Soil health in UK farming

Soils provide the foundation of agriculture and food production systems with estimates suggesting that 95% of global food production is directly or indirectly produced on our soils.[i]

In the context of farming, soil health broadly refers to the continued capacity of soil to function as an ecosystem that sustains plants, animals and humans.

Healthy soils provide ecosystem services and functions with greater longevity, for instance they demonstrate greater resilience against erosion, flooding and climate change. In addition, healthy soils offer a range of direct benefits. These include:

1. Improved nutrient availability – healthy soils provide essential plant nutrients, which reduces the need for artificial nutrient additions overtime., reducing costs.
2. Enhanced resilience to extreme weather – higher levels of soil organic matter increase the ability of soils to hold moisture and increase infiltration rate, which protects land from extreme weather events such as flooding or droughts.
3. Sustainable crop production – healthy soils support robust crop production, contributing to a sustainable future for farming.
4. Environmental regulation – soil health contributes to the regulation of air and water quality as well as climate and supports biodiversity and carbon sequestration.

Threats to soil health and consequences of poor soil management

A 2019 Environmental Agency report assessing soils in England and Wales found that almost 4 million hectares of soil are at risk of compaction and over 2 million hectares of soil are at risk of erosion. Between 40 - 60% of soil organic carbon content was lost as a result of intensive agricultural management practices. In a financial context, soil degradation was calculated to have an annual cost of £1.2 billion.[ii]

Threats to soil health include:

Loss of soil organic carbon

- Loss of soil organic matter diminishes soil structure stability, nutrient retention capacity and microbial activity.
- This leads to reduced soil fertility, diminished soil carbon storage capacity and implications for climate change mitigation.

Soil erosion

- Soil erosion leads to loss of topsoil, lower crop yields, increased flood risk and water quality implications (e.g. sedimentation and pollution).

Soil compaction

- Soil compaction resulting from heavy machinery use can restrict root growth, impair water infiltration, increase runoff leading to flood risk and reduced soil productivity.

Soil biodiversity loss

- Soil biodiversity loss includes the destruction of habitats for earthworms and microorganisms.
- Biodiversity loss weakens the resilience of ecosystems to changing environmental conditions, hinders natural pest control mechanisms and nutrient cycling processes. This ultimately posing a threat to the long-term sustainability of agricultural systems.

Sustainable management practices, conservation strategies and policy interventions can safeguard soil health and ensure the longevity of soils for future generations.

Principles of soil health management

As the global population rises and with it the increasing demands on food productions systems, maintaining healthy and productive soils is vital. Soil health requires a balance between biological, physical and chemical properties of soils in order to provide good structure, water retention and nutrient availability to crops. Whilst soil management practices vary significantly, the Agriculture and Horticulture Development Board (AHDB) have outlined some general principles, summarised below in Figure 1, that influence soil health[3] and underpin all farming systems. By following these principles, farmers will achieve greater carbon sequestration, increased water infiltrations, improved wildlife and pollinator habitat, all whilst optimising yields and profits.

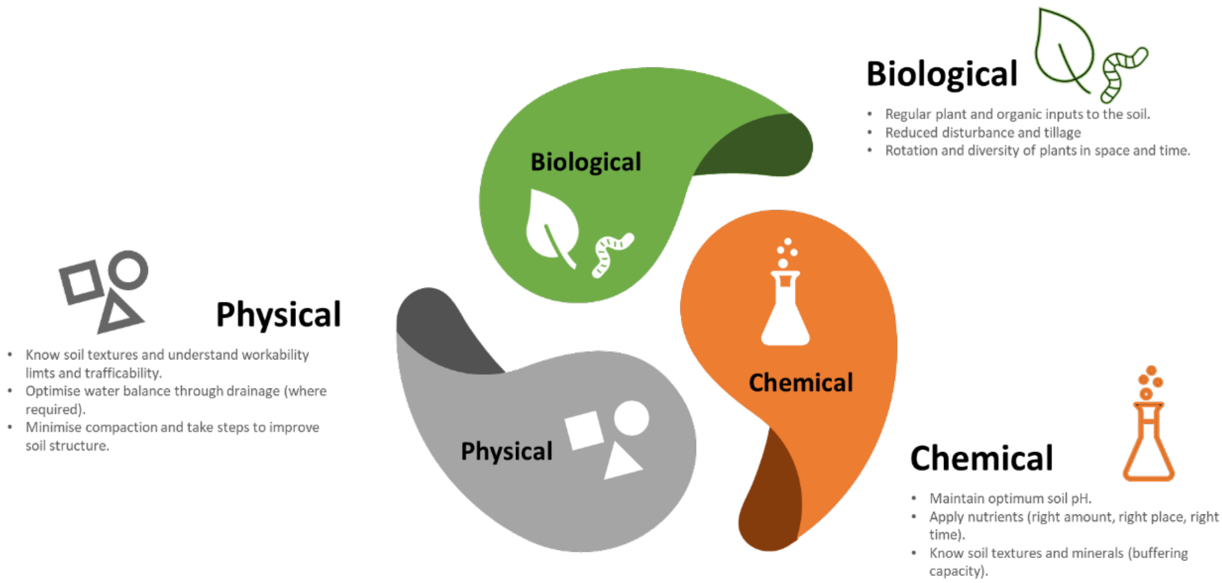


Figure 1. Principles of soil health (adapted from AHDB)[iii]

Biological principles

It is important to understand the influence and importance of soil management practices on maintaining diverse and active biological soil communities.

Organic matter is a key biological component, organic matter inputs will provide a direct source of energy/food for soil organisms.

Tillage can influence a range of properties including root activity, soil surface coverage and the distribution of organic matter throughout the soil. Habitat stabilisation, as a result of reduced tillage, is beneficial to a range of soil organisms and can result in increased soil biological activity.

Rotations should be designed to increase plant diversity to promote species richness of the soil biota.

Chemical principles

The parent material (rock from which soils are derived) is an inherent soil property and controls the texture and types of minerals present in the soil. To optimise soil chemistry, it is important to understand the composition of the soil.

Parent materials control the soil texture and types of minerals present, along with the ability of the soil to retain nutrients. Some nutrients are derived from the parent materials, whereas others may be missing completely and therefore require inputs e.g., fertilisers, lime or organic matter in order to supplement them.

Soil pH optimums will vary between crop types. However, under pH 5.5, biological activity tends to be reduced, and root growth and function may be inhibited. Soil pH also impacts on other soil properties such as nutrient availability.

Physical principles

Soil structure has implications for the balance between air and water within the soil. A well-structured soil will benefit from good root growth and an active soil ecosystem.

Soil texture can vary largely between the topsoil and subsoil and has implications for the workability and trafficability of a soil. The texture may also need to be considered as part of the crop selection process due to potential implications for in drainage and root penetration.

Tillage and compaction disrupt the connectivity of air- and water-filled spaces (pores) within the soil and may result in poor drainage, reduced root growth and limitations on soil biota activities.

Soil health measurement

Many soil properties such as parent material and texture are inherent to a soil, whilst others may be influenced through appropriate management practices. Characterising and understanding the implications of these properties can influence the selection of suitable soil health management actions. There are a wide range of parameters which may be used as indicators of the health of agricultural soils. These include:

- **Common indicators:** pH, routine nutrients, bulk density and penetrometer resistance.
- **Less common indictors**: visual evaluation of soil structure (VESS), soil organic matter/loss on ignition, respiration and earthworms.
- **Newer indicators**: total nitrogen, microbial biomass carbon, potentially mineralisation nitrogen, DNA measures, nematodes and microarthropods.

AHDB has proposed a soil health scorecard to provide a framework against which soil health can be monitored on a rotational basis[iv]. These scorecard indicators align well with the sustainable farming initiative (SFI) and include:

- **Soil structure** – using VESS (visual evaluation of soil structure)
- **Soil pH** – a measure of the acidity or alkalinity of the soil.
- **Extractable nutrients** – the measure of major nutrients essential to plant growth.
- **Earthworm count** – a simple measure of biological health.
- **Soil organic matter** – a measure of the amount of carbon stored in a soil.

To monitor improvements or changes to soil health, it is important to establish a set of baseline measurements. For meaningful comparison, the methods and types of measurements taken on each monitoring occasion should be consistent.

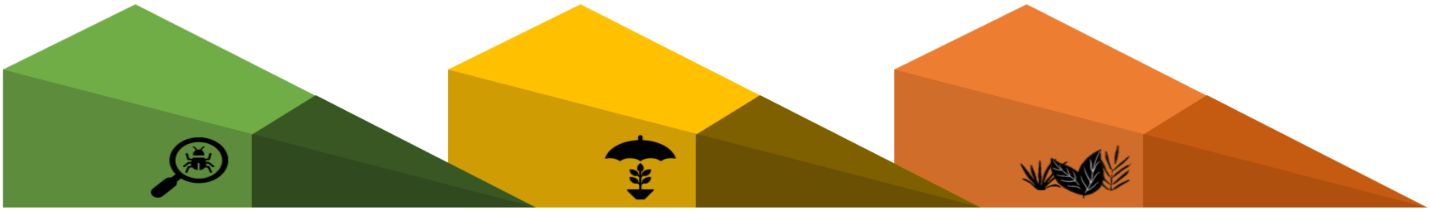
Soil testing requirements

The Farming Rules for Water requires farmers and land managers to conduct soil tests every 5 years to inform planning for applying manures and fertilisers. Nutrient planning ensures that nutrients spread on the land are applied at the right time and in quantities that are sufficient to meet and not exceed the crop or soil need on cultivated agricultural land. This nutrient planning must take into account the results of the soil testing for pH, N, P, K and Mg for every cultivated field. Soil nitrogen levels can be determined by assessing the soil nitrogen supply (SNS).

The soil analysis should be performed by an accredited laboratory. The results must not be more than 5 years old and must be kept to demonstrate compliance with the requirement for up-to-date soil testing.

Sustainable Farming Incentive (SFI) linkage

The SFI includes three actions focused on improving soil health, structure, organic matter and biological activity. Full guidance for the SFI programme may be found on the UK government website[v], however, the soil-specific SFI actions are summarised below.



SAM1

Aim: Understand the condition of your soil and plan how to increase the long-term health, productivity, and resilience of your soil.

Application: Land with leguminous, nitrogen-fixing crops or permanent grassland. further details of land specifications can be found on the gov.uk website.

Payments: £6 per hectare and £97 per SFI agreement per year

Conditions 1. Assessment of soil type, texture, structure and biology.
2. Assess risks to soil from runoff, erosion and leaching
3. Create and regularly review a soil management plan.

Each agreement runs for a period of three years and requires the completion of yearly actions to maintain and evidence eligibility.

Whilst enrolled in SAM1, the SFI also allows application for additional funding through SAM2 or SAM3.

SAM2

Aim: Establish multi-species cover crops during winter months to protect soil surface and provide root growth such that the soil structure and biology will benefit, whilst nutrient leaching, soil erosion and runoff will be minimised.

Application: Land below the moorland line*

Payment: £129 per hectare per year.

Conditions: 1. Multi-species crops (containing at least two species from bassicae, grasses or cereals, herbs, and legumes) must be established in time to cover soil during winter (Dec-Feb).
2.Where a soil is peaty (20% or more SOM to a depth of 40 cm or more), legumes cannot be included in the mixture.
3.Fertiliser must not be mechanically applied.

Evidence can be requested during each year of three-year agreement and can include photographs of the registered land parcels.

SAM3

Aim: Establish herbal leys (multi-species swards) to improve and maintain the soil's structure, carbon, biology, and fertility.

Application: Land below the moorland line*. Land with peaty soil is ineligible.

Payments: £382 per hectare per year.

Conditions: Herbal leys must contain a mixture of grasses, legumes and herbs. Existing herbal leys can be maintained if not already paid for under another ELMs.

SFI allows you to maintain the land area for all three years of your agreement or you can move the area each year as long as it's eligible. Details of land specifications can be found on the gov.uk website.

*Land below the moorland line is classified as permanent crops or arable land, including arable crops, leguminous and nitrogen-fixing crops, fallow land, and temporary grassland.

[i] FAO. Healthy soils are the basis for healthy food production. Food and Agriculture Organisation of the United Nations: Rome, Italy, 2015.
[ii] House of Commons Committee report on Soil Health: https://publications.parliament.uk/pa/cm5804/cmselect/cmenvfru/245/report.html#
[iii] AHDB. Principles to improve soil health. Agriculture and Horticulture Development Board
[iv] AHDB. *The soil health scorecard*. Agriculture and Horticulture Development Board, 2022. https://ahdb.org.uk/knowledge-library/the-soil-health-scorecard
[v] UK Gov. *Guidance: SFI actions for soils*. 2023. https://www.gov.uk/guidance/sfi-actions-for-soils