Compaction Reaction: Soil Compaction and Ruts following a Wet Harvest

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Combine ruts after soybean harvest. Source: Anthony Bly.

In 2019, crop producers faced major difficulties during field operations in the North Central and upper Midwest regions due to excessive precipitation. Many areas had delayed planting in the spring followed by saturated soils and ponding at harvest. This article provides some brief notes and tips on what you can expect when operating in excessively wet conditions and recommendations for minimizing or remediating soil compaction. Earn 1 CEU in Soil & Water Management by reading the article and taking the quiz at www.certifiedcropadviser.org/education/classroom/classes/803.

In 2019, crop producers faced major difficulties during field operations in the North Central and upper Midwest regions due to excessive precipitation. Many areas had delayed planting in the spring followed by saturated soils and ponding at harvest. Fieldwork on these excessively wet soils damages soil structure, aggregation, and soil health by creating ruts, subsoil compaction, and smearing of topsoils. The damage sets up poor conditions for not only the following crop, but for the next several crops. The difficult choices producers must make, during critical times when field operations are important, will either minimize damage to soils or exacerbate them.

The following article provides some brief notes and tips on what you can expect when operating in excessively wet conditions and recommendations for minimizing or remediating soil compaction.

What to Expect When Operating on Excessively Wet Soils

The soil's shear strength decreases with wet conditions. This is due to soil particles being more able to slide past each other in the presence of water. High water contents limit the soil suction (i.e., a cohesive force that pulls particles together) and friction between soil particles.

Although severe soil compaction occurs when soils are saturated, the maximum degree of compaction actually occurs when the soil is just below the state of saturation (e.g., when 85% of pore spaces are filled with water). This is due to water being incompressible and not able to move out of the way fast enough during field traffic. A small amount of air space gives room for soil particles to move into while the soil strength is still quite close its weakest state. Field operations during such conditions will cause soils to fail, compact, and form ruts.

Fields that endured substantial rutting during the fall harvest will have subsoil compaction. The depth of ruts is a poor indicator of how deep and wide the compacted zone spread through the ground. However, if ruts occurred, then there will be some level of serious compaction in the subsoil. Subsoil compaction damages the soil's ability to drain and limits how much of the old root zone will be proliferated by the next crop.

A 6-inch rut made from high axel loads and over-inflated tires can cause twice as much underlying soil compaction as a 6-inch rut made from the same equipment with properly adjusted tire pressures. Deep compaction from ruts extends both vertically and horizontally under the tires. As soil compaction pushes deeper, the affected zone becomes wider.

Deep compaction will reduce crop yields 15%, on average, during the following two to three cropping seasons. Somewhat lower crop losses will be noticeable during and after the fourth crop year or until the compaction is remediated.

For producers who were able to harvest before the fall's wet conditions or after soils froze (i.e., fields that did not have ruts and wheel-track compaction), and are looking to perform some level of tillage to manage crop residues, caution should be used to avoid tillage compaction and smearing by waiting for soils to dry. If it is too wet to plant, then it is also too wet to till. Tilling soil when it's too wet will result in soil smearing and crop yield reductions as well as lost time and extra costs from performing the tillage.

Filling in ruts when soils are still wet will cause further damage. This happens for two reasons. First, the traffic will cause additional deep compaction unless operators drive in the existing ruts. Secondly, the tillage implement used to fill the ruts will cause soil smearing both vertically along the discs/shanks and horizontally along the bottom edge of the tillage depth. These smeared zones destroy soil aggregation and cause very poor soil physical conditions, thus reducing beneficial drainage and adequate crop root growth. A smeared topsoil further adds insult to injury for soils with deep compaction.

The winter freeze will only help alleviate compaction in the top few inches. Freeze-thaw cycles can break up

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The platy nature of the soil structure of these compacted soils is not ideal for water and air movement. Source: NDSU Soil Health.

some compaction; however, several dozens of these cycles are required. Soils in the North Central region typically experience only one or two cycles below a 6-inch depth each winter. Additionally, soil moisture must be very high (>85% of all pores filled with water) before freezing will do anything to help alleviate compaction. If the soil dries prior to freezing, the effect of freezing and thawing on soil compaction alleviation is greatly reduced.

Recommendations for Producers and Consultants

Wait for soils to dry before filling in ruts or performing tillage. Field operations on wet and rutted fields will further reduce next year's yields. This may result in considering alternative practices for next year's crop. That may include reducing or eliminating tillage passes, adjusting planters for high-residue no-till seed placement, or changing crop choices for next year.

Areas that received early snow cover that persisted throughout the winter will result in shallower soil frost depths compared with areas that were uncovered for a substantial period after freezing. This could result in some areas within fields that may still be prone to compaction and ruts during late winter and early spring harvest. The soil frost depths in many areas of the North Central and upper Midwest regions were only about 1 ft deep as of the end of January 2020. Frost depths will become shallower as they thin from the bottom side due to the warmer soil temperatures at deeper depths. Some producers who continued harvesting on snow-covered fields in January and February were dealing with stuck combines in areas where the frost has already gone out.

The shallow frost depths will allow for fields to thaw and start draining earlier this spring as compared with many of the previous years when the region was mostly frozen to deeper depths. However, the amount and frequency of the spring rains may prevent soil drying and delay planting activities this year. Wet spring conditions, especially for fields that have crops over wintering, will likely result in considerable amounts of preventative plant acres for 2020. Getting preventative plant acres planted with cover crops will be of interest to many farmers throughout the entire North Central and Midwest region. Plant roots are very important in soil aggregate and structure formation that helps alleviate compaction.

Wait until dry soil conditions in the spring to fill in and level ruts. Use a tillage implement adjusted to a depth that is shallower than the ruts. Take two or more passes with an implement and just fill them in and level off to make the soil surface trafficable and for planters to obtain consistent seed placement. Deep ruts may need to have a shallow tillage pass followed by time for more drying before a deeper (but not deeper than the original rut) tillage pass can be done. Do not till or work up field areas that do not have ruts. Driving in the old ruts while filling and leveling will avoid additional deep compaction, if this is possible.

Let deep compaction naturally begin to be remediated by soil drying and cracking next summer. Many soils naturally crack during the dry summer months. This cracking can help alleviate soil compaction several feet below the soil surface and is much more effective than freeze-thaw cycles or mechanical methods. The shrinking and swelling process of many clay soils is the most effective way to alleviate soil compaction.

Attempts to mechanically alleviate deep soil compaction with ripping are unreliable with oftentimes poor or detrimental results to both the soil and the following crop. Globally, deep ripping only benefits crop yields approximately 25% of the time while more often having no (50%) or negative (25%) effects on the following crop yields. In rare instances when there are positive impacts on crops, it is because there was a distinct soil compaction layer where the shanks could extend under and the producer waited until soils were dry enough to minimize smearing. However, even these rare benefits of deep ripping,

Fieldwork on excessively wet soils damages soil structure, aggregation, and soil health by creating ruts, subsoil compaction, and smearing of topsoils. Source: Flickr/Nik Stanbridge.

If it is too wet to plant, then it is too wet to till without causing smearing. Tractors pulling tillage implements on wet soils may be causing ruts and subsoil compaction immediately before the tillage. Photo by Tim Scrivener/Agriphoto.com.

when done under optimal conditions, tend to be minimal if the subsequent crop receives adequate rain (i.e., no drought stress) and producers make sure to optimize their soil's fertility. Caution should always be given when deep ripping since producers cannot see the soil depths they are ripping and therefore cannot readily confirm if it is or is not smearing, compacting, and further breaking down soil structure.

Control traffic lanes that minimize the soil area impacted by wheel traffic. Minimize unneeded passes throughout the field season. Eliminating a tillage pass is a good option, especially if the tillage is done to help dry out wet soils. If it is too wet to plant, then it is too wet to till without causing smearing. Additionally, tractors pulling tillage implements on wet soils may be causing ruts and subsoil compaction immediately before the tillage. Spring tillage should be eliminated as a means to dry soils. Tillage can increase soil evaporation temporarily. However, tillage cannot adequately dry soil if there is a drainage issue on poorly drained soils that may need subsurface drainage.

If producers avoid operations on wet field conditions, and those wet conditions persist up to near the time of planting, then they will need to consider methods for seeding into high-crop-residue conditions. This is a great opportunity for producers to get to know their planters better. A properly adjusted planter can handle high amounts of crop residue very well and can result in good crop stands. Make sure the planter row units function property and down pressure is adjusted, set and check that row cleaners are clearing the rows well without creating valleys, and make sure disc openers are not dull and that the closing wheels are doing their job of getting good seed-to-soil contact. For the best results, these adjustments should be done when entering each new field.

Adjust tire pressures or use tracks to distribute more of the load over more soil surface area, and most importantly, be patient. Let fields dry as much as possible before entering for field operations. If tire pressures are set for driving on the roads, then they are automatically too high and overinflated for driving in the fields. Tire pressures for road conditions will be close to 45 psi. Proper inflation for field activities is typically about one-fourth to one-third of that for road conditions. Auto-inflation systems are available for some vehicles to conveniently adjust tire pressures in a timely manner. When using tracks, take caution to avoid slippage, which can cause smearing to topsoil.

> "If it is too wet to plant, then it is too wet to till without causing smearing. … Spring tillage should be eliminated as a means to dry soils."

Stay off excessively wet fields and give the soil adequate time to dry. This will be the best method to maintain crop yields for the following two or three years. Producers who were able to avoid making ruts and compaction this past fall should prioritize avoiding compaction this spring on wet grounds. This would mean eliminating tillage as a tool for residue management and learning how to properly adjust planters for high-residue seeding conditions. For producers who

endured ruts and compaction this fall, focus on filling in the ruts to get a trafficable and flat seed bed, and then direct-seed into those fields. Any mechanical method to alleviate the soil compaction will only make the soil weaker and limit its ability to drain. Let the natural processes that form soil aggregation and structure take care of the soil compaction.

Each additional root system, cycle of wetting and drying, and freezing and thawing will help build soil aggregation and structure. Soil aggregation and structure is the only way to simultaneously develop a strong and firm soil that does not rut and maintains adequate drainage. Therefore, practicing patience will be key in remediating weak soils that have subsoil compaction.

SELF-STUDY CEU QUIZ

Earn 1 CEU in Soil & Water Management by taking the quiz for the article at www.certifiedcropadviser.org/education/classroom/classes/803. For your convenience, the quiz is printed below. The CEU can be purchased individually or you can access as part of your Online Classroom Subscription.

1. Which of the following was NOT listed in the article as a way soil health was damaged by fieldwork on excessively wet soils?

- **a.** Subsoil compaction.
- **b.** Microbe death.
- **c.** Ruts.
- **d.** Smearing of topsoils.

2. Soil saturation is most subject to maximum compaction when soil pore spaces are filled with water at what percentage?

- **a.** 50%.
- **b.** 75%.
- **c.** 85%.
- **d.** 95%.

3. Which of the following is a way that subsoil compaction from the fall harvest negatively impacts the next crop?

- **a.** Limits soil's ability to drain.
- **b.** Increases the amount of the old root zone proliferated by the next crop.
- **c.** Decreases the amount of time for soil to thaw.
- **d.** Increases soil aggregation and structure.

4. How much more damage can over-inflated tires and high axel loads cause compared with tires with properly adjusted pressures?

- **a.** 1.5 times.
- **b.** 2 times.
- **c.** 2.5 times.
- **d.** 3 times.

5. How much does deep compaction reduce crop yields, on average, for the following two to three cropping seasons?

- **a.** 3%.
- **b.** 5%.
- **c.** 10%.
- **d.** 15%.

6. What two conditions must be present for freeze-thaw cycles to help break up some soil compaction?

- **a.** Several dozen freeze-thaw cycles and very high soil moisture before freezing.
- **b.** Ruts deeper than 6 inches and very high soil moisture before freezing.
- **c.** Several dozen freeze-thaw cycles and ruts deeper than 6 inches.
- **d.** Smeared topsoil and very high soil moisture before freezing.

7. Which of the following is NOT an alternative practice to consider using with the next year's crop after ruts are formed in a field?

- **a.** Adjusting planters for high-residue no-till seed placement.
- **b.** Reducing or eliminating tillage passes.
- **c.** Changing crop choices.
- **d.** Working on fields before they completely dry out.

8. What was the approximate soil frost depth in many areas of the North Central and upper Midwest as of the end of January 2020?

- **a.** 4 inches.
- **b.** 6 inches.
- **c.** 12 inches.
- **d.** 18 inches.

9. Globally, what percentage of the time does using deep ripping to alleviate soil compaction positively affect crop yields?

- **a.** 5% or less.
- **b.** 25% or less.
- **c.** 50% or less.
- **d.** 75% or less.

10. Which of the following does NOT help build soil aggregation and structure?

- **a.** Poor drainage.
- **b.** Additional root systems.
- **c.** Cycles of wetting and drying.
- **d.** Cycles of freezing and thawing.