

Management of docks (*Rumex obtusifolius*) of docks through enhanced soil health.

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Introduction

Docks (*Rumex* spp.) are a pervasive problem on livestock farms. They can infest pastures causing reduced forage yield and quality. The seeds can remain viable for over 50 years (Kivilaan & Bandurski, 1973) and can move around a farm, or between farms, because the seeds remain viable in slurry and in silage. Farmers often carry out specific agrochemical treatments to specifically manage docks, which add additional economic cost and increase the risk of environmental pollution. A particular limitation for dock management is that many dock herbicide treatments also kill broadleaf species including those found in herbal leys. Thus, also reducing plant species diversity on farm.

The agro-ecological approach to weed management focuses on what conditions favour particular weed species (McCaman, 2013). It is well documented that docks thrive in low calcium, and compacted soils (Pfeiffer, 1970, Walters, 1991). There is extensive literature defining *Rumex* spp being non or low mycorrhizal forming (e.g. Brito et al, 2014) and compaction results in inhibition of mycorrhizae (Miransari et al, 2009). Therefore, where there is poor soil structure, mycorrhizae-associating plant species become less competitive against docks.

This Field Lab had the aim of testing whether dock populations could be reduced in grassland by addressing potential calcium deficiency and surface or deep soil compactions.



Figure 1: The image shows the lines of docks established down the wheelings where soil has been compacted.

Method

Ten farmers were recruited for the Field Lab as part of the Lottery funded Farm Net Zero project. Each farmer identified a single field which had some dock infestation, and the field would not be herbicide treated for the following season. A field design was created for each field, with half the field treated with a rapid release calcium product, and in the perpendicular direction half the field was to be treated with a compaction reducing mechanical intervention (Figure 2).

Field maps provided to illustrate zoning approach and application of treatments across the field.

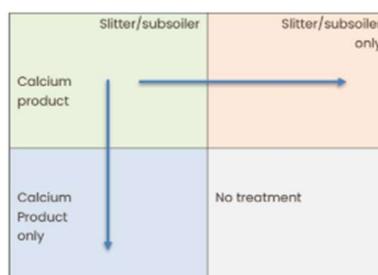


Figure 2: Trial design with half field receiving mechanical remediation of soil structure running perpendicular to any calcium application in order to measure the impact of 4 treatments as shown

Figure 2: An example (Carwen Farm) of the trial design provided to the farmer.

In March 2024, each field was soil sampled to a depth of 30cm. A minimum of 15 augers of soil, using a 1.2cm-bore auger, were taken following a 'W' route across the field. The soil from each field was bulked into a single sample and sent for the complete nutrient package assessment (NRM Laboratories).

On the initial farm sampled, 3 VESS¹ pits were dug per field quarter. This was later amended to 5 pits with 1 in each quarter and a central point. The soil structure was assessed using the VESS methodology at the surface (0-15cm) and at depth (15-30cm). Additional field notes were made as appropriate. Finally at the same five sample points, 5 replicate sets of dock numbers was recorded in a 1 m² area. All sample points were GPS logged.

The farmers were provided with soil reports defining options to address potential conditions that would favour dock infestation.

A repeat dock assessment and soil compaction assessment was planned to take place at the end of the growing season when soil treatments had been carried out by the farmers.

Data for soil compaction was analysed using a two-sample T test (Genstat, VSNi). Dock counts numbers were analysed using REML Linear mixed model (Genstat, VSNi).

¹ Visual evaluation of soil structure (VESS) is a straightforward and quick way to test soil structure in a few simple steps. The soil quality score produced can help highlight where soil structure needs to be improved. AHDB have produced a helpful guide on [How to assess soil structure | AHDB](#)

Results

Compaction assessments

There was some compaction at both the shallow and deeper depths in all field assessed (Figure 3). Each of these fields had been selected by the farmers for the trial due to the dock infestation present. There was no significant difference in top and bottom soil compaction (VESS) scores ($t=0.57$, d.f. = 62, $P = 0.568$) across farm sites.

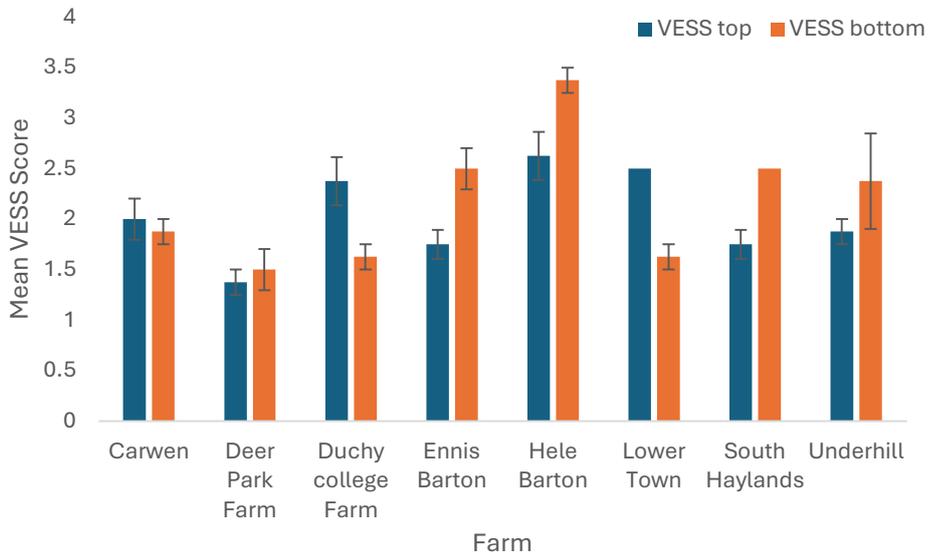


Figure 3: Mean (n=4) VESS score for top (0-15cm), and bottom (15-30cm) of the soil profile. A VESS score of 1 equates to no compaction, and a value of 4 indicates soil which is angular soil ‘lumps’ with little or no root growth within the soil. Error bars indicate standard error; there was no variation in score if there are no errors present.

Dock infestation

There were significant differences in dock infestation between farms ($P=0.001$) and there was an interaction between farm and sample area ($P=0.02$) showing that docks were not evenly distributed across the field (Figure 4).

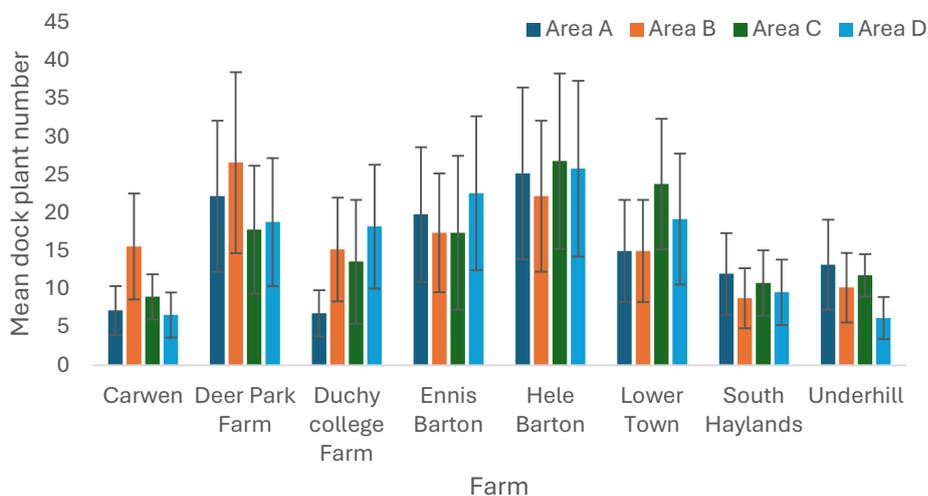


Figure 4 Mean dock plant score (n=5) per field area (A-D) for each farm. Error bars indicate standard error.

Nutrient availability

Table 1 provides details of the calcium availability in the trial fields alongside the other bases of potassium, magnesium and chloride. There are four fields on farms Deer Park Farm, Duchy Farm, South Haylands and Underhill farm which have calcium levels lower than 1000ppm. This is the critical threshold indicated by John Kempf (AEA) for good plant structure although recommendations also need to make sure for every 1000ppm calcium there is 3 ppm boron. Table 2 shows that all fields had an inadequate level of boron to support plant uptake of calcium.

McKibben (2021) recommends using the Albrecht methods to balance calcium availability in soils, particularly in soils above the Cation Exchange Capacity of 10.0 because other cations such as magnesium, chloride and potassium influence the calcium availability to plants as well as cause a break down in soil structure. His recommendations state that a healthy soil should have 60 to 70% base saturation of calcium. From Table 1, all fields are below this level. This indicates that there is a shortage of calcium in all fields, taking pH and the other cations into account.

| | K (%) | Mg (%) | Ca (ppm) | Na (ppm) | mEq K | MEq Mg | MEq Ca | MEq Na | CEC | Base saturation | Base saturation Ca | soil type | VESS shallow | VESS deep |
|-----------------|-------|--------|----------|----------|-------|--------|--------|--------|------|-----------------|--------------------|-----------|--------------|------------|
| Hele Barton | 102 | 91 | 1450 | 19.5 | 0.26 | 0.76 | 7.25 | 0.08 | 12.6 | 66.31 | 57.5 | v heavy | compacted | compact ed |
| Deer Park Farm | 58 | 67 | 860 | 15 | 0.15 | 0.56 | 4.30 | 0.07 | 10.2 | 49.73 | 42.2 | medium | no | no |
| Duchy farm | 142 | 90 | 875 | 21.5 | 0.36 | 0.75 | 4.38 | 0.09 | 10.5 | 53.17 | 41.7 | medium | compacted | no |
| Lower town Farm | 121 | 115 | 1080 | 20 | 0.31 | 0.96 | 5.40 | 0.09 | 11 | 61.41 | 49.1 | medium | compacted | no |
| South Haylands | 68 | 81 | 995 | 19 | 0.17 | 0.68 | 4.98 | 0.08 | 10.4 | 56.80 | 47.8 | m sandy | no | no |
| Carwen | 93 | 90 | 1230 | 21 | 0.24 | 0.75 | 6.15 | 0.09 | 11.8 | 61.27 | 52.1 | heavy | no/variable | compact ed |
| Underhill | 69 | 72 | 965 | 16 | 0.18 | 0.60 | 4.83 | 0.07 | 10.1 | 56.15 | 47.8 | stoney | no | compact ed |
| Ennis Barton | 183 | 151 | 1160 | 17 | 0.47 | 1.26 | 5.80 | 0.07 | 12.2 | 62.31 | 47.5 | medium | poached | no |
| Tregleath | 67 | 91 | 1140 | 29.5 | 0.17 | 0.76 | 5.70 | 0.13 | 10.4 | 64.98 | 54.8 | medium | compacted | no |

Table 1: Farm soil data to include nutrient availability, with VESS (Visual Evaluation of Soil Structure) for shallow (0-15cm) and deep (20-30cm) soil depths. Cation Exchange Capacity is given , with an estimate of base saturation using the Albrecht method.

| | Ca (ppm) | B (ppm) |
|-----------------|----------|---------|
| Hele Barton | 1450 | 0.9 |
| Deer Park Farm | 860 | 0.6 |
| Duchy farm | 875 | 0.6 |
| Lower town Farm | 1080 | 0.6 |
| South Haylands | 995 | 0.6 |
| Carwen | 1230 | 0.7 |
| Underhill | 965 | 0.6 |
| Ennis Barton | 1160 | 0.8 |
| Tregleath | 1140 | 0.7 |

Table 2: Farm soil data comparing calcium and boron soil levels.

Issues with the trial

The easing of compaction with a subsoiler/slitter for the field trial was arranged with a local contractor during the growing season of 2024. However, the confounding effects of weather, and demands on the contractor's time resulted in the operations not taking place. This was the major flaw in the experimental design because of the lack of easy access to the right machinery. Slitting needs to take place when soils are moist but not wet, this allows compacted areas to be crumbled but not 'smeared' (which exacerbates any issues with soil structure). Timing of the operations with respect to weather, grazing and/or cutting is vital to achieve success.

Conclusion

The lack of uniform distribution of docks across a field could have been a consequence of the effect of seed distribution and the source of 'founding' dock plant; uneven levels of calcium across the field and/or the influence of differences in soil compaction.

Anecdotal evidence indicates that sites of drinking troughs, temporary fences, areas of livestock shelter in hedges, and places where ring feeders had been historically placed all had an increased chance of more dock plants. Although there was an unfortunate lack of completion of the trial, the project has increased awareness of weed distribution across fields, and consideration of why higher numbers of docks are found in some areas.

Calcium deficiency in plants can be determined through soils analyses, plant tissue analyses or more recent industry recommendations include plant sap testing. John Kempf (AEA) states that plant sap analyses must have 1000ppm calcium with 3ppm boron. The soil samples had less than the recommended 1.0-1.5ppm boron (McKibben, 2021). It is possible therefore that boron was limiting and thus calcium uptake inhibited. Some recent market products do indeed include boron with calcium as a foliar feed.

Calcium availability to plants can also be influenced by the presence of other cations in the soil. The relative proportion of calcium to magnesium, potassium and sodium are used in the Albrecht calculations. This method was used in analysis of the soil data and it highlighted that the calcium base saturation, the ability of soils to hold and release calcium, was below the recommended threshold of 60-70% in all soils of the trial.

All fields had some level of compaction either at surface or deeper levels. The trial farms are all in the South West of England where rainfall is high. Even with good grazing management, which is demonstrated on the trial farms, compaction can take place due to the weather. Routine checking for compaction with a spade is highly recommended. Furthermore, the low levels of calcium availability can exacerbate poor soil structure

Although the trial did not fulfill the goal of quantifying a change in dock density following intervention with calcium and/or easing of compaction, conditions were ideal to create a selective environment to favour docks over other pasture species.

For farmers, there are a range of methods to track whether soils and therefore plants are deficient in calcium, affecting dock competitive advantage from soil, tissue and sap analyses. These vary in ease and cost of sampling and assessment. There would be value in tracking the trial fields over multiple years, and assessing calcium by all methods, and aligning with dock infestation. It may result in finding that one method is more reliable, or all are equally effective.

Furthermore, there are a range of calcium products, from the granule size, ability to dissolve and calcium formulation (e.g. gypsum, calcium carbonate) which will vary in price and availability for farmers. There would be value in providing a guide to help improve efficiency in the use of these products to address particular soil issues/nutrient deficiencies.

Finally, a key lesson to learn from this FieldLab is in the design. When a single piece of relatively rare equipment is needed over multiple farms, and the weather conditions need to be correct for equipment use, it is important to make sure that either the farms are close together and/or one or several of the trial farmers own the equipment.

Acknowledgements

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References

Brito, I., et al. (2014). Managing arbuscular mycorrhizal fungi for bioprotection: Mn toxicity. *Soil Biology and Biochemistry*, 68, 78–84.

Kempf, J. Advances in Ecoagriculture. <https://advancingecoag.com/podcast/short-1-macropak-and-the-importance-of-calcium/>

Kivilaan, A., & Bandurski, R. S. (1973). The ninety-year period for Dr. Beal's seed viability experiment. *American Journal of Botany*, 60(2), 140–145. <https://doi.org/10.1002/j.1537-2197.1973.tb10210.x>

McCaman, J. L. (2013). *When Weeds Talk*. Acres USA.

McKibben, W. (2021). *A Growers Guide to Balancing Soils*. Acres USA

Miransari, M., et al. (2009). Effects of arbuscular mycorrhiza, soil sterilization, and soil compaction on wheat (*Triticum aestivum* L.) nutrients uptake. *Soil and Tillage Research*, 104(1), 48–55.

Pfeiffer, C. (1970). *Weeds and What They Tell Us*. Floris Books.

Walters, C. (1991). *Weeds: Control Without Poisons*. Acres USA

Appendix 1

| Farm | | A | B | C | D | E | Comments |
|-------------------|-------------|------|------|------|------|-----|--|
| Deer Park Farm | VESS Top | 1.5 | 1.5 | 2 | 1.5 | 1.5 | A Good root mass, slightly tight at 3-4 inches B root rooting, soil friable, bit tight throughout profile C Slight surface capping in top 1 cm. Some tightness at 3-4 inches D stoney but no compaction at depth, slight surface capping E clumps present at 4-5 inches Dock pressure worse at the bottom of the field. |
| | VESS Bottom | 1.5 | 1.5 | 1.5 | 1 | 1.5 | |
| | D1 | 9 | 7 | 7 | 10 | | |
| | D2 | 5 | 4 | 3 | 5 | | |
| | D3 | 10 | 9 | 11 | 14 | | |
| | D4 | 4 | 4 | 19 | 8 | | |
| | D5 | 3 | 6 | 9 | 4 | | |
| Dock zone average | 6.2 | 6 | 9.8 | 8.2 | | | |
| Underhill Farm | VESS Top | 2 | 2 | 2 | 1.5 | 1 | A Top 3 inches (2), 3-5 inches (3), below 5 inches (2.5) Top left B Light surface capping on top 1 cm but compaction below 3 inches C rusting (top right of field) D Top inch (1.5), Below 2 inches (3) E Compaction between 3-6 inches Top of field worst for dock pressure |
| | VESS Bottom | 1 | 2.5 | 3 | 3 | 2 | |
| | D1 | 10 | 6 | 19 | 7 | | |
| | D2 | 12 | 5 | 4 | 6 | | |
| | D3 | 16 | 19 | 17 | 6 | | |
| | D4 | 10 | 9 | 8 | 7 | | |
| | D5 | 18 | 5 | 11 | 5 | | |
| South Haylands | VESS Top | 2 | 1.5 | 1.5 | 2 | 2 | A 2-5 inches (2.5), 5-8 inches (2), Top left of field B Darker soils present here, 1-5 inches shows signs of compaction, C which is densely packed (3) D compaction between 2.5 - 6 inches E 7 inches, worst at 5 inches Dock pressure slightly worse at the top of the field |
| | VESS Bottom | 2.5 | 2.5 | 2.5 | 2.5 | 2 | |
| | D1 | 9 | 5 | 12 | 7 | | |
| | D2 | 14 | 8 | 13 | 7 | | |
| | D3 | 12 | 9 | 11 | 5 | | |
| | D4 | 8 | 9 | 6 | 11 | | |
| | D5 | 17 | 13 | 13 | 18 | | |
| Hele Barton | VESS Top | 2.17 | 2.17 | 2.67 | 1.75 | | A B C D E |
| | VESS Bottom | 2.83 | 3 | 2.67 | 3.25 | | |
| | D1 | 27 | 14 | 29 | 42 | | |
| | D2 | 27 | 27 | 39 | 17 | | |
| | D3 | 15 | 15 | 26 | 24 | | |
| | D4 | 35 | 24 | 16 | 18 | | |
| | D5 | 22 | 31 | 24 | 28 | | |
| Carwen | VESS Top | 2 | 2.5 | 1.5 | 2 | 2.5 | A Top 2 inches compacted B inches C top 1 inch poached with some clumps between 1-3 inches D of compaction and a pan. Plastic found in the profile at 4 inches with E poaching in top inch with some compaction down to 2.5 inches |
| | VESS Bottom | 1.5 | 2 | 2 | 2 | 1.5 | |
| | D1 | 14 | 16 | 8 | 6 | | |
| | D2 | 6 | 19 | 15 | 10 | | |
| | D3 | 4 | 8 | 8 | 5 | | |
| | D4 | 9 | 9 | 6 | 7 | | |
| | D5 | 3 | 26 | 8 | 5 | | |
| Lower Town Farm | VESS Top | 2.5 | 2.5 | 2.5 | 2.5 | 2 | A surface compaction from 0-4 inches. Top left of field B surface compaction from 0-3 inches C Top 3 inches compacted. Top Right of field D Top 3 inches compacted E Compacted down to 4 inches, worst in top 3 inches Right side of field with worst dock pressure |
| | VESS Bottom | 1.5 | 2 | 1.5 | 1.5 | 1.5 | |
| | D1 | 12 | 14 | 12 | 25 | | |
| | D2 | 14 | 13 | 35 | 21 | | |
| | D3 | 16 | 15 | 23 | 20 | | |
| | D4 | 14 | 21 | 23 | 11 | | |
| | D5 | 17 | 12 | 26 | 19 | | |
| Duchy Homefarm | VESS Top | 2 | 2.5 | 2 | 3 | 2.5 | A poaching present in top 3 inches B surface poaching top 2 inches C top 2 inches compacted D 2-4 inches. Dock pressure worse E the main problem Top of field worst for docks |
| | VESS Bottom | 1.5 | 1.5 | 1.5 | 2 | 1 | |
| | D1 | 4 | 18 | 19 | 9 | | |
| | D2 | 12 | 20 | 13 | 21 | | |
| | D3 | 5 | 12 | 9 | 23 | | |
| | D4 | 8 | 13 | 13 | 18 | | |
| | D5 | 19 | 13 | 14 | 20 | | |
| Ennis Barton | VESS Top | 2 | 1.5 | 2 | 1.5 | 1.5 | A poaching. Soil has a distinct smell with rusting at 2.5-3 inches B 2 - 4 inches compacted (3) with signs of rusting, 4 - 8 inches (2.5) C compaction below 4 inches D compaction between 3-7 inches E compaction between 4-8 inches Dock pressure noticeably worse in areas with localized poaching and |
| | VESS Bottom | 2 | 3 | 2.5 | 2.5 | 2 | |
| | D1 | 24 | 21 | 15 | 24 | | |
| | D2 | 10 | 15 | 20 | 23 | | |
| | D3 | 10 | 12 | 11 | 14 | | |
| | D4 | 24 | 23 | 20 | 17 | | |
| | D5 | 31 | 16 | 21 | 35 | | |

Raw field data with comments for each farm. Five zones (A-E) were assessed per field for VESS (Visual Evaluation of Soil structure). In each zone, five separate counts of dock were carried out (D1-D5).