Farm Net Zero:
Soil Testing

Overview

Soil underpins the entire farm system. Healthy, well-managed soils support productive and healthy crops and pasture, which in turn supports a profitable and resilient farming system. A soil that accumulates organic matter will sequester carbon, increase fertility and increase productivity.

Carrying out soil analysis is a useful tool for understanding overall soil health and identifying areas that may require management or action.

This factsheet will detail some of the tests which can be carried out on the soil to understand overall soil health. Learn more at: Soils.

Taking Samples

The best time to undertake soil sampling is in the spring or autumn, when the soil conditions (including temperature and moisture) are such that it's easier to take the samples and the results are more representative.

Avoid taking samples from fields which have recently been disturbed or have recently had an application of manure or fertiliser, as this may impact on the results.

When sampling, the aim is to achieve a sampling pattern which collects a sample that is a good representation of the whole field. Avoid high traffic areas around gateways, troughs and ring feeders. This can be done using either a linear transect, a "W" configuration or through a grid pattern. Aim to aggregate between 10-20 samples from the field together to produce the sample which is sent to the lab for testing.

To understand soil texture, structure, aggregate stability, earthworm numbers and bulk density, dig a soil pit at three locations in the field.

Soil Texture

Soil texture cannot be altered but is important to understand as it impacts on soil structure, aggregate stability, the amount of carbon present and the soil's ability to sequester more carbon.

Soil texture refers to the relative properties of clay, silt and sand. To understand soil texture, rub some moist soil between finger and thumb. Sand is a larger particle size so tends to feel gritty, and doesn't hold when moulded into a ball. Silt feels smooth, silky or floury. Clay feels sticky when wet, looks shiny when smeared and holds in a ball.

This diagram in the RB209 explains how to hand texture your soil.

Soil Structure

Soil structure refers to the size and make up of soil particles. Good soil structure is vital for crop productivity and soil health. It supports and regulates biological activity, water movement and storage, soil temperature, gas exchanges and nutrient cycling. The structure of soil should allow for an even distribution of air, water, mineral particles and soil organic matter.

A typical method of assessing soil structure is VESS (Visual Evaluation of Soil Structure). This is a scoring system which rates the soil in terms of its structural condition from 1 (friable and good structure) to 5 (very compact and impacting on plant root growth and function). The VESS test can be completed at the top of the soil profile pit (between 0-10cm) and then lower down (between 10-30cm) to assess condition throughout the soil profile. More detail on the VESS method can be found here.

Soil Nutrients

Testing soils for their nutrient status provides an indication of the nutrients available to the crop from the soil. Typically these are phosphorus, potassium and magnesium but more detailed nutrient analysis can be carried out by the lab on request (which may include soil mineral nitrogen testing, or the availability of trace elements). .

Nutrients typically are measured in mg/l. The indices reported come from the Defra Index scale and depend on the concentration of nutrients within the soil sample.

Soil pH is a measure of the acidity and alkalinity of the soil. The natural soil pH is determined by the chemical composition but this can be altered through natural and agricultural processes. Soil pH affects the availability of nutrients within the soil and therefore crop productivity, and is a key parameter to understand.

pH can range from strongly acid (less than pH 5.5) to strongly alkaline (more than 8.5). The target pH for grassland is around 6 and for arable soils is 6.5. If the pH results are low, lime can be added.

Infiltration

Soil water infiltration is a good indicator of soil structure which can highlight areas of compaction. A short infiltration time can indicate that the soil is healthy due to the high number of pore spaces allowing the water to infiltrate. Pore spaces are important for root development, soil aeration and water retention. Where compaction is present, the soil pores are effectively squashed together leading to reduced infiltration and risk of runoff and erosion.

To measure soil infiltration a cylinder and a known volume of water is required. The cylinder is inserted into the soil a few inches and the water poured in. A stopwatch is required to measure the time it takes for the soil to infiltrate. A detailed guide on carrying out the infiltration test can be found here.

Aggregate Stability

Aggregate stability is considered a good indicator of organic matter levels in soil. Organic matter and carbon contain glomalin, a protein which acts as a 'glue', binding soil particles together to give good soil structure. This is important for mitigating soil erosion.

To measure aggregate stability, from each soil pit take a handful of soil and air dry for 3-5 days. Once dry, submerge three lumps (3-5mm) of soil in water and assess how well they hold together after 5 minutes and then again after two hours. The lumps of soil are scored using a scale of 0-4 with 0 being good and the lump remaining intact and 4 the score when the lump breaks down:

- 0 - The lump remains intact
- 1 - The lump collapses around the edge but remains largely intact
- 2 - The lump collapses into angular pieces
- 3 - The lump collapses into small round pieces forming a cone
- 4 - The lump completely collapses into single grains

Earthworm Counts

Earthworms are just one of the indicators for soil biology and soil health. They are important siol engineers, redistributing and mobilising nutrients, cycling organic matter and carbon throughout the soil profile, and improving water infiltration.

Earthworms in agricultural soils can be grouped into three ecological types:

- Epigeic - litter dwelling earthworms
- Endogeic - topsoil earthworms
- Anecic - deep burrowing earthworms

To measure earthworm numbers dig a soil pit that is 20cm x 20cm x 30cm deep. Hand sort the soil to count the number of earthworms present. This can then be broken down into types and numbers of adults and juveniles. The higher the value the more worms were present.

More details can be found at GreatSoils.

Bulk Density

Bulk density is the weight of soil in a given volume. Bulk density can be used as an indicator of pore space, soil compaction and will normally increase with soil depth. Sandy soils are more prone to a higher bulk density. Bulk density will tend to range from between 0.8g/cm3 soil to 1.8g/cm3. If bulk density is over 1.6g/cm3 it can impact on root growth.

This is measured at three different depths (O-10cm, 10-30cm and 30-50cm) using an open ended steel cylinder to extract the known volume of soil from each of the depths down the soil profile. The soil is then removed, dried and weighed. Bulk density is measured in g/cm^3.

Understanding bulk density is crucial for effectively measuring the quantity of carbon stored in the soil in tonnes per hectare.

Soil Organic Matter (SOM)

As well as providing a climate change solution which is unique to agriculture, increasing soil organic matter has a number of co-benefits including improving soil water holding capacity, improving nutrient use efficiency and soil fertility, and supporting biodiversity.

Analysing SOM at three different depths within the soil provides an understanding of how the carbon is dispersed throughout the soil profile. Generally carbon near the surface will fluctuate more than carbon held at depth due to carbon cycling.. Typically it is said that soil organic matter is 58% carbon. There are two main methods that are used to test for soil carbon / soil organic matter. **It is important to be consistent in your testing approach.**

Loss on Ignition

Most common test for SOM. Tends to be a cheaper test and best for helping inform on-farm management decisions. This test is not standardised so can vary between labs, so is important to remain consistent with lab choice. The analysis measures soil organic matter content, which then requires a conversion factor to determine the relative carbon content.

Dumas

A more accurate and standardized test for understanding soil organic carbon, however it does not assess overall soil health. In alkaline soils, it's important to ensure that the lab method accounts for inorganic carbon as well as providing the organic carbon content which is reported as a percentage. Both are important parts of the farm carbon cycle but react differently to management practices.

Further information

For further information about the soil health and its impacts on emissions and sequestration: farmcarbontoolkit.org.uk.

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