

**Notes of a meeting held on Tuesday 15 January 2019,
Committee Room 21, Palace of Westminster**

Soil health – the foundation for sustainable agriculture

Present:

Members

Julian Sturdy MP
Earl of Lindsay
Lord Cameron of Dillington
Duke of Montrose
Rebecca Pow MP
Lord Curry of Kirkharle
Lord Trees
Baroness Jones of Whitchurch
Darren Jones MP

Stakeholders

Tom Atkins, National Trust; Adam Barnett, RSPB; Susan Twining, CLA; Kate Farmer, Government Office for Science; Vincenzo Brugaletta, Itaka International; Chris Brown, Society for Applied Microbiology; Tom Storr, Cranfield University; Marco Fioratti Junod, John Innes Centre; Mark Buckingham, Bayer; Mark Jacob, Defra; Stephan Haefele, Rothamsted Research; Daniel Kindred, ADAS; Guy Thallon, Fera Science; James Holmes, AHDB; Fiona McLaughlin, BEIS; Sarah Anderton, CIWEM; Sophie Bennett, Royal Society; Andrew Clark, NFU; Brendon Noble, UKSCF; Andrew Voysey, Soil Capital; Tracie Evans, Defra; Charlotte Curtis, G's Growers; Matthew Orman, Sustainable Soils Alliance; Helen Fox, BEIS; Daniel Pearsall, Group Co-ordinator

1. Introduction

Taking the chair, the Earl of Lindsay (JL) welcomed members and stakeholders to the meeting, and briefly introduced the topic for discussion - soil health - exploring how innovation in soil science is opening up new opportunities to address combined policy objectives for the environment and agricultural productivity. JL noted that after decades of neglect and under-investment there was now renewed interest in soils-related research and a recognition that science-based approaches to improving soil health could offer a win:win outcome for productive farming and the environment.

JL invited Rebecca Pow MP to provide a more detailed introduction to the topic in her capacity as champion of the Sustainable Soils Alliance, a partnership of farming organisations, businesses, NGOs, applied scientists and academia working to reverse the current crisis in soil health and restore the health of our soils within a generation.

2. Guest speakers

[Please note that all speakers' slide presentations are available to download via the meetings section of the All-Party Group web-site at www.appg-agscience.org.uk]

Rebecca Pow MP, Champion, Sustainable Soils Alliance

Highlighting the critical importance of soil as a living medium yet all too often neglected and treated as a substrate, Rebecca Pow (RP) observed that soil not only delivers 97% of our food but also provides important environmental functions - it cleans waters, holds carbon, helps with flood management and provides a biodiverse habitat, particularly under ancient woodland.

RP noted that concerns over declining soil health were frequently linked to the kinds of monoculture farming systems incentivised under the CAP, leading to a range of dire statistics like there are only 1,000 harvests left, and that half of our arable soils in the east of the UK will become unproductive within a decade – highlighting the urgent need for action.

RP also singled out the importance of conserving peatlands as important and biodiverse habitats holding 40% of soil carbon, not only in the UK but worldwide.

To set the issue in context, RP observed that it takes 1000 years to form 1cm of precious topsoil which simply cannot be recreated if it is washed away or eroded by agricultural production.

As a new MP and member of the Environmental Audit Committee, RP was involved in the Soil Inquiry which highlighted the urgency of the soil health issue and made a number of recommendations to Government, and led to the establishment of the Sustainable Soils Alliance with the goal of restoring the health of our soils within a generation.

RP suggested that Brexit presented a key opportunity to influence the policy and regulatory framework surrounding soil health. Following publication of Defra's Health and Harmony consultation and the Agriculture Bill, RP acknowledged that soil was referenced in the explanatory notes in relation to climate change and flood management, but given the much wider range of food production and environmental benefits associated with soil, she argued that action to promote healthy soil should be more explicitly recognised and rewarded as a public good.

RP noted that implementing this in practice would require clarity over how to inspect, monitor, measure and reward improvements in soil health, adding that the Treasury would also need to be persuaded of the need for long-term financial support for agriculture and issues such as soil health.

Concluding, RP expressed optimism about the opportunities within the Agriculture Bill, the 25-year Environment Plan and the forthcoming Environment Bill, to raise the profile and policy focus of soil health, with the ultimate goal of creating a National Soils Policy.

Dr Jacqueline Hannam, Senior Research Fellow in Soil Science, Cranfield University

Jacqueline Hannam (JH) provided an introduction to the concept of soil health, including what the soil testing and monitoring programmes carried out over the past 40 years have told us about the degradation of our soils, and how the introduction of new testing methods, technologies and data science can contribute to improved analysis and understanding of soil health.

JH explained that soil health is a term used to describe the optimal functioning of soils to provide a range of ecosystem services, such as food and fibre production, clean air and water, carbon regulation and flood prevention. She added that the ecosystem services provided by healthy soils would be critical to the delivery of the Government's 25 year Environment Plan, and to support Defra's ambition to achieve sustainable management of all soils by 2030.

As a combination of physical, chemical and biological properties, soil health can be influenced by management or other environmental processes, such as climate change, and specific indicators of soil quality (soil properties) are used to monitor changes.

JH highlighted the key indicators typically measured in previous soil monitoring programmes, such as Nitrogen, Phosphorous, pH level, texture and density, noting that soil biological indicators are also emerging in their use in soil monitoring and soil health.

National monitoring programmes are vital to understanding the direction of travel in the state of our soils, but JH noted that the most recent monitoring took place in the Countryside survey over 10 years ago and that no systematic national monitoring scheme for soil health is currently supported in England.

JH highlighted key findings of the two national soil health monitoring schemes – the National Soil Inventory (NSI) and the Countryside Survey – conducted between 1978 and 2007. Although based on different sampling designs and sampling intervals, both surveys pointed to loss of carbon from the intensively managed arable and horticulture habitat, suggesting that current policies to limit soil degradation are not maintaining soil quality in cropped land. Soils collected during the Countryside Survey in 1998 and 2007 showed a significant decrease in available Phosphorus in most habitats across Great Britain, while the mean pH of soils increased in less acidic soils between 1998 and 2007.

JH highlighted the importance of the soil and vegetation survey being conducted by the Centre for Ecology and Hydrology from 2018-2023 in helping to fill gaps in our understanding of the status and dynamics of soil health since the Countryside Survey ended in 2007, adding that additional soil sampling data collected by farmers to support farm management decisions could be used to provide additional granularity and coverage in the monitoring data.

Turning to the innovations taking place in soil monitoring, JH noted that soil properties can now be mapped and monitored remotely without taking a physical soil sample and testing it in the laboratory (although these methods still require calibration with laboratory derived data to determine relationships between the sensor signal and the soil property).

COSMOS UK is using the interaction of fast neutrons from cosmic rays with the hydrogen nuclei in water to determine soil moisture content, while spectroscopy uses the reflectance and absorption of light at different wavelengths to determine a range of soil properties (e.g. soil carbon and potentially some soil biological properties).

Advances in high throughput DNA sequencing also enable the DNA from soil to be analysed to determine the abundance and structure of microbiological communities such as fungi bacteria, although JH noted that a great deal of research is still required to understand how these signals relate to soil health and soil quality.

Pointing to research taking place in Ireland and the UK, JH added that data science and application of machine learning algorithms can also be used to identify patterns and relationships in different data sources, providing a means to predict soil property data and produce more detail data in areas of data scarcity.

In conclusion, JH suggested that there is a wealth of environmental, soil and agricultural data available but few efforts to integrate datasets to inform soil state and management decisions. Previous monitoring indicates that some aspects of soil health have deteriorated over time and there is an urgent need to support future monitoring, and new innovations in soil monitoring technology can help us do that more effectively. Using data science to integrate national scale and farm scale monitoring programmes offers the opportunity to inform policy and identify where action is needed, and to provide new insights into soil systems and soil health.

Dr Elizabeth Stockdale, Head of Farming Systems, NIAB

Providing a snapshot of on-going work on soil health within the strategic and applied research community, Elizabeth Stockdale (ES) explained that the focus of her own research as a soil scientist was on the availability of nutrients for plant uptake – and the myriad of interactions within the soil and with climate and management that influence this.

Highlighting the complexity of understanding soil health and how farmers and scientists can learn to manage soils more effectively, ES noted that even for a soil function so well studied as nitrogen availability, the same management can be applied in successive seasons yet give completely different results for plant growth and environmental impact (nitrate leaching, greenhouse gas emissions).

Although these differences can usually be explained *post hoc*, understanding what needs to be measured in advance to take appropriate management action that is cost-effective still remains elusive. These are the challenges that applied research seeks to address – underpinned by the increasing body of mechanistic knowledge provided by strategic research.

Unlike air or water, ES noted that there is no single medium making up soil. Most soil is about 10,000 years old, a very spatially diverse material linking atmosphere and geology with biology and hydrology, transforming and transporting the profile as it forms. Hence the soil in each location is the distinct result of place specific interactions between geology, topography, biology and climate.

The UK is privileged to have a good coverage of soil mapping at field scale – with full coverage showing the main soil types (series) and their associations at 1:250,000 scale. Land use capability approaches (now ALC classifications) have been used to describe the soil type in terms of potential uses and to help inform planning decisions.

Knowing the soil type is critical to inform management decisions, but management of soils also changes soil properties and critically these affect the *“capacity of soil to function as a living system, within ecosystem and land use boundaries, to sustain plant and animal productivity, maintain or enhance water and air quality, and promote plant and animal health.”* (FAO definition of soil health, 2008).

ES highlighted a visual example of how soil properties can be influenced by management decisions showing how “Soil Farmer of the Year” Simon Cowell, who farms on heavy clay in Essex, transformed the structure, colour and appearance of the soil over a 5 year period after changes to no-till cultivation, incorporation of compost and an increasingly diverse crop rotation.

ES explained that increasing farmer interest in soils and recognition of a gap in practical understanding of soil biology has led to significant investment by the levy bodies in research and knowledge exchange programmes linked to soil health and improved soil management. ES leads the AHDB-BBRO funded Soil Biology and Soil Health Partnership (GREATSOILS), bringing together a wide partnership in research and practice.

The aims of the partnership are broad. The main research focus is on the development and testing of biological indicators in research trials and on-farm – working with farmer groups to build on existing knowledge and practices considered to improve soil health.

Part of the initial work of the programme was to bring together all the academic, industry and other research organisations to share their ongoing strategic and applied research with a focus on improving soil health. When mapped on a diagram this demonstrated not only the range and diversity of research now taking place on soils, but also that 18 months ago the

main gap was in work commissioned to inform policy development. There have been new projects in all areas since October 2017 – and there are also now several Defra-funded projects specifically drawing from this body of work to target policy development needs.

ES also highlighted the important research taking place to study the role and impacts of cover crops, noting that two PhD students working in this area - Tom Storr (Cranfield University) and Marco Fioratti (UEA, John Innes Centre) were in attendance and on hand to discuss their research.

ES explained that in the first year of the SBSH programme, a key focus was on drawing together the principles for managing soil health – reminding farmers, advisors and others of the need for management practices to optimise the combination and balance of physical, chemical and biological aspects of soil. Many of these approaches require significant upfront investment of time and resources.

Given the diversity of soils, farms and crops, ES suggested that there can be no one-size-fits-all approach to improving soil health. Good farm-specific soil management planning is needed to address damage, minimise risks of further soil degradation and promote soil health. ES added that any future scheme to promote and reward soil health must not penalise farmers and land managers who have already taken effective action to maintain or improve soil health despite economic pressure to take a more short-term focus.

Looking ahead, ES explained that the SBSH programme is testing a range of indicator measurements of soil health for mineral soils to underpin farmer decision-making at field / part-field scale. The approach is being developed on-farm with farmer input from across all sectors and evaluated in research trials as well as on-farm.

The objective is to develop a practical scorecard system for on-farm use by the end of the project. In parallel the newest indicator approaches, especially DNA-based methods for characterising the soil biological community and its function, are being developed and tested on the samples collected. Targeted pathogen detection is already possible using these methods providing further insights into crop protection.

ES concluded that throughout this work area, the link between our underpinning knowledge of soils and the diversity of farming systems in practice is key. Applied soils research is seeking to link observations of the biological, physical and chemical properties of the soil to promote a two-way exchange of knowledge between farmer and researcher, with the ultimate goal of understanding that with x climate, y soil texture and z management practice what are the most likely impacts on soil health and on soil function.

Dr Kate Pressland, Programme Lead, Innovative Farmers

Providing an insight into farmer-led approaches to improving soil health, Kate Pressland (KP) described the 'field labs' concept developed by the Innovative Farmers partnership - part of the Duchy Future Farming Programme - as a new and effective means to mobilise, share and accelerate the uptake of new knowledge on farm and make it relevant to local conditions.

KP explained that the field labs approach centres around peer-to-peer learning and experimentation, with farmers setting the priorities for practical, on-farm trials, supported by respected researchers. Programmes typically involve multiple triallists to amplify learning and share risk and investment, with small grants available up to £10k and low bureaucracy to allow focus on getting research ideas and progress out onto farm.

KP added that the field labs programme is supported by an impressive scientific network across the agricultural R&D landscape, from levy funded organisations to university departments and independent/BBSRC research institutes.

Working across arable and horticultural research areas, KP highlighted a number of field labs research topics related to soil health, which ranged from identifying alternatives to glyphosate for no-till farmers and testing compost teas to trialling green manures, cover crops and herbal leys.

Field labs also brought growers together to rate and evaluate different soil assessment tests in a project feeding in to the GREATSOILS programme, providing a farmer-friendly guide to the soil tests available based on real-world use, relevance, cost and practicality.

KP suggested that farmer-led research such as the field labs programme can be particularly important in relation to soil health because it supports individual farmers to find the best solutions for their specific fields and conditions. She highlighted the importance of regular soil testing, monitoring, data collection and analysis leading to action in terms of better management.

In relation to the funding landscape and the current policy discussions taking place, KP noted that there were encouraging signs of possible support for farmer-led R&D, such as the Agriculture Bill press release signalling the opportunity for farmers to group together to carry out research, and the Industrial Strategy's innovation accelerator fund intended to de-risk the commercial application of innovative ideas. These offered promising opportunities although KP emphasised the importance of ensuring these funding routes did not become top-down and inaccessible to grass-roots farmers.

In conclusion, KP emphasised that the field labs farmer-led approach was not about replacing current research and the contribution of the UK's excellent agri-science base but adding to it and accelerating the uptake of research outputs, developing better tools and applications that work in the real world of commercial agriculture.

Dave Freeman, Policy Manager, Agricultural Industries Confederation

Providing an insight into current activity within the agricultural sector to update and improve understanding of good soil management practices, Dave Freeman (DF) noted that the concept of soil stewardship is not a new idea, and that there is already a strong track record and depth of experience within the agricultural sector in managing soils, including extensive guidance much dating back many years, whether for nutrition, cultivations or managing the risk of soil erosion and run off.

DF explained that organisations such as BASIS, Tried and Tested and AHDB already provide some excellent services, information and training in relation to soil health and management. Indeed BASIS/FACTS have provided training on soil management for a number of years and recently updated the syllabus. A significant number of agronomists have undertaken this training and are competent in advising farmers on good soil management practices.

DF noted that renewed interest in soil health both politically and within the agricultural sector had prompted a significant increase in soil related research and activity in recent years. But he suggested that although there is a lot of good practice, research and advice available there is also a lot of confusion and noise around, and a need to help farmers understand what to do and how to make it work for them.

DF explained that during 2018 a group of industry leaders in soil health met and agreed on the need to help support the industry in improving soil management practices. This was initiated as a result of a workshop in March bringing together stakeholders to collate a

response to government plans for soil monitoring and industry data. This was followed by an exploratory meeting to seek the views of a wider range of agricultural industry stakeholders on the potential to work together to clarify understanding, research and communications in soil management and soil monitoring.

A second workshop in May gained consensus from 30+ key industry stakeholders with the ambition to work together to support improved practice – creating an integrated programme of industry-developed measures, case studies and training to promote effective soil stewardship - and to take a lead on monitoring on-farm to encourage and support a consistent, industry-wide approach to measurement of soil health.

DF added that the soil health initiative was formally launched at the Cereals event in June 2018 and continues to work with partners including Championing the Farmed Environment to develop and distribute information to farmers on actions they can take to improve soil health.

DF explained that next steps for the initiative will be to work with a range of academic, NGO and water industry partners, and the partners are also working together to assimilate and agree the priorities for soil health and management practices in support of a productive and sustainable agricultural system.

Questions and discussion

The following key points arose during discussion:

In view of the renewed recognition of soil health as a public good, the need for a nationally accredited soil test in England - covering all parameters - to provide an independent assurance of accurate and consistent information.

The role of livestock in promoting soil health, and a recognition that mixed farms are more likely to have better soil, although not impossible with good practice to deliver healthy soils on arable-only farms.

Whether cost is a significant barrier to transitioning from poor to healthy soil, and the need for simple, practicable approaches at farm level to promote improved soil health.

Concluding the meeting, Julian Sturdy thanked guest speakers, members and stakeholders for their contribution to a hugely informative and thought-provoking session focusing on one of the major issues which will determine the future productivity and sustainability of UK agriculture.

