

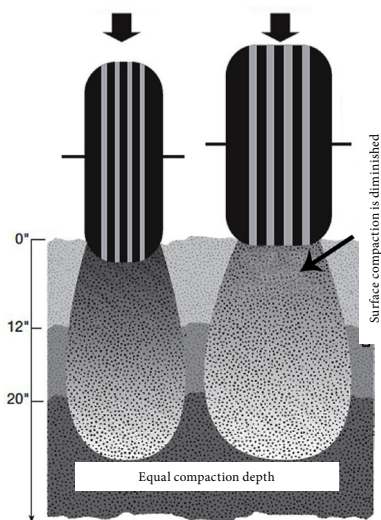
# Compaction

Water puddles persist on the soil's surface? Alfalfa stands are found solely where the drains are buried? Low yields are measured especially in damp places? These are signs of surface water infiltration problems most likely caused by compaction.

**What to do?** There is no shortcut. Soil profiles must be carried out at 75 to 80 cm depths in areas of the field where hard pans are likely to be found. Monitor compaction presence by identifying its location and depth. Your agronomist can be very useful with this investigation.

## Compaction symptoms:

- **Density:** A small knife is an irreplaceable instrument for assessing a more compact soil horizon. Apply small taps with the knife on a 45 degrees angle along the entire soil profile wall. Doing so will help you identify hard pans (if applicable). Note the depths at which you found the hard pans.
- **Structure:** The soil will disintegrate in large blocks under hand pressure. If the soil is really compacted, then it will not disintegrate at all.
- **Color:** All soils, regardless of their texture (clay, loam, sand) develop a greyish hue when they are deprived of oxygen. Properly aerated soils develop a rust-brown hue. The presence of rust spots ("mottling") in a greyish layer is indicative of slow water infiltration capacity.
- **Presence of water:** A profile hole dug in a compacted soil will have water seeping from its sides in wet soil conditions. When a profile is dug in a soil with underground drainage problems (undrained or clogged drains), water will gradually fill the hole from the bottom up. In severe compaction problem, soil will be moist at the surface and dry at the bottom.
- **Root development:** Compaction inhibits root growth, even in the case of alfalfa and forage radish.



*The figure below shows the tire mark against the ground surface according to the tire's surface area. Note that compaction occurs at the same depth, even at equal weight per axle. This explains how tire pressure affects surface compaction, while axle weight affects compaction depth.*

## What does compaction look like?

It is important to remember that the axle weight determines compaction depth.

Compaction type	Average depth (cm)	Most common causes	Corrective measures
Surface	0-18	Excessive soil pulverization when preparing soil bed, stubble mulch tiller	Harrowing, soil structure improvement, cover crops
Tillage pan	18-30	Tillage in wet conditions	Area-till, strip-till, chisel
Deep	30 - 75	Heavy machinery passages, wet soil conditions	Subsoiling , crop rotation, cover crops, preventive measures
Natural	Endless, gradual	Shallow soil, waterproof subsoil	Subsoiling, crop rotation, cover crops, preventive measures, with limited effects

Compacting soil is easier to do than ameliorating soil structure. For example, a severely compacted soil will require a much longer period without rain to enable subsoiling operations.

The deeper the hard pan is, the longer the dry period will have to last before subsoiling can be done. In such cases: i) subsoiling can only be conducted in August or early September; ii) sacrificing a crop production for one year could therefore be more realistic than hoping for a profitable harvest; and iii) cover crops are advisable to improve soil structure and increase subsoiling efficiency.

Such a sacrifice is counterbalanced by average yield improvement in the long run. When subsoiling in dry soil conditions, the machinery operator will feel a marked difference in soil resistance when transitioning between compacted and non compacted areas in the field. The soil between the subsoiler shanks (legs) should raise about 15 to 20 cm above the non compacted soil or that not yet worked.

## Preventive measures

- Avoid any traffic on wet soil; otherwise limit ruts (tire tracks) to shallow depths (< 5 cm).
- Reduce machinery traffic in the field and adopt the reduced tillage or no till systems.
- Limit ground pressure exerted by farm equipment by opting for: radial tires, low tire pressure (103 kPa or 15 psi max., according to manufacturer's specifications), wide wheels with a large diameter and usage of dual wheels as needed.
- Limit the load per axle to 6 tons or less and always work in good soil conditions.
- Maximize all timeframes for manure spreading by prioritizing the most suitable depending on manure characteristics.
- Integrate cover crops and winter cereals in your crop rotations to lengthen the period where the soil is occupied by living root systems.

## The ideal subsoiler

- Subsoiler shanks: 1, 3 or 5 at most, straight shanks or oblique shanks leaning towards the front, 75 cm spacing between the shanks, or adjust spacing at 1.5 to 2 times the working depth.
- Flat tops: as narrow as possible, neither crown, nor chisel, nor flanged sweeps.
- **Working depth: must be at least 10 cm below hard pan.**
- Safety mechanism: safety bolt or spring on each shank to prevent breakage following a major shock.

Subsoiling is not a cure-all: the results are not always immediate. When well done, results are durable as long as compaction is not repeated. Subsoiling is a corrective measure that should be seen as a “patch” and not a recurrent tillage method.

## Conditions for efficient subsoiling:

- 1<sup>st</sup> step: examine the soil profile many places.
- Soil condition: DRY soil at the full working depth.
- Working depth: 10 cm below hard pan.
- Work direction according to field slope and drainage system orientation: this aspect is of little importance. The exceptions are when you are working in a steep slope, or when the shanks cannot reach the entire hard pan. In such cases, work diagonally to the slope or drains.



*Straight subsoiler shanks without sweeps can work down to a 70 cm depth.*

- Cover crops: it is advised to use cover crops to improve soil structure and increase subsoiling efficiency. If a crop season is sacrificed, a winning strategy is to replace it with sorghum-Sudan grass. Otherwise, sow before subsoiling operations (at least several days) to stimulate microbial life and active root system development as soon as possible.
- Do not enter the field until the following spring.

# Tractor Balancing

## Ground adhesion goals :

- Obtain a tractor power/weight ratio for an optimal energy transfer from the engine the ground.
- The ratio takes into account: soil type, soil moisture and ground speed.
- The following formula is used:

$$\text{Ratio lb/HP} = 625/\text{speed (mph)}$$

**Source :** A theoretical basis for tractor ballasting recommendations

The following table shows the optimal values:

Speed (mph)	< 4,5	5	>5,5
Tractor type	lb/HP		
Two wheel drive (front wheel drive)	130	120	110
Four wheel drive	110	100	90

## Adjusting tire pressure

### Tractor weight adjustment

Optimal measurements are essential when adjusting tire pressure to limit soil compaction. The table below presents values that limit soil compaction:

Tractor type	Hitched front/rear	Semi-mounted front/rear	Mounted front/rear
Two-wheel drive	25/75 %	30/70 %	35/65 %
2 + 2	35/65 %	35/65 %	40/60 %
Four wheel drive	55/45 %	55/45 %	60/40 %

**Source :** Vincent Lamarre, Choix et utilisation des pneus de tracteurs, impacts sur la compaction et la consommation de diesel.