Assess your soil structure

Next steps...

Referring to the chart in the centre of this leaflet:

- Dig out a spadeful of soil, break it up and look at the bits. Smell it, feel it and rub it through your fingers.
- Are there any hard layers in the topsoil from the way the soil breaks up?
- Estimate the quality of the structure (Sq) from how easily it breaks up, the shape and size of the lumps and crumbs, the pores and roots. Use the photos in the chart overleaf for comparison.
- Soil quality Sq 1 is the best, with fine, stable crumbs. Sq 3 is moderate with a mixture of crumbs and larger lumps, including a few clods. These soils are likely to store gases well.
- Sq 5 is very compact with large, sharp-edged clods which are very hard to break up. Soil of Sq 5 is degraded and is often grey or blue and smells foul due to the lack of oxygen. Sq 4 is also poor and often has grey or mottled (blue and rusty red colours). Both Sq 4 and 5 are likely to produce nitrous oxide and methane, especially when wet or just after nitrogen is applied.

Good soil structure will benefit crop yield.

Loosen soils only if necessary

Regularly dig up and look at the soil to monitor quality. If there are compact or mottled layers in the top 20 cm of soil, loosen to just below these layers to create aggregates. In grassland, a compact grey layer can occur just below the root zone, which may be penetrated by using a spiked aerator. Compacted soil has closed-up pores which hold up water and reduce aeration. Loosening compacted zones with tines or a subsoiler should be enough to displace aggregates and re-open pores. This should be enough to stop the aggregates squeezing back together when the soil is wheeled again. When preparing seedbeds, avoid overtillage and keep the seedbed as coarse as possible to keep the aggregates large enough to retain gases.

Control compaction

Compaction closes off pores and reduces their number so the soil stores less gas and produces more nitrous oxide and methane. Controlling compaction preserves soil structure and is better than having to remediate soils once damage has been done. Avoid running over wet soil – freshly cultivated soil is often highly compactable especially when wet. Reduce compactive effort by decreasing weight (reduced payload, light machinery) or reducing ground pressure (wide tyres, minimum tyre pressures, tracked vehicles). For high value crops, consider controlled traffic where all or most vehicle wheels are confined to semi-permanent tracks between traffic-free zones for crop growth.

Grow crops with plenty of roots

Roots divide up the soil, contribute soil organic matter and provide the 'glues', which stick the soil together. Crops help to protect the soil from compaction, run off and erosion. Keep the soil covered with crops as much as possible. Consider cover crops such as clover, vetch or rye to improve soil structure when the crop is otherwise absent. Taproot crops such as clover, comfrey, lucerne, oilseed rape and turnips may also improve drainage, particularly in clay soils.

Soil structure benefits from a range of rooting types and this can be encouraged by adopting a ley-arable rotation. It should also increase organic matter content.

Maintain soil organic matter

Keep up soil organic matter levels by regularly including grass breaks and by adding organic matter. Any addition of organic material is helpful. Organic material helps to keep aggregates intact but separated and adds carbon. Poultry manure is very effective at improving soil structure and biochar may be worth consideration. The addition of organic matter also helps promote earthworm activity, which again improves soil drainage and aeration.

Assess Your Soil Structure

Practical Guide

Soil structure is the size and shape of the crumbs and lumps that make soil; good soil structure will benefit crop growth.

Structure includes the holes and cracks, called the soil pores. On average, about a quarter of the soil volume has soil pores that are full of gas. Gases, mostly carbon dioxide, are made by the bugs in the soil using oxygen from the atmosphere. The wetter the soil the less oxygen gets to the soil, making the soil poorly aerated. This results in greater volumes of the greenhouse gases nitrous oxide and methane.

Roughly 5% of soil volume is made up of organic matter. About half of this organic matter is carbon, which is stored from atmospheric carbon dioxide as a result of the breakdown of crop residues and roots. Although this percentage is small, it adds up to a lot of stored carbon over a wide area; this carbon is protected by the soil structure. Tilling the soil or soil erosion opens up the pores so that large volumes of gas are lost to the atmosphere. Tillage also exposes the organic matter so that stored carbon is broken down and returned to the atmosphere as carbon dioxide.

This Practical Guide concentrates on how to assess and improve soil structure using the VESS (Visual Assessment of Soil Structure) system This can benefit crop yields and reduce GHG emissions.

Top tips for EVERY farm:

- ✓ Keep tillage to a minimum
- ✓ Avoid tillage of wet soil
- ✓ Maintain soil drainage
- ✓ Avoid soil compaction
- ✓ Maintain soil organic matter
- ✓ Add organic manure to keep the bugs active
- ✓ Keep the soil smelling good
- ✓ Look at soils regularly

How to assess soil structure on your farm

Using the information in this leaflet, you can assess your soil structure.

- **Equipment:** You will need an ordinary garden spade. A light coloured plastic sheet, sack or tray. A small knife and digital camera to record what you see would be useful but not essential.
- **When to sample:** You can sample soils at any time of year, but preferably when the soil is moist. If the soil is too dry or too wet it is difficult to obtain a representative sample. Roots are best seen in an established crop or for some months after harvest.
- **Where to sample:** Select an area of uniform crop or soil colour or an area where you suspect there may be a problem. Within this area, plan a grid to look at the soil at 10, preferably more spots.

The back page guides you through what you need to do next.

Farming for a Better Climate

There are five sets of Practical Guides covering :

Use energy and fuels efficiently

Develop renewable energy

Lock carbon into soils and vegetation

Optimise the application of fertilisers and manures

Optimise livestock management and the storage of manure and slurry

Find further information, including links to other Practical Guides and Case Studies, at

www.farmingforabetterclimate.org

Funded by the Scottish Government as part of their Climate Change Advisory Activity

Websites

www.farmingforabetterclimate.org

www.farmingfutures.org.uk

www.sac.ac.uk/knowledge/soils/vess

www.soilassociation.org.uk

www.agrecalc.com

2015 International Year of Soils

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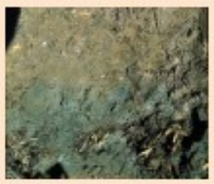
The Scottish Government Riaghaltas na h-Alba

Structure quality	Size and appearance of aggregates	Visible porosity and Roots	Appearance after break-up: various soils	Appearance after break-up: same soil different tillage	Distinguishing feature	Appearance and description of natural or reduced fragment of ~ 1.5 cm diameter	
Sq1 Friable Aggregates readily crumble with fingers	Mostly < 6 mm after crumbling	Highly porous Roots throughout the soil			 Fine aggregates		The action of breaking the block is enough to reveal them. Large aggregates are composed of smaller ones, held by roots.
Sq2 Intact Aggregates easy to break with one hand	A mixture of porous, rounded aggregates from 2mm - 7 cm. No clods present	Most aggregates are porous Roots throughout the soil			 High aggregate porosity		Aggregates when obtained are rounded, very fragile, crumble very easily and are highly porous.
Sq3 Firm Most aggregates break with one hand	A mixture of porous aggregates from 2mm -10 cm; less than 30% are <1 cm. Some angular, non-porous aggregates (clods) may be present	Macropores and cracks present. Porosity and roots both within aggregates.			 Low aggregate porosity		Aggregate fragments are fairly easy to obtain. They have few visible pores and are rounded. Roots usually grow through the aggregates.
Sq4 Compact Requires considerable effort to break aggregates with one hand	Mostly large > 10 cm and sub-angular non-porous; horizontal/platy also possible; less than 30% are <7 cm	Few macropores and cracks All roots are clustered in macropores and around aggregates			 Distinct macropores		Aggregate fragments are easy to obtain when soil is wet, in cube shapes which are very sharp-edged and show cracks internally.
Sq5 Very compact Difficult to break up	Mostly large > 10 cm, very few < 7 cm, angular and non-porous	Very low porosity. Macropores may be present. May contain anaerobic zones. Few roots, if any, and restricted to cracks			 Grey-blue colour		Aggregate fragments are easy to obtain when soil is wet, although considerable force may be needed. No pores or cracks are visible usually.