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Use of a Sward Lifter to Improve Grassland Soil Compaction

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Summary

- **Sward lifters are used to manage deeper soil compaction problems (down to approx. 35 cm)**
- **The correct operation of the sward lifter is very important to prevent further soil structural damage**
- **Use a spade to establish the depth of the soil compaction before use**
- **Use when soil moisture is not too wet that only channels are cut but not too dry to cause soil heave and excessive tractor power use**
- **Set the leg points to 2.5 to 5 cm below the soil compaction layer**
- **Check the sward lifter is achieving the required soil shatter on a trial run**
- **Sward lift in autumn, if conditions permit, to allow regrowth of the sward and repair root damage over winter**
- **Avoid re-compaction – recently sward lifted areas are more susceptible to compaction damage**

Introduction

Soil structure

A good soil structure is essential to achieve optimum grassland growth. Soil structure is determined by the way that particles of soil are bound together to form fragments. A good soil structure is friable and crumbly (picture 1) and allows the roots to pass easily through the soil profile. Excess rainwater can drain through cracks and pores within the soil, while some water can be retained in the finer pores for plant growth. A good soil structure has sufficient movement of air through the soil and has a healthy soil biology. A poor soil structure soil (picture 2) has the opposite characteristics, it is large and blocky in structure with little airspace and reduced biological activity. Plant root growth is restricted, crop growth is limited and therefore requires remedial action to alleviate the problem.

Soil compaction

Compaction in grassland soils has become more of a concern over the last decade. With increased rainfall, the use of heavier machinery and the extension of grazing both at the start and end of the season in spring and autumn has contributed to increased soil structural damage. Compaction can reduce water infiltration rates leading to soil saturation and land drainage issues. This can result in the loss of soil nutrients through leaching and reduce soil nitrogen mineralisation. Soil compaction is known to reduce grassland yield dry matter by as much as 14% over a three year period, in wet soil conditions, where there has been only one compaction event (i.e.heavy tractor travelling over the grassland or grazing of animals) each year. Increased compaction and the reduction of yield can result in the greater application of fertiliser to ensure similar yield to an uncompacted pasture. It has been estimated that soil compaction can increase fertiliser run-off by 60%, along with increased soil loss. Any reduction in yield will result in an increase in bought-in feed, to replace the lost dry matter. These all result in greater production costs.

Although compaction of the soil from animals grazing in the field generally results in damage closer to the surface

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of the sward (0 to 10 cm depth), the compaction that results from machinery damage can be deeper down the soil profile (15 to 30 cm depth) and become much more difficult to remedy.

Limiting access to wet fields, especially for 48 hours after heavy rainfall, for both machinery and animals is the best prevention for soil compaction. Nevertheless, the UK weather means that this is not generally possible, and some soil compaction will occur through grazing or vehicle activity.

Picture 1. Good crumbly soil structure

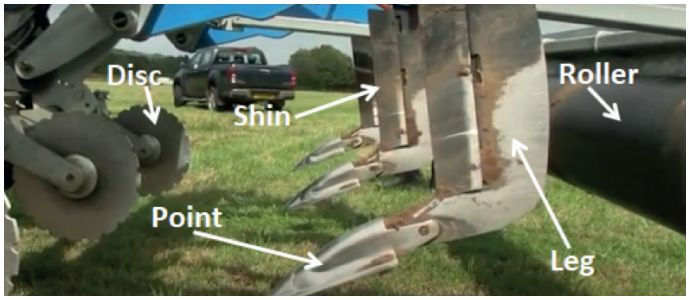
Picture 2. Poor blocky soil structure

Sward Lifters

Sward lifting is a form of non-inversion tillage to remediate soil compaction at depth. Sward lifters are designed to remediate compacted soils down to approximately 35cm. The successful operation of the sward lifter requires the lifting and fracturing of the soil from below the compacted layer.

Photo 3. Three leg sward lifter in operation with front cutting discs, lifting legs and rear rollers

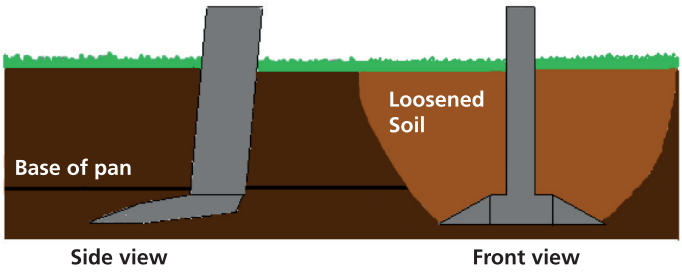
Photo 4. Sward lifter working parts



Sward lifters sold in the UK are of similar design. They are mounted on a tractor three-point linkage and typically have three to five vertical legs with a working width of 3m-4.5m. Each leg has a wearing shin plate (photo 4) which cuts through the soil and a leg point which is designed to cut below the compaction layer to lift and shatter the soil up through the soil profile towards the surface. The leg points can come in different shapes and sizes depending on the manufacturer. Some have elongated chisel points and some may have a winged foot to help increase the shatter of the soil (Figure 1). The lifter legs can be straight or forwardly slanted and have either a shear bolt or a hydraulic reset system to prevent damage from large stones in the soil. Commonly, discs are used in front of the legs, to help cut the sward allowing easier movement of the legs through the soil, reduce damage to the sward and prevent soil being pulled up at the surface (Photo 3). A packer roller follows on the surface behind the lifting leg and is designed to press the opening of the soil back together to prevent moisture loss and leave an even finish. Some rollers can have spikes which can help alleviate any surface compaction.

The tractor power requirement for a sward lifter is recommended at 140-160 HP to prevent wheel slip and further soil structure damage. This power requirement is also dependent on the lifter size, model and field conditions.

Figure 1. Loosening a compaction pan with a winged foot sward lifter



Note: the working depth must be below the zone that needs broken up.

Operation

The successful operation of the sward lifter in repairing soil compaction needs careful preparation, as if used incorrectly it can result in further structural damage to the soil.

The sward lifter needs to be operated in the correct soil moisture conditions. If the soil is too wet, the front edge of the legs will slice through the soil causing a channel, smearing and a potential deeper pan. The desired soil lift and shatter effect will not be achieved. Conversely, if the soil is too dry, the surface of the sward can be damaged and soil lift will be excessive which can pull soil and stones to the surface. Additionally, this can result in the excessive use of tractor power & fuel consumption.

Sward lifting should be carried in the autumn months when grass growth is declining and after the final silage cut or grazing when the sward height is less. The ideal forward speed depends on soil moisture, but should be sufficient to allow lift over the advancing leg without causing turf to 'flip' over the packer roller.

Operation Depth – setting the leg depth

Using a spade to dig down to below the level of compaction is essential, as this will determine the depth setting for the lifting leg. A visual assessment of the soil structure can be done using the Visual Evaluation of Soil Structure (VESS) as this will provide information on the severity of the compaction and its depth. If soil compaction is between 0 cm and 10 cm deep, using a sward slitter would be the appropriate remedy. If the compaction is between 10 and 30 cm then the sward lifter will be required.

A common working depth for a sward lifter is around 25 cm however it important to know the depth of compaction, as the leg point needs to operate 2.5 to 5 cm below the lower part of any compaction layer. If the leg point operates within the soil compaction area this will result in increased compaction as the compacted soil will be pushed to the sides and will not be shattered. Sward lifters should not be used unless compaction is identified and they should not be used at depths below their critical working depth as more soil structural damage can occur. Generally, the critical working depth is calculated as 6 times the width of the leg point i.e. if the width of the leg point is 6 cm then the critical working depth is 36 cm. Photo 5 below shows a soil with a compacted pan layer 13 cm below the soil surface.

The compacted layer is 10 cm deep so a sward lifter will need to operate 5 cm below this. A working depth of 28 cm is therefore required to alleviate this compaction.

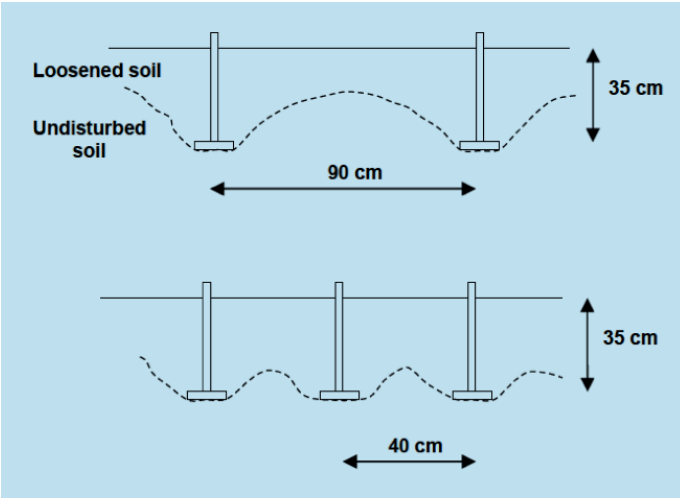
Photo 5. Soil with a compacted pan layer 13 cm below the soil surface

Spacing of the legs

If the legs of the sward lifter are set too far apart the soil will not be disturbed sufficiently between them, therefore closer spacing of the legs can help to achieve soil structure improvements across the field, especially for deeper compaction (Figure 2).

An assessment of the effect of the sward lifter in the field after a trial run is recommended. This will allow further adjustment of sward lifter settings, to ensure the required improvements in soil structure.

Figure 2. Soil shatter profiles for sward lifter legs set at different spacings



Taken from ADAS Report Bhogal et al, 2011

Potential Soil Loss

As there will be some channels evident from the passing of the sward lifter, operators should consider the direction of travel across a field in advance of completing the works required. Attempt, if possible, to work across the slopes to ensure that heavy rainfall does not give rise to soil erosion from within the channels.

As the sward lifter operates at soil depths greater than surface slitters it is beneficial to check if there is any previous drainage in the field to ensure that this is not damaged. Normally drainage starts at a depth of approximately 70 cm and should not be affected but some drains may be closer to the surface in more shallow soils.

Soil Improvement

The use of a sward lifter is intended to improve the structure of the soil by improving aeration and drainage, so any surface water should drain away more quickly. Successful sward lifting should reduce overall water-logging of the soil and allow the soil to dry more quickly after heavy rainfall. This has the potential benefit of extending the grazing period at the beginning and end of the season. An optimum soil structure will also promote soil nitrogen mineralisation from organic matter and reduce potential losses through leaching and denitrification.

Yield improvements

Research has shown that the use of a sward lifter can improve grass yield by up to 1 t/ha for a clay/loam soil that had severe soil compaction problems (Frost 1988 a+b). Although the sward lifting was undertaken in the autumn, the first cut grass yield from the following year showed a reduction in yield compared to the control. It was the second and third silage cuts that showed the increased yield. The action of the passage of the tines through the soil can damage the grass roots and this can result in reduced yields for the first silage cut in the following year.

Further research from SRUC has shown that even with moderate grassland compaction on a clay loam soil there was a 0.5 t/ha dry matter yield advantage in the following year's silage cuts after the use of the sward lifter on areas that had suffered tractor compaction.

The advantage of better drained soils for grazing dairy cattle has been calculated and has shown a £1.48 per cow/day advantage from extending the grazing period for up to 10 days (AHDB, 2018). The housing cost savings for a 50-cow suckler herd plus 10 month old calves for a one week grazing period in spring and autumn has been calculated at £2,450 (Environment Agency Wales, 2015).

Re-compaction

While the successful use of the sward lifter improves the soil structure, the soil is more susceptible to further compaction from high stock grazing or running over the field with heavy machinery. Grazing or using heavy machinery in the lifted field should be avoided for several weeks to allow the soil to reconsolidate under its own weight and allow the roots to branch into the uncompacted soils. When operating machinery in fields, it is beneficial to use light weight machinery where possible. Using floatation tyres or low ground pressure tyres will also reduce compaction due to the increase in soil and tyre surface contact area and the increased distribution of weight.

References and further reading

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