Senedd's Economy, Trade and Rural Affairs Committee
Inquiry on Soil Health in Agriculture

Written evidence by Prof Bridget Emmett OBE, UK Centre for Ecology and Hydrology;
Scientific Lead of ERAMMP and member of the EU Mission Board for Soil.
11th April 2025

Headline messages regarding:

- **The role of soils in agricultural systems**

Soil is the main natural capital all agricultural systems rely on. It underpins all agricultural production and supports all land-based wildlife embedded in and around our agricultural systems. This includes (although is often missed) the bacteria, fungi and animals living in soils and which are thought to represent 60% of global biodiversity.

Soil is a precious resource which renews only very slowly (around 0.5cm every 100 years). All current soil in Wales has developed since the last glaciation around 11,000 years ago.

Soil (and peatlands) are the dominant land-based carbon store representing 94% of biosphere carbon in the UK and it has the potential to help us decarbonise the agriculture sector if we change current land use and management practices. However when we captured the full range of evidence from many studies this may be limited to a reduction of 5-10% of the net greenhouse gas emissions from the agricultural sector (Emmett et al. 2023).

Soil carbon is the Well-Being of Future Generations (Wales) Act 2015 National Indicator No. 13. We believe Wales is one of the few countries globally to have soil as an indicator of national well-being.

Concern that soil health has slipped through the protection and regulatory net is already well established in Europe with one of the 5 EU Missions dedicated to improving soil health https://mission-soil-platform.ec.europa.eu/. This followed an analysis of all current soil monitoring data available which revealed 60-70% of EU soils were unhealthy. Issues of concern identified by the Mission and that are relevant for agricultural soils in Wales are; loss of organic matter and carbon, nutrient enrichment, compaction and erosion, levels of control chemicals and contaminants and loss of land/soil to urban development. With the exception of the last issue, all of these are related to current agricultural management practices.

- **Monitoring of soil health to assess state and change in soil health in agricultural soils**

A monitoring programme in Wales (ERAMMP) has just recently (April 2025) published the status and trends of soil health in Wales for the last 10 years linking to legacy monitoring programmes started in the 1970s (https://erammp.wales/en/nationaltrends). The report also evaluates the impact of the Glastir agri-environment scheme on soil health and the extent and benefits of restoration of agricultural land on peatland on greenhouse gas emissions. This provides a timely and statistically robust insight into current trends in soil health in agriculture which we hope will be of interest to the Committee.

Key ERAMMP findings relating to soil health in agriculture over the last 10 years include:

1. 8% decrease in topsoil carbon concentration in Arable soils
2. 6% in Arable increase in soil bulk density (which is indicative of increased compaction), a 10% increase in Improved Grassland and 12% increase in Semi-Improved Grassland. Overall there was a 8% increase across Wales.
3. a) 15% increase in topsoil phosphorus level in Improved Grassland with a 3 fold increase in number of sites exceeding leaching threshold (19% now exceed recommended levels which risk leaching to rivers)
   b) 18% increase in topsoil phosphorus in Arable and 2 fold increase in number of sites exceeding recommended levels (11% of sites now exceed recommended levels.)
   c) 10% reduction in nitrogen levels in Arable soils but remaining within recommended guidance levels for production
4. 72% of Improved Grassland sites fall below the minimum soil acidity levels when productivity may be reduced. This statistic has not changed over the last 10 years
5. 5% loss (-49,000ha) of Arable and Improved Grassland land between 2010 and 2021 primarily to increased Urban (+28,200ha) and Woodland (+23,600 ha)
6. The agri-environment scheme Glastir has had minimal benefit effect on soil health in agriculture over the last 10 years.
7. 3% (526ha) of agricultural peatland has been restored (rewetted, scrub removal etc)
8. A new baseline assessment suggests 4% of Wales experiences some form of soil erosion and disturbance
9. Baseline data is also available for soil biodiversity. Dried and frozen soil samples have been archived for future needs such as assessing soil biodiversity change and levels of contaminants and control chemicals.

Overall, these results suggest one of concern for soil health in agriculture as all of these indicators (except 3c) indicate a decline in soil health. Below these findings are put into

context and described in greater detail. I look forward to discussing this evidence and their implication with the Committee on the 30th April 2025.

Personal experience

I have over 35 years as an environment research scientist as a Soil and Ecosystem Science specialist. I am providing this evidence as the independent Scientific Lead for a major Welsh Government funded programme of work called ERAMMP (https://erammp.wales/en; https://erammp.wales/cy) which brings together over 20 organisations to deliver evidence, modelling and review to support policy development and evaluation which underpins Sustainable Land Management of the Welsh landscape. Welsh Government has supported the work since 2012 which is led by the UK Centre for Ecology and Hydrology. As I am also one of the 15 members of the EU Mission Board for Soil, I can provide some insight as to the direction of travel on this topic in Europe.

Monitoring Soil Health in Wales: Evidence from ERAMMP

On the 4th April 2025 ERAMMP published an independent evaluation of the current national trends of Wales' natural resources and the outcomes of the Glastir agri-environment scheme (AES) (https://erammp.wales/en/nationaltrends; https://erammp.wales/cy/tueddiadaucenedlaethol). Wales is unique amongst the four UK Nations in having and maintaining a long-term, integrated national monitoring programme across its rural environment. The quality and breadth of the evidence base presented in the report is unmatched. The design of the programme enables us to compare the results from the last 10 years with those from the historic UKCEH Countryside Survey stretching back to the 1970's. In addition, the same design and methodologies used for national trend reporting have been used for Glastir evaluation enabling the contribution of Glastir to be assessed both for land where management options were applied but also how they aggregate up to contribute to the national trends reported.

As part of this evidence we have specific data relating to the status of, and change in, topsoil health in agricultural systems which is outlined below (Emmett et al. 2025). Note that results cover the top 0-15cm of the soil as this is the part of the soil most actively managed and most exposed to climate change. Going forward it is hoped the resources will be made available by Welsh Government to extend soil monitoring to deeper soil.

Headline messages with context

1. 8% decrease in topsoil carbon concentration in Arable soils

Context: Carbon in soil is considered one of the most most helpful indicators of overall soil health as it is linked to soil moisture retention, effective nutrient cycling and overall good soil structure which benefits root growth. It also contributes to carbon sequestration and thus helps meet the Net Zero target. Soil carbon loss is usually attributed to intensive management practices such as tillage and a lack of organic matter inputs. The decrease in Wales reported by ERAMMP compares to an increase in Arable soils across Great Britain (driven primarily by trends in England) reported by UKCEH's Countryside Survey which reversed a longstanding trend of decline of 11% since 1978 (Bentley et al. In review). The reason for the different signals in England and Wales is being explored but could include a lower rotational diversity in Wales (Upcott et al, 2023 which uses UKCEH's annual crop map) and / or lower uptake of actions often described as regenerative agriculture which we believe may now be reversing the longstanding decline of soil carbon in arable soils in England.

2. 6% increase in soil bulk density in Arable soils (which is indicative of increased compaction), 10% increase in Improved Grassland and 12% increase in Semi-Improved Grassland. Overall there was a 8% increase across Wales.

Context: An increase in bulk density / compaction is of concern as it is linked to a more dense soil structure (more soil per volume of soil) which leads to less favourable root growth and poor infiltration and rapid runoff of rainfall into rivers. The increase varies across habitats and currently the levels remain below recommended thresholds and in-depth analysis is needed to understand the drivers of change. However, the ERAMMP results provide an early warning of a possible lack of adaptation of management practices in response to wetter winters and drier summers associated with climate change.

3. a) 15% increase in topsoil phosphorus level in Improved Grassland with a 3 fold increase in number of sites exceeding leaching threshold (19% now exceed recommended levels which risk leaching to rivers).
   b) 18% increase in topsoil phosphorus in Arable and 2 fold increase for Arable (11% now exceed recommended levels.)
   c) Topsoil nitrogen concentrations have reduced but remain with productivity guidelines in Arable soils **(note is a positive outcome)**

Context:

3a&b Phosphorus fertiliser is used to maintain production in both Improved Grassland and Arable systems. The general increase in soil P levels reported by ERAMMP is at first

difficult to reconcile with the reported reduction in the use of manufactured fertiliser between 2010 and 2023 of 55% in England and Wales (British Survey of Fertiliser Practice 2023 (BSFP 2023)). However, manure use trends between 2014 to 2023 suggests a 14% increase in dressing cover of organic manures for the whole of Great Britain (data for England and Wales from 2010 and separate to GB are not available) (BSFP 2023). Therefore the mismatch between the BSFP survey and the ERAMMP results may be related to the use of sustained, and possible increased, use of organic manures, in particular the use of poultry manures as poultry litter and manure is very phosphorus rich compared to other animal slurries and farmyard manures.

The ERAMMP results of increased number of sites exceeding soil P recommended thresholds also highlights the issue of local use versus national averages. It is the use of high levels by just some farmers near to sensitive river systems which can result in nutrient enrichment (called eutrophication) of soils, freshwaters and coastal systems recently highlighted in the media. As we develop future indicators for Sustainable Land Management we need to consider indicators which can identify extremes which can cause local issues such as river pollution as well as national averages.

(Note: It is worth noting the design of the British Survey of Fertiliser Practices is targeted towards reporting change in use of manufactured fertiliser not manures and therefore the data for use of organic manures is not as robust but it is the only data available.)

Context 3c: A decline in soil nitrogen levels reduces the risk of nitrogen entering rivers and other water bodies and the risk of emissions of nitrous oxide from the soil (a potent greenhouse gas). It also reduces the potential transfer of nitrogen from field to field margins which are important refugia for wildlife and are damaged by raised nutrient levels. It is possible this is an early signal of an environmental benefit of The Water Resources (Control of Agricultural pollution) (Wales) Regulations 2021 which came into force April 2921. No change was reported for improved Grassland.

4. 72% of Improved Grassland sites fall below the minimum soil acidity levels when productivity may be reduced.

Context: The majority of Improved Grassland sites have soil acidity levels which fall below the recommended threshold. This number has not improved over the last 10 years. Below the threshold, lower fertiliser use efficiency particularly of phosphorus can occur. This low acidity is most likely due to the use of manufactured fertiliser (particularly ammonia-based fertiliser) without the use of lime to offset its acidifying effect. Low pH also increases the risk of nitrous oxide emissions from soil – a powerful greenhouse gas.

5. 5% loss (-49,000ha) of Arable and Improved Grassland land between 2010 and 2021 primarily to increased Urban (+28,200ha) and Woodland (+23,600 ha)

Context: These results are obtained from the use of satellite data by UKCEH for ERAMMP. It demonstrates the multiple demands on our land resource as building new houses and new woodland are priorities as is a resilient and sustainable food system. Currently these results suggest these priorities are directly competing for the same land.

Impact of Glastir

6. The agri-environment scheme Glastir has had minimal benefit for agriculture soils over the last 10 years.

One of the six environmental objectives of the Glastir agri-environment scheme which ran from 2012 to 2023 was "Improving soil quality and management". The ERAMMP National Field Survey found minimal evidence soil quality had been improved on land in the Glastir scheme which had taken up management options intended to improve environmental outcomes. However 11% farmers in scheme self-reported they were more likely to have carried out soil nutrient testing and 10% had undertaken more manure actions. Management options taken up appear not to have been sufficiently widespread or transformative in nature to protect or restore soil health in agriculture.

Peatland restoration in agriculture

7. Limited peatland restoration on agriculture land representing (526ha / 3% of agriculture land on peat).

Peat soils represent 4% of Wales but contribute 10% of the combined Agriculture and Land Use Land Use Change and Forestry GHG inventories due to their water logged nature. Their restoration is often suggested as a priority to help meet Net Zero by 2050.

Agriculture (arable, intensive and extensive grassland) represents 19% of this peatland (0.8% of all agricultural land in Wales) but is responsible for 54% of GHG emissions from all peatlands.

Whilst an estimated 5,000ha of peatland restoration has been carried out (most since 2010), only 526ha has been carried out on agricultural land representing 3% of land area and 3% reduction in GHG emissions from agriculture on peatland. Most peatland restoration 5,000ha has been on bogs.

New baseline for future broader assessments of soil health

8. Soil erosion and disturbance features
   The ERAMMP report provides a first estimate of the area of Wales where there is soil erosion and disturbance present. This is estimated as 4% of Wales using a combined approach of aerial photography and the ERAMMP National Field

Survey. Linking this data to erosion modelling indicated the majority of this eroding soil contributes to soil in rivers but is re-distributed within the fields and landscape.

9. Soil Biodiversity

   Welsh Government paid for one of the most comprehensive national assessments to date of soil biodiversity ever undertaken using eDNA. The data provides a fascinating insight into the current distribution of bacteria, fungi and animals in soil across the different habitats of Wales and describe the inherent properties of soils and climate which drives the observed distributions. This provides a robust baseline for future assessments using soil samples frozen from ERAMMP or future surveys should this be prioritised by Welsh Government. (Emmett et al. 2017; George et al. 2019). This builds on Countryside Survey soil biodiversity assessments (Griffiths et al. 2011)

10. Contaminants

    Baseline assessments for metal concentrations have been made with dried samples archived should change data be requested (Emmett et al. 2010). Frozen samples are also available for assessment of Persistent Organic Pollutants should this be requested (GMEP and ERAMMP samples).

Sources:

Bentley et al. (2025) Soil. *In* Emmett, B.A., et al. (2025). ERAMMP Technical Annex-105TA1: Wales National Trends and Glastir Evaluation. Report to Welsh Government (C208/2021/2022) (UKCEH 08435) https://erammp.wales/sites/default/files/2025-04/ERAMMP%20Technical%20Annex-105%20Wales%20National%20Trends%20and%20Glastir%20Evaluation_0.pdf

Emmett, B., Evans, C., Matthews, R., Smith, P., Thompson, A. (2023). Environment and Rural Affairs Monitoring & Modelling Programme (ERAMMP). ERAMMP Report-101: The opportunities and limitations of carbon capture in soil and peatlands. Report to Welsh Government (Contract C208/2021/2022)(UK Centre for Ecology & Hydrology Project 08435) https://erammp.wales/sites/default/files/2025-01/101%20Report101_ERAMMPShortReport_Carboninsoil_EN_v1.2%20%281%29.pdf

Emmett, B.A. & the ERAMMP team (2025). ERAMMP Report-105: Wales National Trends and Glastir Evaluation. Report to Welsh Government (C208/2021/2022) (UKCEH 08435) https://erammp.wales/sites/default/files/2025-03/Report%20105.%20Wales%20National%20Trends%20and%20Glastir%20Evaluation.pdf

Emmett, B.A., Reynolds, B., Chamberlain, P.M., Rowe, E., Spurgeon, D., Brittain, S.A., Frogbrook, Z., Hughes, S., Lawlor, A.J., Poskitt, J., Potter, E., Robinson, D.A., Scott, A., Wood, C., Woods, C. (2010). Countryside Survey: Soils Report from 2007. Technical Report No. 9/07 NERC/Centre for Ecology & Hydrology 192pp. (CEH Project Number: C03259). https://www.ceh.ac.uk/our-science/projects/cs-soils

Emmett, B. A., & the GMEP team (2017). *Glastir Monitoring & Evaluation Programme. Final Report to Welsh Government.* https://gmep.wales/sites/default/files/GMEP-Final-Report-2017.pdf

George, P. B., Lallias, D., Creer, S., Seaton, F., Kenny, J. G., Eccles, R. M., . . . Jones, D. L. (2019). *Divergent national-scale trends of microbial and animal biodiversity revealed across diverse temperate soil ecosystems*. *Nature Communications 10*.

Griffiths et al. (2011) The bacterial biogeography of British Soils. Environ. Micro. 13: 1642-1654.

Upcott et al (2023) A new approach to characterising and predicting crop rotations using national-scale annual crop maps. Science of the total Environment 860: 160471