KNOW YOUR SOILS 1

Agricultural soils are a blend of sand, silt, clay, organic matter, water and air, coupled with a wide range of living organisms. On a global scale, soils are influential in a range of ecological functions from water cycling to carbon storage. Protecting soil quality through early recognition of poor soil conditions, remedial treatments and improved management is important. Soil erosion, reduction in organic matter, over-compaction through increased trafficking, overstocking and poaching by livestock can all pose a significant threat to long term soil quality, crop and livestock yields and the wider environment. This section will highlight the importance of soil organisms, differences between soil texture and structure, outline some common soil problems and suggest ways to improve soil quality.

Life in the soil

Estimates suggest that one gram of healthy soil can contain in the region of one billion organisms including 5 million bacterial cells, 10,000 protozoa, 200m of fungal hyphae and around 100 nematodes. Along with earthworms and arthropods (e.g.mites, springtails and beetles) these organisms play an important role in maintaining soil health. The range of microbes at work in soils can include root nodule forming nitrogen fixers (more active in soils without N applications), through to large fungi which can help to breakdown organic matter or act as feeding tubes for plant roots. Some nematodes and arthropods can help to recycle nutrients, suppress disease and increase microbial decomposition of organic and surface matter. Methods to increase soil microbe numbers include reduced pesticide and chemical applications, conservation tillage and increased organic matter inputs such as livestock manures or composted material.

Of the more visible soil organisms, arthropods and earthworms help to breakdown and mix organic matter within the topsoil. Arthropods feed on potential crop pests whilst earthworms help to increase aeration and drainage in soils.

Soil texture and soil structure

Soil texture is defined by the proportion of sand, silt and clay particles bound together by organic matter. Soil organic matter - or humus - is a vital component of soil, influencing fertility, soil structure, workability and water holding capacity, as well as storing carbon. Soil texture is very variable and can indicate a range of soil properties, for example:

Loamy sands and soils with a high content of fine sand and silt are susceptible to soil problems – watch out for surface capping, compaction and erosion damage unless high organic matter levels are maintained.

Sandy loams and sandy silt loams (soils with <18% clay) – most suitable soils for all enterprises in wetter areas and suitable for more intensive cropping.

Clay soils and sandy clay loams (containing >18% clay particles) tend to be imperfectly or poorly drained. Even when the drainage system is working well, the range of moisture contents when clay soils are suitable for cultivation is small. These soils are prone to drainage related problems and poaching, compaction and smearing.

The soil textural triangle is a common method used to determine soil textural class if you already know the percentage of clay, sand and silt in a soil sample. If these factors are known, you can follow the three lines coming from the percentage numbers until they all intersect at a point, indicating your soil texture type. Alternatively, when percentages are not known soil texture can be estimated by laboratory analysis or hand texturing (see Section 6).

Soil structure is the arrangement of particles in blocks or aggregates within the soil. Structure is strongly influenced by tillage, cropping, texture, organic matter, compaction and biological activities and can be affected by drainage status and weathering. Maintaining a good, stable soil structure can

- Increase water holding capacity
- Promote root growth
- Maintain aeration and drainage
- Make cultivation easier
- Reduce erosion risk.

Common problems seen on Scottish soils

A wide range of soil problems can go unseen. After examining soils you can consider actions needed to rectify any problems. It may be necessary to seek specialist advice, as general recommendations may not be appropriate to all soil types and conditions.

Surface capping

Problem	Action
Heavy rainfall on bare soils can break down soil surface structure leading to the formation of a surface crust or cap (1 to 10 mm thick). This makes it harder for seedlings to emerge from the soil, reduces water infiltrating through the soil surface and increases run-off risk. Fine sandy and silty soils are particularly at risk from capping. The formation of erosion rills and gullies can result in soil deposition at sides of fields, on roads or in watercourses and ditches.	*Suggested actions* Avoid producing too fine a seedbed during cultivation and where possible, retain residues of the previous crop at the surface as a protective layer. The incorporation of organic matter (e.g. composted material, straw or dung) can greatly improve soil structure and reduce capping risk. When capped soil dries, break the cap with a light harrow or Cambridge roller.

Compaction

Problem	Suggested actions
Compaction compresses the soil and restricts drainage, aeration and rooting depth. Over -cultivation (the production of an excessively deep and/or fine structured seedbed) and heavy trafficking, such as multiple passes of machinery on wet soils, will increase the risk of soil over-compaction, plough or wheeling pans. Such pans can extend into the subsoil, particularly if vehicles are heavy and sink during wet conditions. Poaching and shallow pan formation from livestock is a common problem on grassland soils.	Identify depth of compaction (see Section 6). If the plough pan restricts water movement or root growth then consider altering cultivation or ploughing depth to get below this layer and break up the compacted soil. Ideally, loosen such layers before the winter and mix in crop residues so that weathering and biological activity can loosen and split the clods produced by tillage. Subsoiling, moling or grassland aerators (e.g.spiked or knife rollers) may help to remediate soil compaction. These operations should be carried out in dry conditions at working depth to avoid further soil damage. Avoid over trafficking and restrict access when soil is saturated.

Anaerobic layers

Problem	Suggested actions
Anaerobic layers are wet, (permanently or over long periods, especially in winter) are often blue-grey in colour and can give a foul, sulphurous (rotten eggs) smell. Roots cannot grow in anaerobic conditions and nitrogen can be lost as a gas from anaerobic soils. In some instances, incorporating crop residues to anaerobic soils can increase the problem, as valuable oxygen is used up during the decomposition process.	Improve drainage of the soil within and below the anaerobic layer. Planting a vigorously growing crop (e.g. a grass ley) can help to deplete moisture and promote soil structural development.

Poor drainage

Problem	Suggested actions
Poor drainage is common in many soils and can be aggravated by an ineffective or blocked drainage system or compacted soil layers preventing drainage. Indicators of poor drainage include: • anaerobic soils • wet areas impeding machinery operations and stock turnout • patchy yellowing of crops • excessive growth of weeds.	Assess drainage by digging soil inspection points. If the soil is dry deeper in the profile, then localised waterlogging could be present. You may need to consider whether to repair or renew the drainage system. Alternatively, persistent areas of poor drainage could be used to create a wetland. Funding to support wetland creation may be available through agri-environment schemes.

Recommended measures

- Maintain field drainage systems (unless there are good reasons not to).
- Where possible, avoid working or grazing wet land as this may lead to smearing, and/or compaction. Consider using smaller or lighter vehicles, low ground pressure tyres, dual wheels or tracked vehicles to minimise soil damage.
- Keep trafficking to already established tramlines where possible.
- Reduce the frequency of traffic over the field. Soil damage and reductions in yield quantity and quality may be apparent.
- Consider how poor soil conditions could be rectified as part of the next cultivation.
- Consider a more varied rotation to exploit the different soil management and root growth habits of different crops in generating and preserving soil structure.
- Put wet fields under low intensity grass or allow them to form wetlands. Agri-environment funding may be available for this.