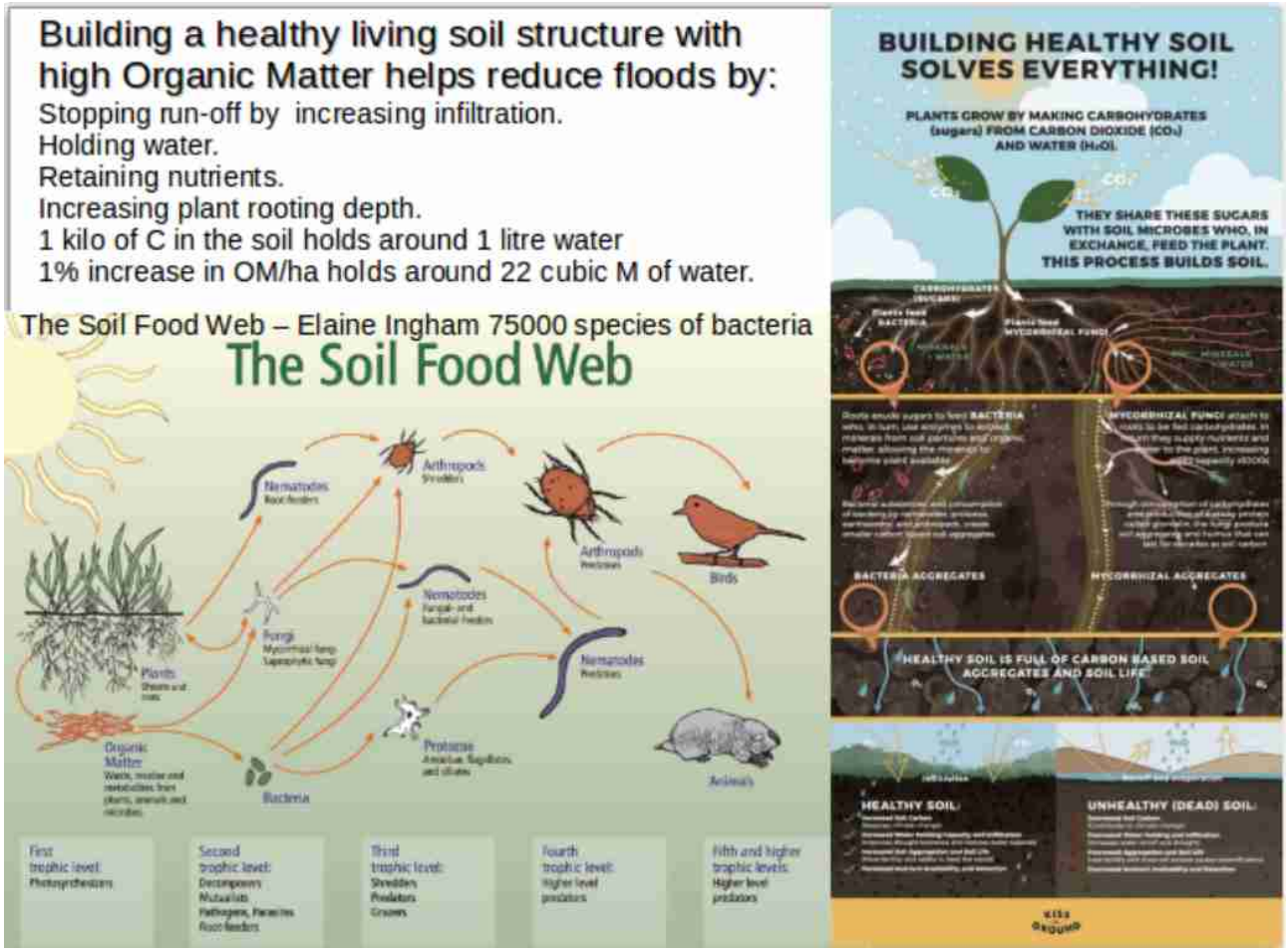
Potential methods to improve living soil

Living soil with a rich mix of bacteria, fungi, earthworms and other soil organisms helps add resiliant fertility to farmland.



A fertile soil rich in its soil food web absorbs and holds water in the land where it is needed. Fungal hyphae help spread nutients and water throughout the soil

A poor soil tend to repel rain water and leads to flash flooding. This fast removal of water will pull nutrients out of the ground and often causes erosion with direct loss of soil.

Elaine Ingham in USA, a soil scientist who works worldwide on soil restoration, suggests that a good soil under grassland should have equal proportions of bacteria and fungi.

The use of NPK fertilizers of over 100 units disrupts this healthy balance and the use of fungicides and many herbicides also disrupt this fragile system. More recently it has been found that some anthelminthic wormers upset the earthworm population and dung beetles.

Soil is the most important asset on the farm and looking after it will benefit farm productivity soil water retention in times of drought and help increase water infiltration – reduceing flooding downstream.

(The new ELMs proposed as a response to the Agriculture Bill are likely to reward good soil management, high Organic Matter and activities that reduce flooding.)

The following is part of soils-e-mail soilassociation.pdf

Living soils

In any agricultural or horticultural system, nutrients are removed from the system when crops and livestock are harvested and sold. Fertility can be built by either growing, or adding organic matter, but in essence this can be likened to supporting the soil micro-organisms to enable them to form associations with the root systems of plants.

One quarter of all species on Earth live in soils, providing the basis for food production for the other three-quarters. Like all habitats, soils must provide the full range of conditions necessary for these species to survive and thrive. Until now most of us have not managed soils with their biology in mind, the life in soils 'requires the same attention as above-ground biodiversity'. Biodiverse soils have potential benefits beyond healthy crops and higher yields: soil has contributed to a number of recent discoveries, including new forms of antibiotics and anti-depressants.

Soil is a combination of minerals, organic matter, air, water and living organisms. None can be taken in isolation, it is their balance that is important.

Author: Jasmine Black, Producer Support

Bacteria
One teaspoon of productive soil can contain 100 million to 1 billion bacteria. Some bacteria convert organic matter into forms useful for plants; others break down pollutants. Some form mutually beneficial partnerships with plants, supplying nitrogen which in turn provide sugar for bacteria.

Fungi
Fungi are important for nutrient cycling, water dynamics, disease suppression and just physically binding soil particles together. Forming long thread like structures called hyphae, they convert hard-to-digest organic material into forms that other organisms can use.

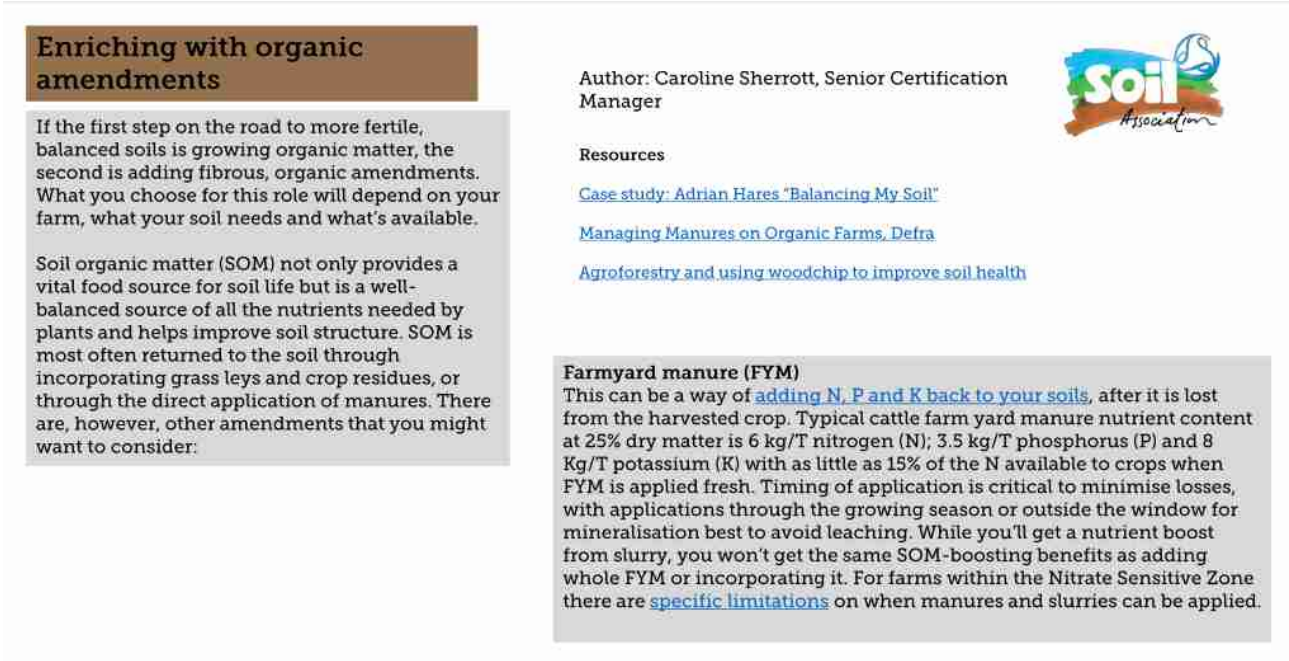
Protozoa
Protozoa are aquatic single-celled animals that live in water filled pores and the film of water that surrounds soil particles. Living in the top 6 inches of soil they consume bacteria, releasing excess nitrogen in a form available to plant roots.

Living soils

Nematodes
Nematodes are microscopic organisms, most of which are beneficial for agriculture. Living in the thin film of moisture that surrounds the soil particles, beneficial nematodes play an important role in decomposing organic matter and therefore the recycling of nutrients.

Earthworms
The feeding and burrowing activity of earthworms incorporates organic matter into the soil promoting decomposition and nutrient cycling. The tunnels they leave behind them provide channels for root growth, water infiltration and gas exchange. A review of nearly 60 different global studies has demonstrated that earthworms can increase yields in the absence of nitrogen fertiliser – by on average 25% [Willem van Groenigen et al (2014) *'Earthworms increase plant production: a meta-analysis'* Scientific Reports]. However, earthworms do not only create good soils, they need good soils to live in. Even slightly degraded soils can affect worm populations.

Arthropods
Arthropods include centipedes, springtails and beetles. They can be grouped as shredders, predators, herbivores, and fungal-feeders, based on their functions in soil. Most soil dwelling arthropods eat fungi, worms, or other arthropods. Root feeders and dead-plant shredders are less abundant. Arthropods mix and introduce air into the soil, shred organic material and control the population of other soil organisms.



Enriching with organic amendments

If the first step on the road to more fertile, balanced soils is growing organic matter, the second is adding fibrous, organic amendments. What you choose for this role will depend on your farm, what your soil needs and what's available.

Soil organic matter (SOM) not only provides a vital food source for soil life but is a well-balanced source of all the nutrients needed by plants and helps improve soil structure. SOM is most often returned to the soil through incorporating grass leys and crop residues, or through the direct application of manures. There are, however, other amendments that you might want to consider:

Author: Caroline Sherrott, Senior Certification Manager

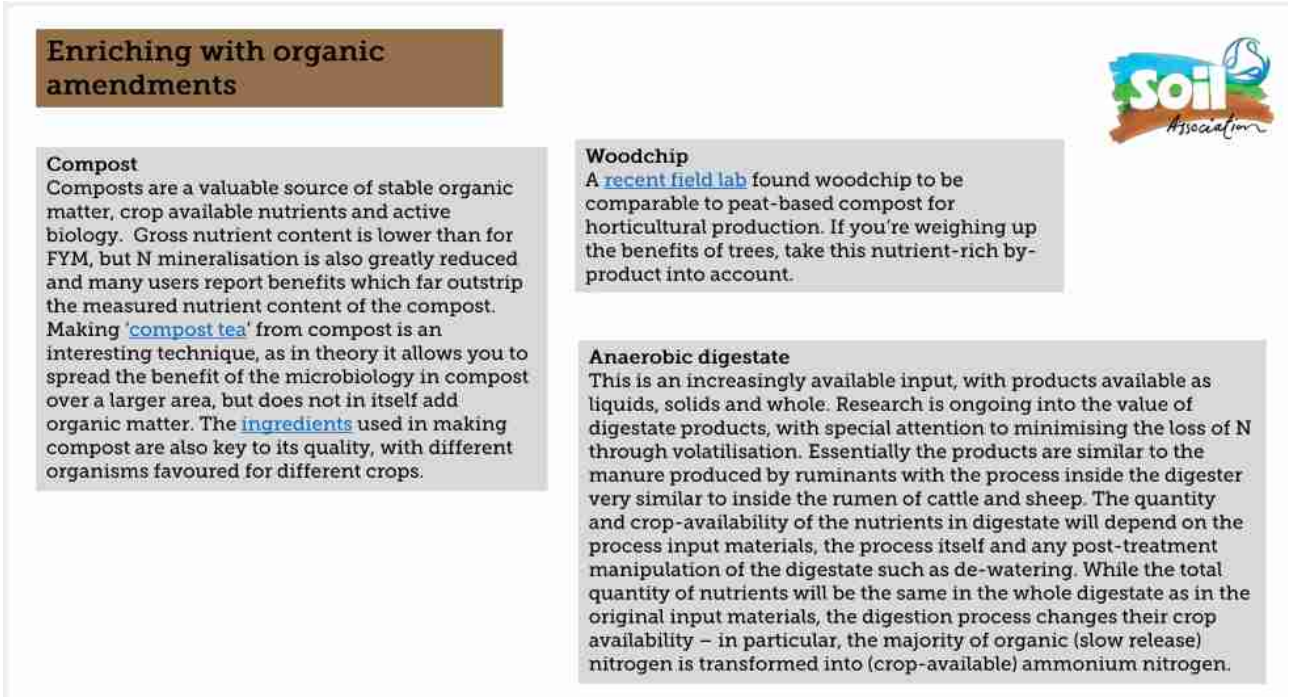
Resources

Case study: Adrian Hares "Balancing My Soil"

Managing Manures on Organic Farms, Defra

Agroforestry and using woodchip to improve soil health

Farmyard manure (FYM)
This can be a way of adding N, P and K back to your soils, after it is lost from the harvested crop. Typical cattle farm yard manure nutrient content at 25% dry matter is 6 kg/T nitrogen (N); 3.5 kg/T phosphorus (P) and 8 Kg/T potassium (K) with as little as 15% of the N available to crops when FYM is applied fresh. Timing of application is critical to minimise losses, with applications through the growing season or outside the window for mineralisation best to avoid leaching. While you'll get a nutrient boost from slurry, you won't get the same SOM-boosting benefits as adding whole FYM or incorporating it. For farms within the Nitrate Sensitive Zone there are specific limitations on when manures and slurries can be applied.



Enriching with organic amendments

Compost
Composts are a valuable source of stable organic matter, crop available nutrients and active biology. Gross nutrient content is lower than for FYM, but N mineralisation is also greatly reduced and many users report benefits which far outstrip the measured nutrient content of the compost. Making 'compost tea' from compost is an interesting technique, as in theory it allows you to spread the benefit of the microbiology in compost over a larger area, but does not in itself add organic matter. The ingredients used in making compost are also key to its quality, with different organisms favoured for different crops.

Woodchip
A recent field lab found woodchip to be comparable to peat-based compost for horticultural production. If you're weighing up the benefits of trees, take this nutrient-rich by-product into account.

Anaerobic digestate
This is an increasingly available input, with products available as liquids, solids and whole. Research is ongoing into the value of digestate products, with special attention to minimising the loss of N through volatilisation. Essentially the products are similar to the manure produced by ruminants with the process inside the digester very similar to inside the rumen of cattle and sheep. The quantity and crop-availability of the nutrients in digestate will depend on the process input materials, the process itself and any post-treatment manipulation of the digestate such as de-watering. While the total quantity of nutrients will be the same in the whole digestate as in the original input materials, the digestion process changes their crop availability – in particular, the majority of organic (slow release) nitrogen is transformed into (crop-available) ammonium nitrogen.

Methods to improve the soil food web

Earthworms innoculation

Bruce Marshall improved his hill farm in Tweeddale Scotland in the 1980's to the point where he over wintered his stock outside on areas that were previously deep bogs and eventually filled in all his drainage ditches. "Rushy peat bogs. There is no need to put artificial drainage, or spray and cut rushes – rushes are a sign of infertility, as well as of impeded drainage. When clover and earthworms are established throughout the bog, sheep and cattle will eat out the rushes as the bog shrinks and becomes highly fertile, well drained pasture." (it is important that this work is not carried out on species rich areas or blanket bog)

He initially increased the pH to around 5.5 to 6.0 and scattered earthworms in small clusters around

5 metres apart under upturned sods and planted clovers.
He suggested using Lumbricus terrestris and Lumbricus rubellus and other agricultural earthworms. His worms spread around 9 metres per year.

Worms can be collected from a worm rich area, indicated by worm casts and moles, by applying a surface spray of mustard. This can be made up of 30gm English mustard powder in 3 litres of warm water. Stirr well and leave to sit overnight. This will bring up the earthworms over 1 square metre. Gently wash the mustard from their skins.

Earthworm activity is stimulated by bedding muck, mature compost and seaweed sprays.
Remin Scotland produce a Volcanic rock dust that will add a wide range of minerals that might be missing in the soil. This stimulates degraded soils in a very dilute form and helps encourage earthworms.

“on average earthworm presence in agroecosystems leads to a 25% increase in crop yield and a 23% increase in aboveground biomass. The magnitude of these effects depends on presence of crop residue, earthworm density and type and rate of fertilization. The positive effects of earthworms become larger when more residue is returned to the soil, but disappear when soil nitrogen availability is high. This suggests that earthworms stimulate plant growth predominantly through releasing nitrogen locked away in residue and soil organic matter. Our results therefore imply that earthworms are of crucial importance to decrease the yield gap of farmers who can't -or won't- use nitrogen fertilizer.” Earthworms increase plant production: A meta-analysis- J.W.Van Groenigen etal

http://www.wormscience.org/ explains how to count earthworms.

If you are interested in taking this further, it may be possible to get some funding to work with earthworms through Rothamstead Research – Farminn.

Using biofertilisers

Biofertilisers nourish, recover and reactivate life in the soil.
These can easily be made on the farm.(details from The ABC of organic agriculture phosphites and stone meal – Jairo Restrepo Rivera and Julius Hensel)
The basic ingredients are 150 litres water, 50 kilos cow dung, 2 litres mollasses, 2 litres of milk(or whey) and 4 kilos of wood ash or finely ground volcanic rock dust(Remin). These are taken through an anaerobic fermentation (similar to a cows stomach) for around 30 days or more. This massively increases the beneficial bacteria and fungi that will help bring back soil life.
The fermented product is diluted around 30 x and then sprayed on the pasture. A very fine mist will help to innoculate the soil. This could be innnoculated at the same time as using keyline subsoiling.

Composted bedding muck can be used as the basis for making a liquid tea, rich in soil beneficial organisms.

Using composted wood chipping

Composted wood chippings should have evidence of fungal activity with white mycelial strands running through it. Often available from local authority composting where woody material is processed.
If this is applied to the land, or innoculated when keyline subsoiling is undertaken then this will help to build the fungal network in the soil.

Forest soil usually has a high level of fungal activity and a small amount may help stimulate its development in a compost, or mixed with bedding muck.

If you would like to explore any of these techniques for improving soils please let me know and we

may be able to contibute to this work and on farm training with the Water Environment Grant.

Rod Everett 2019

Sector Mentor for Soils outlines simple soil tests that you can carry out on your farm to monitor any changes in fertility and water holding capacity.
https://soils.sectormentor.com/soil-tests/which-tests-should-i-do/