to be retained on the surface during the tillage process.

Finally, many who are seeing high soybean yields in 2010 are wondering why, if compaction was so widespread, soybean yields don't seem to have suffered. We don't have a simple explanation, but it is clear that corn and soybean responded to weather and soil conditions very differently in 2010 and that soybean plants somehow got enough water to keep them going in August, as corn was coming to an end.

This also reminds us that soil compaction, as much as we work to prevent and relieve it, does not always have a negative effect on yield; in fact, in some cases it might even increase the water available to a crop by improving the connection of root systems with water that can move up from deeper layers in the soil. Compaction is more often negative than positive, though, so we need to pay attention to it, preventing it to the extent possible and relieving it when we can't prevent it. Δ

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