SoilCare

Study site experiment #2: DEEP-ROOTING GRASS LEYS FOR WATER INFILTRATION AND SOIL ORGANIC MATTER

The problem

Flood risk is associated with compacted soils due to a high amount of trafficking, including sheep and machinery for harvesting. This experiment in the east of England explored the potential of deep-rooting grass leys for reducing flood risk and increasing soil organic carbon, whilst maintaining food production.

The proposed solution

'Festuloliums', ryegrass (*Lolium* sp.) hybrids with Meadow Fescue (*Festuca pratensis*) and Tall Fescue (*F. arundinacea*), have been developed for their deep rooting characteristics, primarily to improve drought resistance. They also have the potential to increase water infiltration rates by around 50%. Cocksfoot (*Dactylis glomerata*) cultivars have also been developed for their deep-rooting characteristics but have not been tested for their potential to deliver ecosystem services.

These alternative grass leys could, therefore, offer a solution for reducing soil compaction and flood risk by improving soil structure and porosity for better water infiltration and holding capacity. They could potentially also help to sequester carbon below the plough layer (approx. 30 cm).

A fenced-off section of the plot.

Experimental design

A plot trial experiment was carried out from 2016-2020. There were five test cultivars, two of which, the Festulolium 'Fojtan', and a Cocksfoot, 'Donata', were studied in detail'. Control plots contained a standard ryegrass mixture with white clover (*Trifolium repens*) and red clover (*T. pratense*). There were three replicates of treatments and control, and plots measured approx. 230 m x 8 m.

A 3 m area was fenced off during years 3-4, in which no grazing or mowing took place to test the effect on root growth. The remaining trial area was cut for silage and grazed by weaned lambs in the spring and autumn in line with normal management.

Measurement	Time of year	Approach used
Sward volume	June	Rising plate meter
Grazing counts	Spring and Autumn	Counts
Root volume	Autumn	Hand sorting of roots from soil samples, extraction, drying and weighing
Penetration resistance	Autumn	2 cm intervals to 45 cm depth (Fieldscout SC900 penetrometer)
Infiltration rates	Autumn	Double ring infiltrometer

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Results

- No significant difference in sward volume was found between the test and control plots
- Grazing lambs showed no significant preference between plots
- Soil organic carbon differed with depth but not between treatments
- There was a significant effect on root volume at 70cm depth for grass cultivar and harvesting
- Control plots had highest root volume in harvested areas, whilst, Fojtan had significantly higher root volume in unharvested areas (Figure 1)
- Penetration resistance was significantly lower in unharvested plots at 0-10 cm depth. This was correlated with amount of forage (Figure 2)
- Fojtan had the highest water infiltration rate in Year 1, but there was no difference in Years 2 and 3

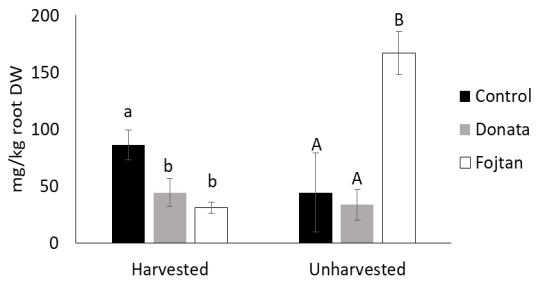

Figure 1. Amount of roots at 70 cm depth in cut and grazed, and unharvested sections of plots.

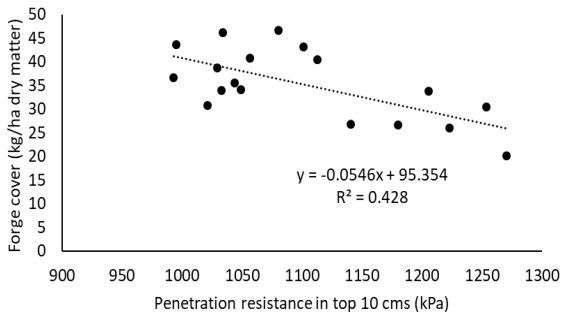

Figure 2. Relationship between forage amount and soil compaction to 10 cm in fenced unharvested sections of experimental plots.

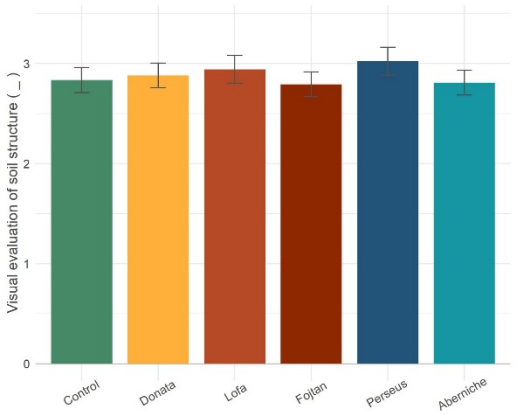

Figure 3. No significant differences were found between the different grass cultivars and Visual Evaluation of Soil Structure (VESS) scores.

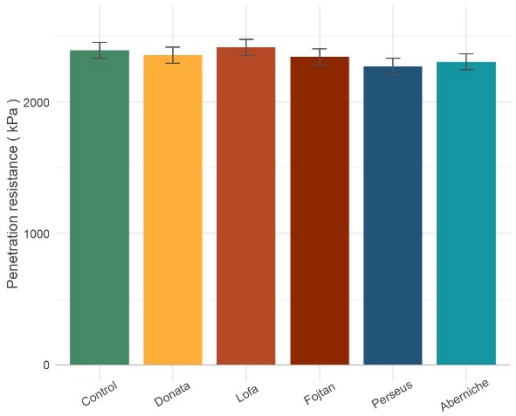

Figure 4. No significant differences were found between the different grass cultivars and penetration resistance.

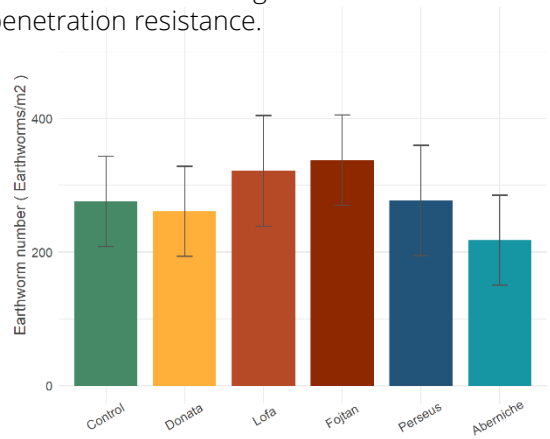

Figure 5. No significant differences were found between the different grass cultivars and earthworm counts, though Fojtan and Lofa had slightly higher counts.

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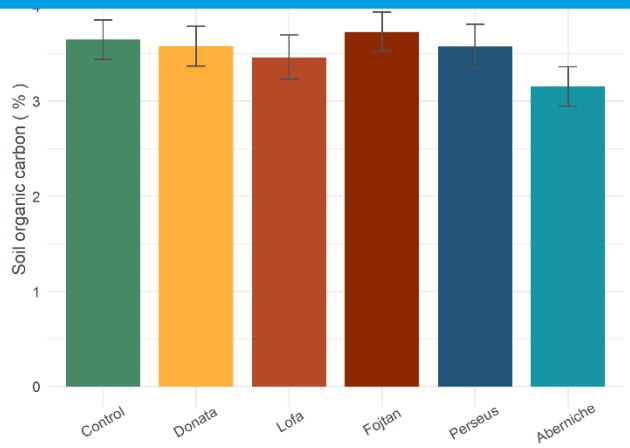

Figure 6. The different grass cultivars had no significant effect on soil organic carbon during this experiment.

Measuring water infiltration rates

Stakeholder feedback

- Farmers showed particular interest in the results which showed higher root volumes for festulolium cultivar (Fojtan) in ungrazed plots compared to the control.
- Results were considered particularly interesting for farmers who are considering land use change in mixed farming areas.
- The results highlighted the need for further research to improve understanding of grazing pressure on different grass species. They also provide evidence for a need to introduce an agri-environment scheme option reducing grassland management intensity.
- There was some disappointment that the deep-rooting grass leys did not have any significant impact in the grazed plots. It was suggested that perhaps plant breeding for these deep-rooting species had occurred in the absence of livestock e.g. not in "real world" situations.
- *Note: No economic data were gathered for this experiment as the cost of establishing each cultivar was the same.*

Factors encouraging the adoption of grass leys in the rotation:

- Deep-rooting grass leys are simple to implement with existing practices
- May help with blackgrass control

Barriers preventing the adoption of grass leys in the rotation:

- Limited knowledge amongst farmers about the costs/benefits of these grass leys
- Lack of awareness about any financial support for farmers
- May not be attractive to wholly arable farmers
- Conflict with the goal of increasing food supply (cereal yields may decline at catchment scale)
- 5-year rule for permanent pastures prevents ploughing of grass leys after 5 years
- Countryside Stewardship prevents conservation of forage

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Key findings

- In unharvested plots, Fojtan had significantly higher root volume at depth than the control and Donata.
- Less intensive harvesting and lower associated compaction may increase the potential for reduced flood risk through Fojtan root growth.
- Fojtan and Donata are as productive and palatable to weaned lambs as a conventional ryegrass and clover ley.
- Cutting and grazing the forage create soil compaction and reduce root growth and the soil's ability to absorb water.
- Using Fojtan could contribute to flood risk management if combined with low intensity harvesting.
- The different grass cultivars resulted in no significant differences in VESS scores, earthworm numbers, soil organic carbon or penetration resistance. Further soil carbon research is now being conducted as a result of this trial.
- Some of the stakeholders who participated in a final workshop which presented the results of the study were disappointed with the findings of the study, with a suggestion that a longer-term data set would have been more plausible.
- Regardless, stakeholders remain largely supportive of the SoilCare project.

Conclusions

The aim of this experiment was to see if deep rooting grass cultivars (mainly festuloliums) could perform better than a rye grass clover mix control for sheep forage, and help alleviate some compaction across the field. We hoped to see improvements in SOC, infiltration and reduced penetration resistance due to the deep rooting grasses, but we found very little difference. After the experiment had finished we dug deep trenches (70 cm depth) in the soil again and found that in the area that was fenced off so no grazing could occur, four of the five test cultivars had higher root volume than the control plots at 70cm, but this difference was not statistically significant. We conclude that compaction inhibited root growth in the main plots after the first year, and that root growth may have reduced as the plants aged.

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