

MANAGING SOIL COMPACTION IN VEGETABLE PRODUCTION

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PRACTICAL STRATEGIES FOR NOVA SCOTIA GROWERS

Soil compaction remains one of the most persistent and limiting factors in vegetable production systems. It is often a “hidden yield killer” that develops gradually and can go unnoticed until crop performance starts to decline. Because intensive vegetable farming requires regular soil disturbance and heavy equipment traffic, eliminating compaction is unrealistic. However, reducing its formation and improving soil recovery capacity are highly achievable goals.

1. UNDERSTANDING THE PROBLEM

Compaction occurs when soil particles are pressed together, reducing crucial pore space. It is typically an accumulated result of heavy equipment loads, machinery traffic (especially under wet conditions), repeated tillage passes and a lack of soil organic matter.

The Hidden Impacts of Compaction:

- Restricts root growth and limits deep root development.
- Reduces water infiltration, leading to poor drainage and pooling.
- Limits nutrient uptake by crops.
- Decreases soil biological activity, harming beneficial microbes and earthworms.
- Lowers overall crop yields and farm profitability.

Important Note: While tillage may temporarily loosen soil, repeated deep or aggressive tillage weakens soil aggregates, making the soil more vulnerable to severe re-compaction. The long-term goal is to build a soil structure that resists compaction in the first place.

Soil compaction can significantly reduce crop productivity by making the soil harder for roots to penetrate, restricting root growth and limiting the movement of air and water through the soil. A meta-analysis of 51 published studies from 20 countries found that traffic-induced soil compaction reduced yields of corn, wheat, barley and soybean by 6–34%, depending on the crop and growing conditions (Obour & Ugarte, 2021). Reviews of soil compaction research also show that compaction can restrict root development, reduce access to water and nutrients and ultimately reduce crop growth and yield (Hamza & Anderson, 2005; Nawaz et al., 2013). The severity of yield loss depends on factors such as soil texture, soil moisture at the time of traffic, depth and severity of compaction, crop species and environmental conditions.

2. PRACTICAL STRATEGIES TO BUILD HEALTHY SOIL

Reduce Field Traffic and Passes

Every pass across a field can contribute to soil compaction, but compaction can be more severe when field operations are conducted under wet soil conditions, which are common in Atlantic Canada, particularly in early spring.

- Combine field operations where feasible (e.g., combining seedbed preparation and fertilization).
- Avoid unnecessary passes and work only when soil moisture conditions are suitable.
- Practice controlled traffic farming by establishing wheel tracks that suit several pieces of equipment.

Separate Crop and Traffic Zones

Reduce random traffic across growing areas by implementing designated wheel tracks or traffic lanes. Using permanent beds for vegetable production and keeping heavy machinery on consistent traffic lanes can significantly reduce localized compaction and improve crop uniformity.

McCain’s Farm of the Future in New Brunswick uses Controlled Traffic Farming (CTF) in potato production. Field preparation, cover crop planting and potato production are carried out using permanent traffic lanes, keeping machinery on designated tracks and reducing compaction in the crop-growing zone. Modern tractors with adjustable track spacing, such as some John Deere 8RX, 8RT and 9RX models, can be configured to support permanent traffic lanes and wider crop zones.



Figure 1. Tractor wheelbase is widened to approximately 11 feet, allowing four potato rows to be planted between the wheel tracks as part of a Controlled Traffic Farming (CTF) system. Photo Credit: Leigh Hunter, McCain Farm of the Future.



Figure 2. Tractor forming potato hills as part of a Controlled Traffic Farming (CTF) system. The GPS-guided tractor travels only on permanent traffic lanes, while the four potato rows between the wheel tracks form the crop zone. This keeps machinery traffic out of the crop zone and minimizes soil compaction around the potato rows. Photo Credit: Leigh Hunter, McCain Farm of the Future.

Be Strategic with Equipment

Compaction risk increases with axle load and soil moisture at the time of traffic.

- Weight matters: Heavier machinery creates deeper, more persistent compaction.
- Tire selection and axle load: Use wider tires or tracks to distribute weight more evenly and actively manage tire pressure to reduce soil loading.
- Reduce tillage where practical: Consider transitioning to strip tillage (working only the planting row), reduced tillage or no-till systems to minimize soil disturbance and machinery traffic.



Figure 3. Strip tillage, where only the planting rows are tilled while the soil between rows remains undisturbed.

Use Cover Crops as a Biological Tool

Cover crops act as “biological plows” to improve soil resilience under Nova Scotia conditions.

Cover Crop Options to address Compaction

To alleviate soil compaction, selecting cover crops with strong and extensive root systems can be an effective strategy.

Warm-season grasses such as sorghum-sudangrass and pearl millet thrive under warm conditions and, to maximize biomass production and rooting benefits in Nova Scotia, can generally be planted from June through July.

Alfalfa can be established in early spring, such as early May, in a mixture with oats and other suitable cover crop species. Early establishment gives alfalfa more time to develop its deep root system, produce biomass and fix atmospheric nitrogen. Because alfalfa is relatively slow to establish, faster-growing species such as oats can provide early ground cover, compete with weeds and contribute additional biomass while the alfalfa becomes established.

Tillage radish is another useful cover crop for addressing soil compaction. Its large taproot can penetrate compacted soil and create root channels that may benefit subsequent crops. As a cool-season species, tillage radish generally performs better when planted in early fall. It is less suited to the hottest part of the summer, so appropriate planting time is important for maximizing root development and biomass production.

Multispecies cover crops can be successfully grown in Nova Scotia's Annapolis Valley. When warm-season species are included in the mixture, planting in June can provide good growing conditions and sufficient time to develop high biomass and extensive root systems. Diverse root systems can help improve soil structure, increase soil porosity and reduce the effects of soil compaction over time.

In 2026 On-Farm Climate Action Fund demonstrations, it was observed that pearl millet, sorghum-sudangrass, alfalfa and tillage radish can perform exceptionally well as cover crops in Nova Scotia when matched with the appropriate planting window. Their different rooting characteristics and growth patterns make them valuable tools for improving soil structure, alleviating compaction, producing biomass, suppressing weeds and, in the case of alfalfa, fixing atmospheric nitrogen. Choosing the right species for the season and planting at the appropriate time are key to maximizing these benefits. For more information on these species, please visit [Perennia's Cover Crop Selection Tool on Farm Data Tools](#).

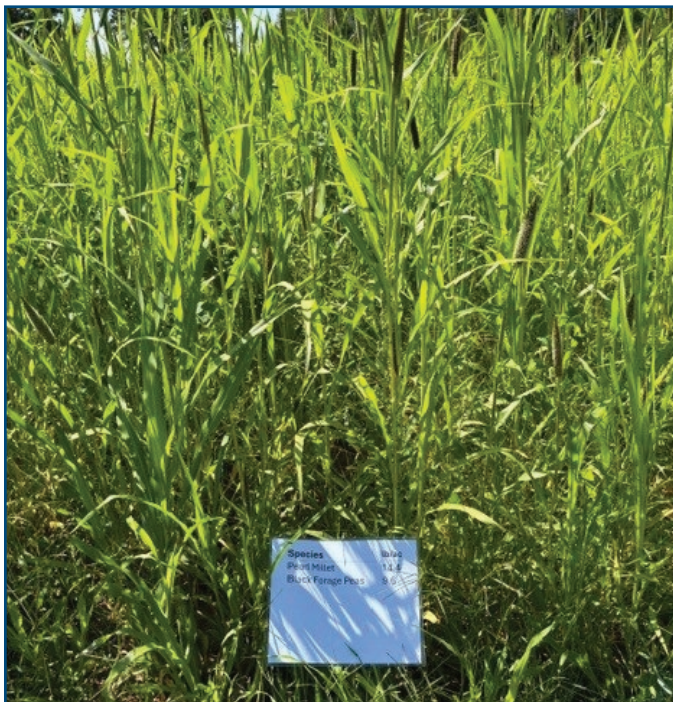


Figure 4. Pearl millet and black forage pea blend in the 2026 OFCAF cover crop demonstration at the Perennia Field House. Pearl millet is a warm season cover crop that can produce high biomass and develop an extensive fibrous root system, which can help improve soil structure and reduce soil compaction over time. Certain pearl millet cultivars may also help suppress some plant-parasitic nematodes. Black forage peas complement the mixture by fixing atmospheric nitrogen and contributing additional biomass and root diversity. These cover crops were planted on June 10 and the photo was taken 63 days after planting on August 12.



Figure 5. Sorghum-sudangrass and black forage pea blend in the 2026 OFCAF cover crop demonstration at the Perennia Field House. Sorghum-sudangrass is a warm-season cover crop that can produce high biomass and develop an extensive fibrous root system, helping improve soil structure, add organic matter and reduce soil compaction over time. Black forage peas complement the mixture by fixing atmospheric nitrogen and contributing additional biomass and root diversity. These cover crops were planted on June 10 and the photo was taken 63 days after planting on August 12.



Figure 6. Sorghum-sudangrass root system after mowing, showing soil held together by the extensive fibrous roots at the 2026 Perennia Field House cover crop demonstration. The dense root system helps bind soil particles, improve soil aggregation and structure and increase organic matter inputs. Over time, this extensive rooting can help improve soil porosity and reduce the effects of soil compaction. These cover crops were planted on June 10 and the photo was taken 63 days after planting on August 12.



Figure 7. Alfalfa plant showing deep and extensive root development at the 2026 Perennia Field House variety demonstration. The extensive root system of alfalfa can penetrate deeper soil layers, improve soil structure and porosity and help reduce the effects of soil compaction over time.



Figure 8. Nitrogen-fixing root nodules on alfalfa at the 2026 Perennia Field House variety demonstration. The visible nodules demonstrate the nitrogen-fixing ability of alfalfa. In addition to biological nitrogen fixation, alfalfa contributes below-ground biomass and supports soil structure, nutrient cycling and long-term soil health.



Figure 9. Tillage radish root bending at a compacted soil layer in the 2026 OFCAF cover crop demonstration at the Perennia Field House. Tillage radish can help alleviate soil compaction through its strong taproot; however, at this site, the compacted layer was severe enough to restrict downward root growth, causing the root to change direction. This type of hard, compacted layer, often referred to as a plow pan, commonly occurs 15–30 cm (6–12 in) below the soil surface. Wet harvest conditions and long-term intensive crop production and tillage can contribute to the development of these compacted layers. These cover crops were planted on June 10 and the photo was taken 63 days after planting on August 12.

- Deep tap-rooted crops (e.g., radish, alfalfa): help open deeper layers and improve water infiltration pathways.
- Fibrous-rooted crops (e.g., sorghum-sudangrass, pearl millet): build surface aggregation and improve structural stability.



Figure 10. Tillage radish showing a large taproot and extensive root development in an area with less soil compaction.



Figure 11. Multispecies cover crop blend (oats + peas + crimson clover + sorghum-sudangrass + radish + sunflower) in the 2026 OFCAF demonstration at the Perennia Field House. This demonstration shows that productive multispecies cover crops can be successfully established in Nova Scotia's Annapolis Valley. Diverse cover crop mixtures can help reduce soil compaction while also providing additional benefits such as improving soil structure, adding organic matter, protecting the soil from erosion, supporting nutrient cycling and suppressing weeds. These cover crops were planted on June 10 and the photo was taken 63 days after planting on August 12.

REFERENCES

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