Economy, Trade and Rural Affairs Committee meeting:
Soil Health in Agriculture

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This report offers a brief overview of the areas of interest specified. Where appropriate summary bullet points are provided at the end of a section.

The role and state of soils in agricultural systems

Soils offer a range of ecosystem services (e.g. carbon storage, water regulation) and are the foundation of food production. Soils are complex ecosystems being governed by a dynamic interplay between biological, chemical, and physical properties. These properties interact to give a soil its characteristics. Soils are subject to change, particularly in relation to biological and chemical characteristics. Across Wales there is a significant variability in agricultural soils with differing suitability for agri-systems. Quantifying the 'state' of a soil requires a clear target condition and related assessment factors.

<u>Production</u>:

Soil is fundamental to agricultural production. Soil offers a rooting medium and supplies of water and nutrients for growing plants. Parikh and James (2012) note that soils best suited for agricultural production possess a balanced soil texture (without extreme proportions of sand, silt, and clay), SOM, and air/water filled pore space. This allows for adequate water retention and drainage, root aeration, and nutrient availability. As such, factors that control soil texture will to a degree determine the potential of a soil to support agricultural and different crop productivities (Silver *et al*., 2021).

Inappropriate management can degrade a soil significantly and rapidly. For instance, the loss of organic matter or excessive trafficking would drive physical degradation. Growth of plants in soils where SOM has dropped to below 2% will be supressed even when fertilisers are applied (Johnson *et al*., 2009). Reduced liming applications may constrain productivity in the medium term. Crops such as fodder maize, when grown without the use of understorey or cover crops, have the potential to lead to significant erosion of bare soils in winter (Jaafar & Walling, 2010), leading to the loss of the nutrient rich surface soil layer.

- Failure to maintain optimum pH a medium term risk
- Precision techniques have potential to better match inputs to demand

<u>Organic matter and carbon</u>:

Soil organic matter (SOM) includes material of biological origin, both as living and dead material. This can be taken as a proxy for soil health as it directly relates to several key soil functions, including fertility. To some extent the amount of more labile SOM in soil will vary seasonally (Leinweber *et al*., 1994) due to factors altering the balance of addition/decomposition (management, climate, topography, and others) (UKSO, 2025). But in the medium term stocks are in equilibrium unless external factors change. The level of SOM, and soil organic carbon (SOC), is relatively high in Welsh soils (EEA, 2024). This is mainly due to the large stock of organo-mineral and peat soil in Welsh upland systems, and to the large proportion of grassland-livestock systems across Wales (Mahmood *et al.*, 2024). It should be emphasised that these findings relate to C stocks not dynamics and the relatively high C contents are vulnerable to decline due to climatic and management changes.

Grasslands are typically subject to less disturbance than arable or other high-intensity management system soils and have higher SOM consequently. For instance, according to the Countryside Survey, there has been no change to SOC in grassland systems since 1978, whereas soils in arable and horticulture systems have lost 11% of SOC over this period (Emmett *et al.*, 2010). Climate change and agricultural economics are likely to promote a switch to cropping of grassland soils.

However, the levels of organic matter will still vary within Welsh grassland systems subject to the intensity of management. High levels of disturbance (ploughing and reseeding), high stocking densities, and high rates of nitrogen/nutrient input will have a broadly negative effect. Additionally, management which favours monocultural grassland will have lower overall soil carbon (Cong *et al.*, 2014; Yang *et al.*, 2019). This may represent a loss of opportunity where SOC could be higher under alternative management with a focus on increased biodiversity.

- Need to distinguish stocks from fluxes
- Potential land use changes may lead to a loss of soil C
- Limited potential for C sequestration in most Welsh soils

Water regulation:

Soil has an important role in hydrological cycles capturing, storing and gradually releasing incident rainfall into rivers or groundwater. During passage through soils microbial activity and physical filtering ameliorate influents such as applied animal slurries. Macropore space dominates the movement of water through soils where these pores are interconnected as is the case with earthworm burrows and former root channels. However, these pore systems are however heterogenous and vulnerable to loss by compaction or declines in earthworm numbers. Where surface infiltration is limited surface runoff predominates during heavy rain increasing local surface flooding risk.

Much of upland Wales has been subject to pasture improvement, where acid grasslands have been limed, cultivated and reseeded to more productive species. Cultivation of these soils destroys surface organic layers and their high rainfall acceptance. However. the resulting circumneutral pH allows colonisation by earthworms whose burrows promote infiltration. There has however been a decline in lime applications in the UK over recent decades (Goulding, 2016), particularly in less accessible upland soils. As a result, these soils have become more acidic, earthworm abundance has declined and water infiltration has decreased (Scullion *et al.*, 2023). The implications of this for reduced water storage for catchment scale hydrology will depend on factors such as topography and proportions of affected pastures on steeper slopes.

Productive grassland swards in Wales are often dominated by perennial ryegrasses due to their high productive potential. However, many of these grasses have profuse surface rooting traits which militate against ingress of excess rainfall. Surface infiltration rates under pure ryegrass swards have been found to be up to 5 times lower compared with those under clovers (Marley *et al.*, 2024). Ryegrass/clover mixtures have rates close to the mean of individual components. Over reliance on ryegrasses and reduced rainfall capture presents an enhanced local risk factor.

In addition to the flooding risks associated with increased surface runoff, bypassing the soil reduces plant uptake of nutrients and the extent to which added influent is ameliorated by soil processes. This has particular relevance to issues surrounding slurry applications.

- Agriculture management practices affect water infiltration and flood risk
- Reduced infiltration can limit nutrient uptake and exacerbate pollution risk

Monitoring of soil health

The objectives of a monitoring system need to be clear and can vary from soil protection to providing evidence of medium term trends in conditions. Historically, the focus has been on the suitability of soil for crop production, whereas, more recently, the focus has shifted towards multi-functionality assessment, considering the provision of ecosystem services and the resistance/resilience of the soil ecosystem to perturbation (Hanley *et al*., 2018; Toor *et al.,* 2021).

A range of tools exist for monitoring variability in the health of soil. Whilst soil properties are dynamic and heterogenous, certain predictions can be made based on factors including land-use type, soil type/texture, and climate. The tools available range from scorecard-style systems (e.g. AHDB, 2025) to online calculator tools (e.g. UKCEH, 2025).

The scorecard approach from AHDB (2025) offers a system to interpret soil health for farmers and land managers that considers values for SOM, pH, fertility (phosphorus, potassium, magnesium), structure, and earthworms against expected ranges for given UK soil types. These present a colour-coded 'traffic light' hierarchy to represent quality and where action is required. This approach is focussed on optimum conditions for crop production, which is not necessarily the same as optimal soil health, and requires sampling and analysis of a range of soil variables to be undertaken.

The SOD (SOil funDamentals) is a tool from CEH based on Countryside survey data. This uses the robust dataset to offer insight on the quality of soil across a range of indicators, including SOM, pH, bulk density, and earthworm abundance (UKCEH, 2025). However, this tool still requires a reasonable understanding of the environment in question (i.e. soil textural type, annual rainfall rate), and measurements to be taken of the main characteristics in order to be applicable, which may lead to challenges. Nevertheless, where the required input data is known, the SOD tool can help contextualise the quality of a soil relative to expectations. The factors considered by this tool to determine soil health are by virtue interrelated. For instance, SOM can act as a buffer against soil pH change and soils with high organic matter would be expected to have greater porosity and general physical structure.

The above approaches require input derived from on-site analysis of the soil under consideration. The future of large-scale soil health assessments must utilise remote sensing technologies, offering a rapid approach to health status quantification (Aqdam *et al*., 2023). This is an active area for research but to date no one consistently accurate approach has emerged. Studies vary from single issue assessments as a proxy for health (i.e. soil carbon), (Endsley *et al*., 2020), to multi-factor assessments of remote sensed information (Wang *et al*., 2023) and are expected to improve rapidly with the application of machine learning and artificial intelligence.

- Various systems exist for assessing soil quality suitable at farm and broader scales
- Developments in remote sensing offer the prospect of landscape scale assessments

Classification of soils for land use

The soils of Wales have been mapped as part of the Soil Survey of England and Wales. These maps have been digitised as part of the Land Information System (LandIS) project and are available through the Soilscapes Viewer (LandIS, 2025). According to Cranfield University (2025) there are 298 distinct soil types (or soil associations). These broad classifications can be simplified by aggregating broadly similar groups together, which results in 27 distinct soil units (Haygarth & Ritz, 2009), but this still represents a significant diversity of soils across the Welsh landscape.

The Agricultural Land Classification (ALC) is a system of categorisation which can show the suitability of a given soil to produce food (MAFF 1988). Whilst this system considers more than simply soil, it offers a broad framework for considering the potential of a landscape in the context of agricultural productivity. However, current factors which would be considered essential, such as the delivery of ecosystem services from soils, would not be adequately considered by this approach and classifications tend to be static.

Understanding the different soil types present in a given location can indicate likely vegetation landcover, and *vice versa* (through plant-soil interactions), at least for ‘natural’ or unmodified landscapes. The existing spatially-explicit soil data could allow the quantification of land use capability subject to underlying soil type, where the requirements of land use and the limitations of a soil type are adequately quantified. However land use change can modify soil through alterations to SOM, soil biodiversity, and pH. Quantifying the influence of land use on soil types is necessary to understand the influence on soil health and ecosystem service provision for each soil type under differing management.

- Ongoing developments in classification promise digital, high resolution mapping with the option of varying factors and outcomes

The policy and legislative mechanisms to protect soils and productive land (including the Sustainable Farming Scheme, National Minimum Standards and planning policy (amongst others))

Soil protection in the Wales is governed through devolved and UK-wide policies. Wales has developed distinct mechanisms compared to the wider UK, tailored to its unique environmental and agricultural context.

The Sustainable Farming Scheme:

The proposed Sustainable Farming Scheme (SFS) in Wales is central to future agricultural land and soil protection. The scheme encourages farmers to adopt sustainable land management practices that enhance soil health, reduce erosion, and increase carbon sequestration. The SFS is framed within the Agriculture (Wales) Act 2023, which mandates support for sustainable land management (Welsh Government, 2023a).

National Minimum Standards:

Alongside the SFS, National Minimum Standards (NMS) for environmental protection are intended to ensure all land managers meet baseline regulatory requirements. These standards need to be enforceable and include requirements relating to soil health, such as minimising compaction, maintaining ground cover, and preventing pollution from run-off. The NMS are intended to replace the cross-compliance mechanisms.

Planning policy and land use:

Land use planning plays a key role in protecting productive land from harmful development. Planning Policy Wales (PPW) emphasises the protection of the best and most versatile (BMV) agricultural land (grades 1, 2, and 3a) from development unless there is an overriding need. The policy mandates local planning authorities to consider soil quality and sustainable land use in development decisions (Welsh Government, 2021).

The above initiatives in Wales are delivered in line with national legislation: the Environment (Wales) Act 2016, the Agriculture (Wales) Act 2023, and the Well-being of Future Generations (Wales) Act 2015.

The legislative landscape surrounding the protection of soils remains complex and transitional. Continued coordination between government, enforcement of minimum standards, and robust data collection are essential to improving long-term soil health and protection of productive land.

The potential for legal frameworks and targets for soils.

Soils in the UK and Wales lack dedicated legal protection. Soil degradation continues due to compaction, erosion, organic matter loss, and sealing through development (Graves *et al*., 2015). Existing legal instruments, such as the Environment (Wales) Act 2016, acknowledge soil as a natural resource but do not set enforceable standards or monitoring obligations.

The Well-being of Future Generations (Wales) Act 2015 and the Environment (Wales) Act 2016 provide foundational legal tools that could support the development of soil health objectives. These Acts obligate public bodies to pursue long-term environmental sustainability and sustainable natural resource management. Soils could be more explicitly incorporated into the

Natural Resources Policy and the associated Area Statements under the oversight of Natural Resources Wales (NRW).

The Agriculture (Wales) Act 2023 and the upcoming SFS present promising opportunities for embedding soil health principles into law through conditional support payments, baseline standards, and incentivised practices. While not legally binding in a regulatory sense, these frameworks have the potential to set *de facto* standards for soil management, especially if linked to measurable indicators.

Scientific consensus supports using indicators such as SOM, erosion rates, and compaction measures to assess the health and quality of soil (Kibblewhite *et al*., 2008; Hanley *et al*., 2018; Toor *et al.,* 2021). Incorporating this into statutory targets, alongside monitoring obligations, would align Wales with best practices in natural capital accounting and environmental governance.

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