

What is the best way to minimize soil compaction?

Soil compaction negatively affects crop health and grain yield. There are many factors that contribute to soil compaction, but what are the biggest contributors and how can their impact be reduced?

The simple answer

Focus on these five best practices for the greatest impact on minimizing soil compaction:

1. Conduct field activities only when soil conditions are “fit” (avoid wet and saturated soils)
2. Reduce the total weight of each equipment pass through the field
3. Reduce axle weight (i.e. more axles)
4. Increase tire size
5. Reduce tire pressure (i.e. use radial tire)



Figure 1. A tractor and grain cart. Reducing axle weight, increasing tire size and reducing tire pressure will lower the risk of compaction.

A little more information

Since 2017, eight compaction events have been held across the province. A wide range of equipment was brought in to measure the amount of soil pressure exerted under different conditions. The data collected from these events provided a general ranking of farm machinery from “bad” to “better” in terms of their contribution to soil compaction (Figure 2).

COMPACTION LOAD ON TOPSOIL			
BAD			BETTER
<ul style="list-style-type: none"> • Hay wagons • Gravity wagons • Sprayers • Trucks 	<ul style="list-style-type: none"> • Balers • Forage harvesters • Hay equipment 	<ul style="list-style-type: none"> • Grain carts • Manure spreaders • Combines 	<ul style="list-style-type: none"> • Tractors

Figure 2. The relative amount of soil compaction that each type of farm machinery creates based on data collected from eight compaction events from 2017-2023.

Farm machinery ranking was strongly influenced by total weight, axle weight, tire size and tire pressure (low pressure = bigger footprint). Standard features on farm implements will greatly impact the level of compaction. For example, a gravity wagon with narrow width (220 mm) bias ply tires inflated to 100 pound per square inch (PSI) will exert more pressure than a similarly weighted tractor with wide radial tires (710 mm) inflated to 9 PSI. We know that implement compaction can be reduced significantly by reducing total weight load, axle load and tire pressure, and increasing tire size.

The full story

In the simplest sense, soil compaction is the reduction in pore space within a soil. An ideal soil is composed of 50% mineral content (a small portion is organic matter), 25% water filled pores and 25% air filled pores. These proportions are extremely important to all soil functions. Compaction tends to squeeze out water and air pores, changing the function of soil in the ecosystem and resulting in lost yield.

Traffic control

In an ideal world from a soil compaction standpoint, there would be a system where every vehicle and implement can drive in the same wheel tracks. This is manageable when equipment is all the right size, but cost is a huge barrier. A more achievable change in management would be to limit traffic through the field. Consider a manure spreading task. For each load spread, there are two trips in and out of the field where nothing is being done. Depending on field size, you could adjust the application rate so that you end up near one end of the field when the spreader is empty, or only fill up enough so that you end on a headland. This would avoid loaded trips into the interior of the field. But the cost is more trips between the manure storage and the field. When possible, consider having multiple points of field entry to reduce extra driving through the field.

Monitor moisture

Wet soils (at depth) are a major factor for subsoil compaction, which is also harder to correct. Soil may be dry on top in the spring, but it will likely be too wet as you go deeper. The compaction events have shown that wetter soils are weaker than dry soils. Wetter soil at depth will be affected by higher axle weights.



Figure 3. A manure tank with multiple axles, large tires and a centralized tire inflation system (CTIS).

Long-term mitigation

Within the five best practices outlined, there are additional ways to address soil compaction that require a longer period of time to implement.

1. Conduct field activities when soil conditions are “fit”
 - Add or improve tile drainage
 - Improve soil structure (increase organic matter, less tillage, perennial root systems)
 - Be patient
2. Reduce total weight of each equipment pass through the field
 - Smaller machinery or lower load weights
 - Fewer passes through the field or over areas within the field
 - Work toward a control traffic system
3. Reduce axle weight
 - More axles per implement
 - Dual wheels
4. Increase tire size
 - Increase width
 - Radial tire instead of bias tire
5. Reduce tire pressure
 - Add a centralized tire inflation system (CTIS) for road versus field travel