<u>The Importance of Soil and How we aim to preserve it</u>

<u>Soil Background</u>

Healthy soil is composed of 50% minerals, 25% water, 15% air and 10% soil organic matter. Soil organic matter is the term used for all living, or once living, materials within, or added to, the soil. This includes roots developing during the growing season, incorporated crop stubble or added manures and slurries. All organic matter contains carbon (C), but it also contains nitrogen (N), phosphorus (P), sulphur (S), potassium (K), magnesium (Mg), calcium (Ca) and a whole range of micronutrients (e.g. copper, (Cu) and zinc (Zn)). Soil organic matter can be estimated by multiplying soil carbon x 1.72 (Walkley Black method) (de Vos et al, 2007). Walter Jehne describes healthy soils like cathedrals — the masonry is the mineral particles, the cement the soil organic matter, and the void within necessary for healthy soil to have sufficient surface area for both the uptake of essential minerals and nutrients and free-space for water storage. The glomalin produced by a functional mycorrhizal network is the glue that binds the soil aggregates (O'Brien, 2020). Individual roots should not be visible. Whether an agroecological approach or a sustainable intensification route is followed their has been a reinvigorated understanding that the health of the entire food system is intrinsically linked to soil health. A biologically active soil is regarded as the engine of the farm ecosystem, and with active management the soil will improve in both its quality and the ability to sequester carbon (Brown, 2018). It will also support a greater biodiversity both above and below ground. Regenerative agriculture practices centre on the limited disturbance of soil, whether physically, chemically (synthetic fertilisers) or mechanically (tillage); the requirement for constant vegetation covering soils, with living roots within the soil for as long as possible each year, and the absolute avoidance of bare soils. A biodiversity of plants and animals is encouraged. In contrast to post World War II farm specialisation (Robinson and Sutherland, 2002), livestock grazing is integrated within the system.

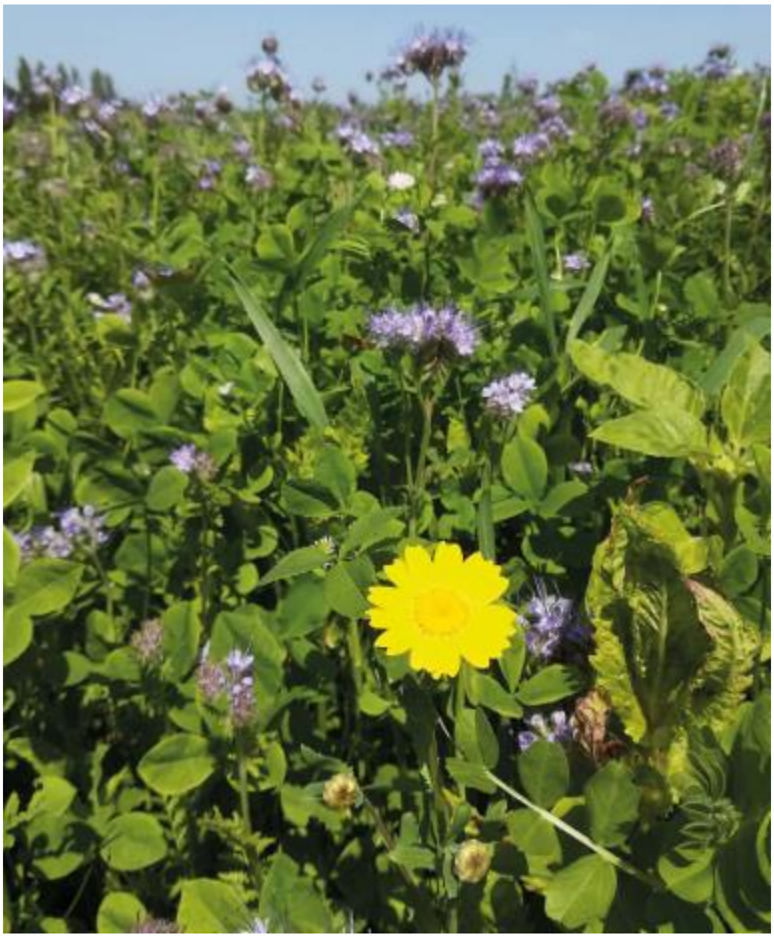
Soil as Water Storage

The soil forms an intricate sponge that soaks up water, both delivering it down to the groundwater and maintaining moisture for the crops. Ploughing or tillage is shown to interfere with the water cycle. Soil that contains 1% more carbon, will store 140 000 litres more per hectare (Puthalpet, 2022). Rainfall penetration can be used as a key marker of soil health, with water penetrating the first inch in under 10 seconds and the second inch in under 20 seconds in the healthiest soils. Ideally, water will efficiently infiltrate soil profiles, and be stored within the soil until required by plants. Abingdon reservoir in the Upper Thames catchment has been proposed as a partial fix to water scarcity in South East England. Construction is aimed to be commenced in 2026, with completion at the end of 2037, however it would then take until the end of 2039 to fill the reservoir. There are various versions of the reservoir with a maximum size of 150 Billion litres of water. However research implemented by Affinity water in South East England indicates no-till techniques would allow for increased flow to the natural underground aquifer. The increased amount of extra water in the aquifer would be comparable with the volume of Abingdon reservoir. The argument for water companies to invest in agriculture is quite clear. They are aiming to both mitigate agricultural run-off from pesticides and nutrients to protect water quality and also support farm productivity. Separate to no-till methods, they are also looking to finance water storage facilities on farm.

Cover Crops

Southern Water are now paying farmers to leave crops on their fields over winter, rather than bare, tilled earth – financially incentivising no-till farming. This is not only for the groundwater-recharge benefits, but also to reduce nitrates from conventional farming leaching into the groundwater and rivers and prevent sedimentation in watercourses from soil erosion and protect the soil surface from extreme rainfall events. The farmer also gains via protecting their most valuable asset, soil, from erosion, compaction and evaporation. Covering bare soils captures CO_2 and prevents N_2O production from bare, waterlogged soils over winter.

Flowering plants provide pollen and nectar for pollinators and seed for birds. Enhanced soil biology supports the bottom of the food chain in the farm ecosystem. Multi species cover crops, including triticale, rye, winter wheat, peas, sugarbeets, as well as diverse pasture also optimise the collection of solar energy via photosynthesis with the resultant sugars being transferred into the plant roots and feeding the soil biome. Cover crops can be selected based on their nutritional value to the soil or may be allowed to be grazed by livestock eg. Stubble turnips, kale, forage rape, rye and clover can be grown as cover crops over winter and utilised for livestock grazing, providing a clean, early lambing turnout.or as a break crop to disrupt pest and disease cycles. It may be beneficial to allow them to decay within the soil, eg. nitrogen fixing legumes such as deep rooting radishes or as a method of biofumigation -particularly brassicas, mustard and rocket which produce glucosinolates (the fumigant) which suppress soil borne pathogens eg. nematodes. They can suppress autumn germinating weeds eg.with hairy vetch and cereal rye, help control Blackgrass control and provide a refuge for beneficial predatory insects. Usual guidance (As being utilised by Severn Trent's Farming fund) requires a dense and fast growing cover crop to be established by September 15th and the crop to remain in situ until at least January 15th, unless being used as a biofumigant.



Example of cover crop

Soil Tillage, Maize cultivation and Mob Grazing

Although the nutrients may be within the soil, without functional bacteria or mycorrhizal fungi, plant life does not have the ability to efficiently access these nutrients. An undisturbed mycelial fungal network associated with no till soils has been found to supply 80% of a crop's nitrogen requirements and up to 100% of its phosphorus requirements. Synthetic fertilisers, whose production is a potent producer of greenhouse gas emissions, also suppress the role of nitrogen-fixing bacteria and further amplify the decomposition of soil organic matter. The destruction of the soil resource coupled with the lack of biodiversity seen within monocultures provides lower nutrient cycling.

At present soil is being destroyed at 10 times faster than it is created (Maximillian et al, 2019). Specific to the UK, although our islands only occupy 1% of Europe's land mass, we account for 5% of the continent's soil erosion by water (Panagos et al, 2015). And specific to Southwest England is the visible increased surface run-off associated with the degraded soils of farmland (Palmer and Smith, 2013). Also pertinent to the Southwest is the tripling of the area used to grow maize since the early 1990s (Farnworth and Melchett, 2015). Fields where maize is grown are subject to high rates of erosion because of shallow roots failing to bind the soil, the lack of under sowing that occurs with maize cultivation, and by the timing of harvesting (late autumn). Where maize is grown, up to half of river sediment can come directly from maize fields (Mokhtar, 2010). For this reason water companies are offering a per hectare figure for cover crops are sown after maize in surface catchments and established by October 15th. (Fertiliser is not to be applied to the crop and grazing of cover crops in surface water catchments is permitted but not until after January 31st) Cover crops funded by water companies cannot count towards any grown under Defra's Sustainable Farming Initiative. To encourage undersowing cover crops may be sown into a growing maize crop, via direct drilling into a growing crop to give good establishment (Broadcasting of seed gives both poor uptake and cover). Undersowing maize requires careful crop management and the Maize Growers Association over good guidelines for this.

Unlike maize cultivation, Adaptive multi-paddock (AMP) grazing, which aims to mimic how ancestral herds grazed the earth, is particularly efficacious in increasing soil organic matter. It can be described by the rule of thirds: eat a third, leave a third and trample a third into the ground, (Teague et al, 2013). Grazing periods are followed by sufficient resting times (30–45 days in the growing season and up to 90 days in the nongrowing season, compared with a standard 21 day rotation). You can read more about AMP Grazing in the following article

Regenerative agriculture — the practices involved and its position within modern agricultural systems

<u>The Axe Catchment</u>

The River Axe catchment has shown a steady decline in the river's water quality and it has been given a status of "failing good ecological status" under legislation known as the Water Framework Directive. Priority sites like the River Axe Site of Special Scientific Interest and the Special Area of Conservation are becoming increasingly degraded largely due to high loads of sediment, phosphorus and faecal matter indicator organisms, resulted in brown water, low fish numbers, algal blooms and bad bathing water quality. The annual average phosphorus concentration in the River Axe SAC needs to be reduced by at least 50% to achieve the SAC standard of 0.05 mg/l. The current concentration is 0.106 mg/l, and the diffuse agricultural pollution share of the concentration is assessed as 0.072 mg/l (70% of total concentration in the SAC), with the remaining share coming from other industries and sewage discharges. The Environment Agency has been working with farms over the last 2 years to help farm operations be compliant with current regulations like SSAFO (Storing silage, slurry and agricultural fuel oil) and the Reduction and Prevention of Agricultural Diffuse Pollution (England) Regulations 2018 (more frequently referred to as the Farming Rules for Water).

Video link – EA Axe video

Buffer Strips and Riverside margins

We are accustomed to seeing cattle and sheep graze floodplains with unchecked access to waterways. Whilst this helps create stretches of open river, which allows for sunlight to enter the channel, a healthy River Axe catchment requires a mosaic of shaded and open runs to support optimum river corridor biodiversity.

Livestock grazing in riverside areas has the potential for harmful zoonotic pathogens (ie transmissible to humans) to enter the water, eg. Cryptosporidum. Elsewhere in the UK, water companies have been working with farmers' of their catchments to both reduce faecal disease in their livestock and reduce faecal losses to the environment. Reducing river access prevents these potential pathogens entering the waterways. Creating riverside margins where cattle and sheep do not graze right up to the river's edge also will stabilise the river's banks and help to reduce soil erosion. A caveat to this is the acknowledged side effect of allowing for the unchecked growth of invasive species eg. Himalayan balsam which grazing usually keeps from proliferating.

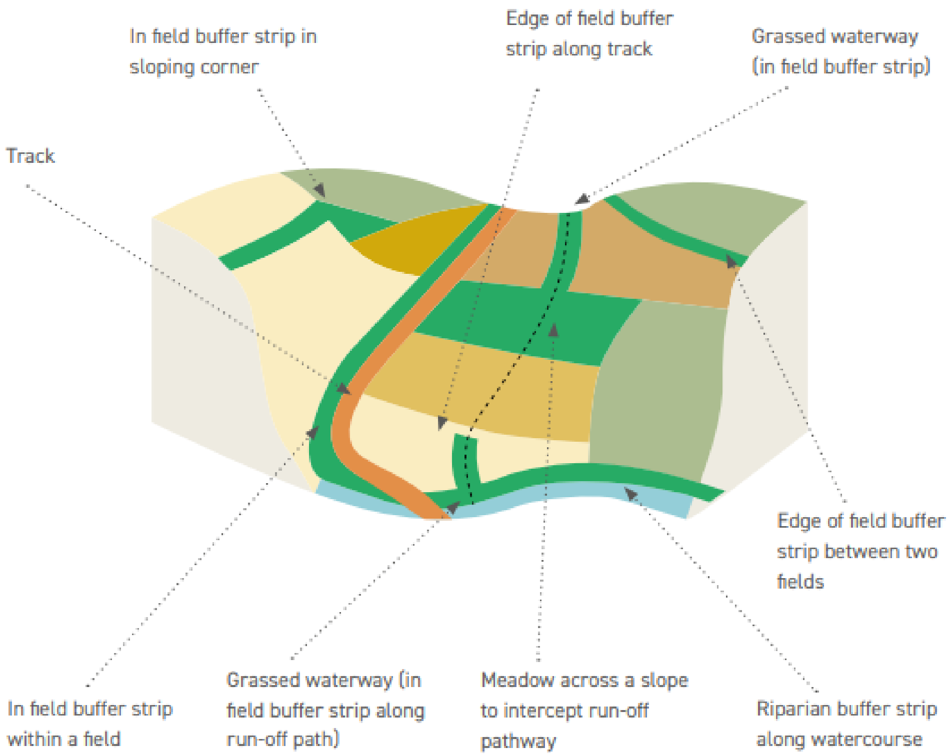
Buffer strips aim is to prevent pesticides entering waterways or hedges, either through direct application, drift or run-off. Of paramount importance is keeping pesticides, especially autumn- applied weedkillers, out of surface and groundwaters.

Undisturbed margins along fields' edges or waterways also boost biodiversity and provide refuge for a range of beneficial insects. Buffer strips may be specific planted areas alongside watercourses or fenced separating livestock grazing or areas of established crops left unsprayed. Grass margins in arable fields provide a habitat for all manner of flora and fauna, especially when enhanced with wildflower seed mixes. As they intercept run-off pathways, they help to keep soil and nutrients on farm, helping farmers comply with the Farming Rules for Water regulations (2018) Preventing run off relies on farmers also following best practice_ regarding both sprayer filling and washing and then field application of the chemicals. 40% of all pesticides that are detected in water are assessed to come from poor practice during sprayer filling and washing, whilst the remaining 60% of pesticide detection comes from the field.

Where livestock graze to the water's edge, alternative drinking points need to be provided for livestock.


Alternative weed management in grassland fields

Herbicide use in grassland fields, though usually less frequent than on other agricultural land, is still a significant source of pollution to watercourses and drinking waters. While there can be no substitute for following best practice with pesticide application and land management, alternative non-chemical methods are available to control problematic weeds. See https://www.pan-europe.info/sites/pan-europe.info/files/public/resources/reports/Alternative%20methods%20in%20weed%20managment%20to%20glyphosate_PAN%20Europe_III.pdf for further details.



Farm tracks

Another crucial area is farm tracks which can act as pollution pathways. There is no "one size fits all" solution for this. However, run-off can often be channelled into appropriate areas for this water to be safely dispersed or slowed, such as culverts and ditches, low erosive, well drained grassland or sediment traps.

Pesticide Handling and Storage

A pesticide handling and washdown area provides a dedicated space where pesticides can be safely loaded into sprayers, and acts as a safe area for housing the sprayer and for sprayer cleaning. Getting the right sprayer step is also critical to protecting watercourses from pollution. One of the most common challenges, in even the best set up spraying operations, is dealing with spills as well as washings from containers and sprayers.

Managing the washings and wastes that come from pesticide handling is one measure that can be taken to help keep pesticides out of water. Significant funding is available for specific pesticide washdown areas.

A biobed provides a simple method for on-farm treatment of dilute pesticide wastes. The biomix in the biobed allows any pesticides within the waste liquid to lock onto the organic matter. The bacteria within the soil and the biomix then slowly break down the pesticide residues. Managing the washings and wastes that come from pesticide handling is one measure that can be taken to help keep pesticides out of water.

Agriculture needs to feed an ever-expanding global population while providing part of the solutions to both climate change and biodiversity loss, with soil health and the water cycle being at the core of the system. Every drop of water has been constantly recycled since the beginning of time. Our health, the viability of our flora and fauna, and our future food production all depend on the continued function of the water cycle.

<u>Further reading</u>

The Last Drop: Solving the World's Water Crisis, published by Picador

Ravenous, Henry Dimbleby with Jemima Lewis

steps-handbook-2023.pdf (stwater.co.uk)

‘Drought is on the verge of becoming the next pandemic’ | Water | The Guardian

https://www.gov.uk/guidance/catchment-sensitive-farming-reduce-agricultural-water-pollution