Norway study site experiment 1: DEEP-ROOTING COVER CROPS FOR REDUCING SOIL COMPACTION

The problem

Economic pressures have led to an increase in the use of large farm machinery, often under unfavourable conditions. In Norway, this problem is amplified by climate change and increases in precipitation during the growing season and at harvest.

Soil compaction, a leading cause of soil structure damage, occurs when pressure applied to the soil exceeds the capacity of the soil to withstand the load. As a result, soil particles are pushed together and the number of large and medium pores between soil aggregates decreases. The resulting damage to the soil structure causes decreased root growth and reduced water infiltration. This can lead to an increase in denitrification, reduce efficiency of fertilizers, and increase greenhouse gas emissions. damages below 50 cm are considered permanent.

Use of heavy machinery during non—ideal conditions causes soil compaction below the ploughed layer. In moist conditions, standing water can increase erosion, whilst under dry conditions, layers of dense soil reduces water transport through the soil profile. Soil management measures or plant roots can affect the deeper layers of the soil.

Field trial in Solør Odal

The proposed solution

The study site in Solør-Odal (Roverud, Kongsvinger) was established in spring 2017, in a field previously used to study soil compaction.

The aim of the SoilCare experiment was to investigate the possible loosening effect of compacted silt soil by growing deep rooting plants (biological soil loosening, biodrilling) Alfalfa (Medicago sativa) and "rybs" (Brassica rapa ssp. Oleifera) in a crop rotation with barley.

Field trial in Solør Odal

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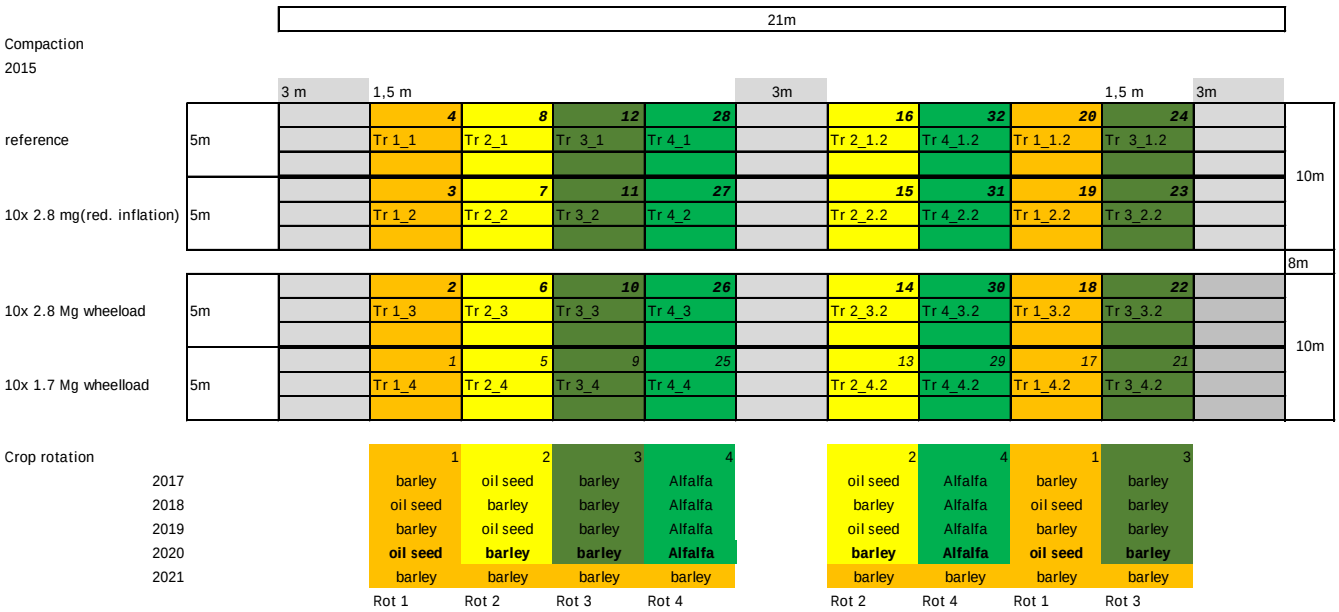
Experimental design



The plots were compacted in 2015 by multiple wheeling (10x) with either 1.7 Mg or 2.8 Mg wheelload.

Results

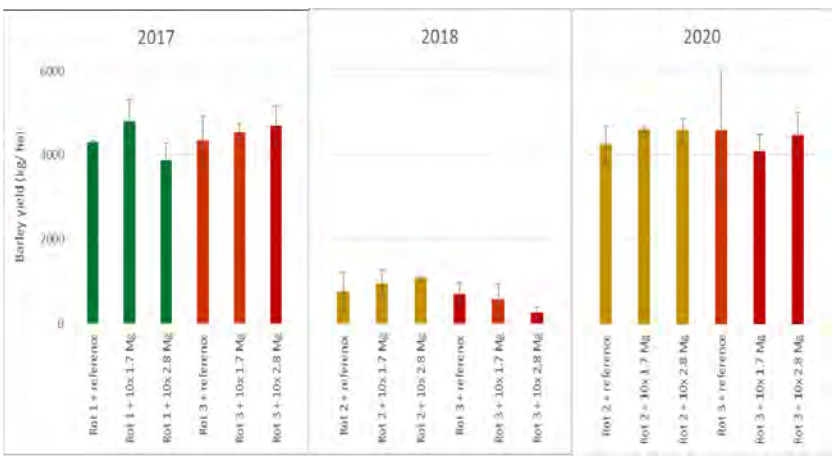


Figure 1. Barley yield (kg/ ha) versus treatment. Yields varied between years but not so much between treatments.

Deep rooting Alfalfa

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Results

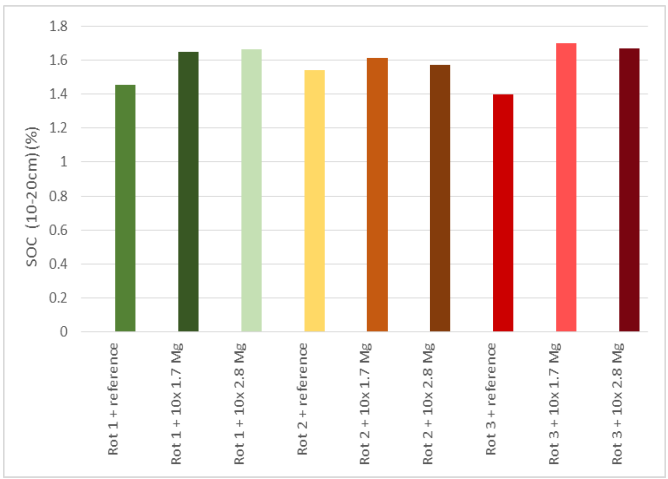

Figure 2. Soil organic carbon (10-20cm, %) versus treatment (2019).

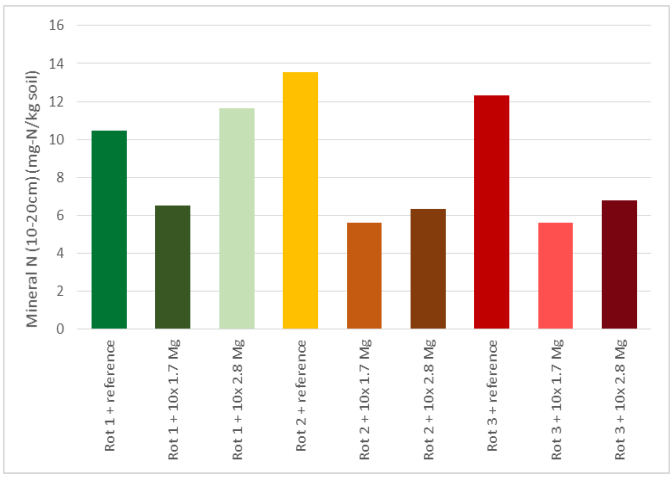

Figure 3. Mineral N versus treatment (2019).

Roots of alfalfa in the soil during growing season 2020. Picture: T. Seehusen

Compaction trial (2015)

Ruts due to compaction (2015). Picture: T. Seehusen

Despite comparatively low wheelloads and workable conditions did multiple wheeling with 2.8 mg wheel load led to severe soil compaction in both top- and subsoil in 2015.

Multiple wheeling created ruts. Picture: T. Seehusen

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Effect of plant roots on bulk density in subsoil

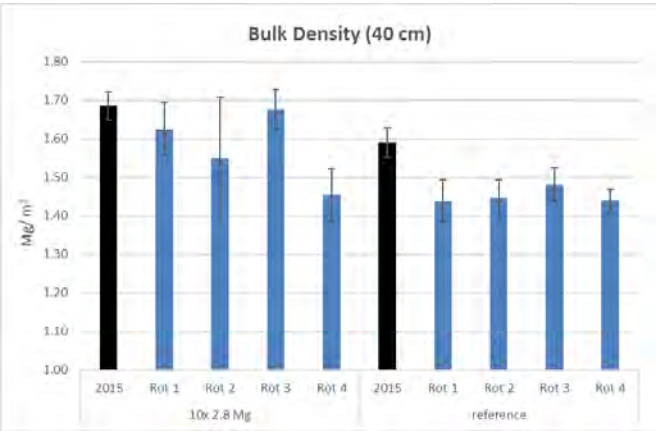

Figure 4. Bulk density (40 cm) on compacted (10x 2.8 Mg wheel load) and non-compacted reference plot in 2015 and 2020

- Bulk density (BD) reflects the soil's ability to function for e.g. root growth, water movement and soil aeration
- BD was significantly increased by compaction in 2015
- BD improved especially on non-compacted reference plot (2015- 2020)
- BD in 2020 was still higher on former compacted plot
- Roots of Alfalfa (Rot 4) significantly reduced BD on compacted plot while roots of barley (Rot 3) had no effect on BD (2015- 2020)

Roots of alfalfa in the soil during growing season 2020. Picture: T. Seehusen

Economic impact

- Oilseed (turnip rape) had the potential to result in the best economic benefits. The growing season is, however, too short for this crop in this part of Norway
- Alfalfa copes better under the climatic conditions
- On the one hand, Alfalfa neither needed fertilizer nor plant protection. Since it was grown over several years, costs for establishment were only generated the first year which made Alfalfa comparatively cheap to produce
- On the other hand may crops grown over multiple years, reduce flexibility for the farmer
- In addition, Alfalfa crops are difficult to sell in Norway which may result in economic loss compared to producing cereals

Agricultural management technique	Barley (control)	Alfalfa (SICS)
Investments costs	10	0
Maintenance costs	492	38.2
Production costs	0	0
Benefits	208	208
Summar y= benefits-costs	-294	169.8
Percentage change	-154.7	

Summary of the benefits of SICS (SICS vs. control), the numbers are in euro/ha.

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Stakeholder feedback

- Stakeholders were pleased with the focus on cover crops, which they found both interesting and useful. Some did, however, expect the results to be more significant, with larger effects.
- Some acknowledged that SoilCare has been important for raising awareness and changing perceptions surrounding cover crops
- It was posed that planting cover crops in larger blocks may have reduced slug burdens
- Further research is needed according to stakeholders, using longer-term experiments for easier verification of the results.
- Also, further research is required into the effects of cover crops on more soil variables and the suitability mapping of more cover crop species in collaboration with the extension services and farmers.
- Overall, SoilCare appears to have been successful in building stakeholder networks both nationally and internationally, and for providing stakeholders with information and knowledge surrounding cover cropping.

Key findings

The yields for all three seasons showed a variation between years but no significant effect of treatments on yields (Fig. 1).

The results for the SOC (Fig. 2) show no clear effect of crop rotation, but a tendency towards reduced SOC on the non-compacted reference plots was identified. In addition, a trend towards lower N min (Fig. 3) following compaction was identified, especially in rotations 2 and 3.

Alfalfa had a positive effect on bulk density, (Fig. 4) especially on compacted plot, where the bulk density improved significantly compared to compacted state.

Although the oil seed variety grown had been expected to be well-adapted to the short growing season in Norway, the oilseed established poorly. It is expected that Alfalfa residues will result in a considerable amount of biomass on and in the soil (roots). This addition of biomass will result in increased SOC over time.

Conclusions

- Low yields were mostly due to unusual, poor weather conditions during the whole research period.
- The growing season in this part of Norway is too short for a proper establishment of oil seed.
- The experimental plots were comparatively small. This made mechanisation challenging.
- Alfalfa established an impressive root system and seems to be well-suited to loosening up soil compaction.
- Alfalfa may be costly to produce for the farmer.

Fact sheet authors

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