SoilCare

SOILCARE FOR PROFITABLE AND SUSTAINABLE CROP PRODUCTION IN EUROPE

Factsheet #4: SOIL IMPROVING CROPPING SYSTEMS FOR COMPACTION

THE PROBLEM

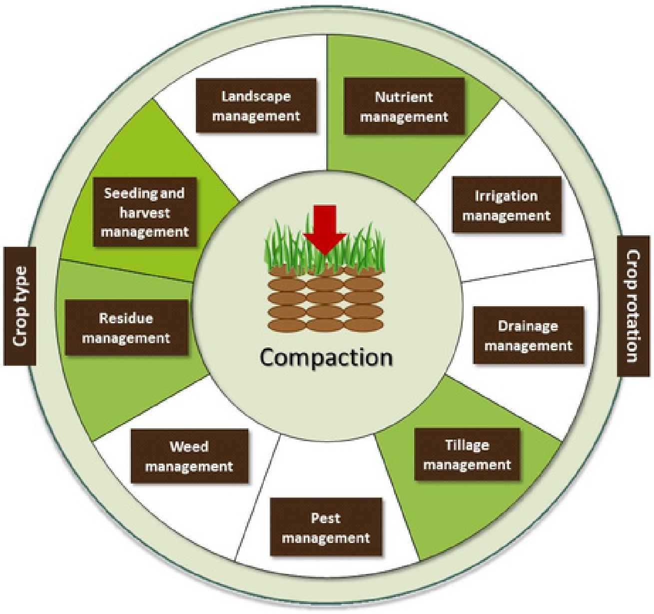
Soil compaction occurs where soils have become denser due to a reduction in pore (air) space. This affects several ecosystem services alongside crop yields and quality. In agricultural fields, compaction may be induced by natural factors or by farming practices, including excess livestock grazing and heavy agricultural machinery. Once subsoil compaction occurs, it is very difficult to remediate so should be prevented wherever possible (read more here). Meanwhile, topsoil compaction can be remediated using appropriate SICS (see below).

HOW CAN SOIL-IMPROVING CROPPING SYSTEMS PREVENT & REMEDIATE SOIL COMPACTION?

Soil improving cropping systems (SICS) are specific combinations of (1) crop types, (2) crop rotations and (3) management techniques aimed at halting soil degradation and/or improving soil quality and at the same time having positive impacts on profitability and sustainability. They need to be suited individually to each farm's local environment and are most likely to be successful for reducing topsoil compaction. The key principles for preventing compaction are:

- Organic matter management
- Reducing traffic on the soil (e.g., machinery)
- Rotation management

These can be put into practice through the following SICS:



SICS component	Basic principle
Long and diverse crop rotations	Improves soil structure through having various root lengths and growth structures
Tillage measures	Subsoiling followed by min-till can, on some soil types, improve structure by breaking up compaction and minimising trafficking which causes further compaction
Controlled traffic management	Confines machinery to certain areas (e.g., permanent tramlines, headlands) and using lightweight, unmanned machinery (e.g., Robotti)
Crop residues and mulches	Adds organic matter which reduces the density of soil, thus reducing compaction

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CROP ROTATIONS

Crop rotations are an integral part of SICS and can prevent soil compaction through breaking up the structure of soil and allowing air to enter, for example, alternating deep-rooted and shallow rooted plants or alternating a series of crops with a period of grassland (grass-ley) and introducing cover crops.

Choice of crops: Diversity of crops is key to providing a variety of root structures to break apart compaction and allow the formation of channels for air and water flow. Daily changes in root diameter can also loosen compacted soil. Tap-rooted dicots often have this characteristic. Vegetables, fruits, grains and seeds which are harvested above ground in drier summer weather can have a lower impact on compaction than root crops, which may be harvested by machinery at wetter times of the year. This can cause more compaction, but could be alleviated by a long and diverse rotation.

Cover crops: Cover crops are grown between rows of main crops in orchards and vineyards or between periods of regular production to improve soil structure. Some cover crops such as alfalfa and clover also replenish the nitrogen supply of the soil. Tap-rooted fodder radish and rapeseed cover crops have been shown to leave deep root channels in compacted soils, enhancing the root development of subsequent crops. Which species is most suitable also depends on local conditions such as climate, soil and farming system.

Fallow crops: Fallow crops can allow the soil to recuperate if the fallow period is long enough. On soils with very poor structural stability, consider moving towards ley-arable rotations.

Trees: Incorporating trees and hedges into the farm landscape can also provide deep and large roots to help prevent and alleviate compaction over a longer timescale.

CROP RESIDUES AND MULCHES

Covering soils with residual crops left after harvest, mulch from resources such as tree cuttings and adding manure in suitable quantities for the specific soil type and situation can protect and enhance soil structure.

Crop residues: Crop residues can be left on soils to add organic matter as they break down and are incorporated into the soil through natural processes. Organic matter binds with minerals, which increases porosity and aggregate strength. The effect can be dependent on the soil type, moisture, temperature and the type of crop.

Applying organic manure or soil stabilisers: This improves the structure, elasticity and cohesion of the soil which strengthens it against compaction.

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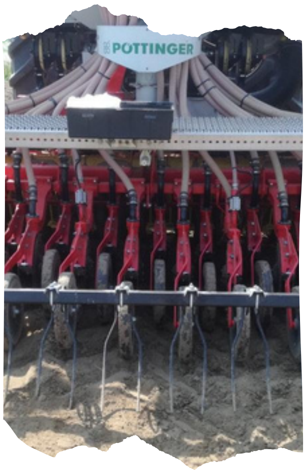
TILLAGE MANAGEMENT



Tillage management is another essential SICS tool which can prevent and help remediate compaction at the topsoil level. Considering timing, frequency and depth of tillage can allow soil organisms to be minimally disturbed and soil structure to improve, alleviating compaction.

Subsoiling: Sub-soiling, or deep cultivation, allows hard pans to be broken up to alleviate compaction. However, there is a variable effect on crop yield. Following subsoiling, reduced-tillage and traffic on the field should help to prevent further compaction. Creation of cracks and fissures may be preferable to sub-soiling.

Tillage management: This can include no-tillage, reduced-tillage, ridge-furrow systems, hillocks and mulch tillage. Reducing tillage reduces the amount of trafficking used and disturbs the soil less, thus reducing compaction risk. Studies suggest that conservation tillage can reduce yields but this varies strongly on crop type, tillage technique, soil texture and crop rotation.

CONTROLLED TRAFFIC MANAGEMENT

Controlled-Traffic Farming (CTF) is a management strategy to minimise traffic-induced soil compaction. Trafficability is the ability of the soil to support and withstand traffic such as machinery and livestock, without causing major or long-term damage. Traffic management can also relate to timing, operating when soils are drier and less prone to compaction.

Controlled-Traffic Farming: Here, machinery pathways are used so that the majority of the field is not driven on and therefore the risk to compaction is reduced. These pathways can be created through automation such as automatic steering and navigational equipment in machinery. In order to minimise the risk of subsoil compaction, wide, low-pressure tyres should be used.

Traffic management timing: Good traffic management includes considering the timing of machinery use so that wet periods where tyres may slip and put pressure on wet soils is avoided. Terranimo and Tyres/tracks And Soil Compaction (TASC) allow the calculation of trafficability for farmers and can be useful tools.

Soil variance across fields: Understanding where and how soil types vary across a field can also help with planning the use of machinery. For example, if machinery is being used that will change in weight as the operation continues (e.g., slurry application), when the load is heaviest, it can be driven over an area of the field which are least prone to compaction. When the weight lessens, more compaction-prone areas of the field can be driven over.

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