University of Reading

‘HEATHLY SOILS’ WORKSHOP REPORT

2nd Soil Research Centre Annual Partnership Event, 18th November 2015, University of Reading

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SUMMARY

Background

Healthy soils are essential for food security and ecosystem functions that make human life possible. Raising awareness about the importance of soil for human life is a key objective of 2015 International Year of Soils programme, led by the Food and Agriculture Organisation (FAO) of the United Nations. Soil health, and how to measure and promote this, was also identified as a key research priority by our Partners at the 2014 SRC Event (https://www.reading.ac.uk/web/FILES/soil-research-centre/2014SRCEventWorkshopFeedbackAndActions.pdf). This report captures the discussions among groups on the topic of Soil Health and other priority areas identified at the SRC 2014 event of data access and visualisation, pesticides, forestry and peatlands.

In the workshops, delegates explored priority areas for collaborative action, by reflecting on shared knowledge among each group. Key questions considered by each group was:

- What are the current needs in this area?
- What do we know already?
- What do we need to know?
- What are the priorities?
- Who will lead on the agreed actions?

Key outcomes

1. Demand for a monitoring system to track soil health is high across all sectors; but the evidence base is not yet in place to move forward. Need to track long-term benefits from different environmental improvement measures were identified for use under trees, abandoned mine reclamation, conservation agriculture and impacts of anaerobic digestate on soils.
2. Data sharing is a priority. We need to make better use of the information we already have. Access to the national soil survey data and the detailed measurements of soil chemical and physical properties is limited to those who can pay for it. This is a major barrier to monitoring soil health. Awareness of tools, such as the UK Soil Observatory (http://www.ukso.org/), that provide access to soil maps need to be widely publicised across sectors, and beyond academia, so that people who need information know where to find it.
3. Data integration is a priority. Information about soil health is held in many different locations, from Universities, research institutes, consultancies to the farm office and garden shed. We need to pool data sources together to make better use of information available through platforms like the UK Soil Observatory.
4. The simple problems is that we have no specific definition of what soil health means in terms of quantitative indicators. Definitions depend on the intended user/industry (e.g. farmer, forester, golf course manager, conservationist) and the specific functions we want soils to be able to do (e.g. provide food, mitigate flooding and climate change). A question arose about whether we should measure soil health directly, or other indirect measures that act as an indicator of 'health' e.g. ability to support a crop; or ability to buffer again environmental stressors like drought or flooding.
5. Another challenge is whether we can define universal indicators that cover the diverse range of soils we have in the UK (and globally). For instance, a healthy agricultural soil may have high nitrogen content, whereas a high nitrogen content in a peatland is associated with poor health of that particular system.

6. Farmers and land managers noted that monitoring the direction of travel (improving or degrading) was more important than quantify the exact values of a specific indicator, e.g. soil organic matter or nitrogen content. They need to know if their management practices are actually improving soil health or not.
7. Delegates stressed the need for simple tools; particularly the need to improve the evidence base supporting the efficacy of rapid low-cost visual assessments. Although a range of measures are available, academics do not yet have the evidence to make a recommendation about the utility of a single tool. We have a good knowledge of soil physical and chemical properties, our understanding of soil biology is less well developed and currently a key frontier in research.
8. Healthy soils are essential to support human life, from the most obvious things like food production to less obvious things like drinking water purification, climate change regulation, flood mitigation and cultural heritage; and the things we perhaps take for granted like turf to support recreation and the sports industry. Unhealthy soils will provide less of the things we need; critical issues as demand from a growing population increases.
9. One critical driver for interest in soil health from the farming community is the yield plateau; why have wheat yields not increased over the last 20 years in spite of advances in science and technology supporting food production? Many are concerned that declining soil health has had a role to play. Some people noted that perhaps there is an overreliance on technological solutions rather than integrating knowledge about managing fertility through crop-rotations, for instance.
10. Many examples of good practice, motivated by a desire across sectors to 'do good' by our soils.
11. As noted above, we need a better evidence base to enable us to understand the benefits of different management strategies and simple tools to enable us to track soil health and provide the demonstrable benefits to persuade others to change practice and/or behaviour. For instance, many of the benefits of agri-environment measures for the full range of ecosystem services, including flood mitigation and water purification, provided by different types of soils has yet to be fully quantified and captured.
12. We need to put people at the heart of soil health. Soil science has traditionally focused on the soil itself, rather than the relationship between people and the soil/natural environment. Bringing the social dimension in earlier is more productive, rather than in crisis such as in response to flooding or a pollution incident.
13. Government and organisations need to consider is how to bring together the many fragmented measures. We need a whole systems approach to measurement, data collection, analysis and sharing.
14. Another key issue identified was one of land tenure. Tenants who don't own the land may not feel long-term responsibility or obligation to protect 'soil health'.
15. Government needs to bring together all stakeholders to build a shared understanding of what soil health is and co-ordinate programmes to evaluate utility of different indicators across a range of soil types. We have national capability to do this work within and outside research institutions; what is need is leadership and resource to make this happen.
16. Government needs to bring consistency and alignment across current policies that directly and indirectly affect soils and the services they provide to people. At present, fragmented policy can present itself as apparently conflicting advice to farmers and land managers. Integration between air pollution, climate change, biodiversity, food and water policy is needed.
17. Government needs to develop cross-theme initiatives between soil health and tree health. Government has invested heavily in tree health and plant biosecurity research in recent years – efforts need to be coordinated.
18. Government needs to ensure there is alignment between policy targets and what is feasible in practice on-farm, in forests, gardens, sports turfs etc.

WORKSHOP SESSION REPORTS

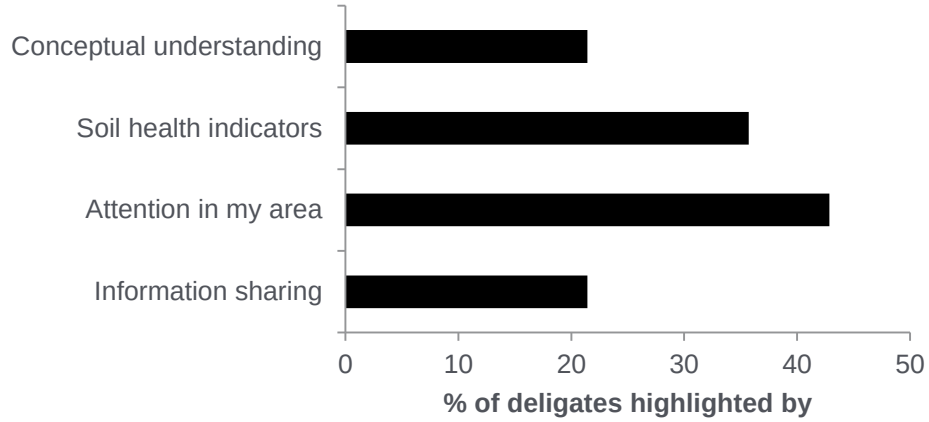
Soil Health #1

Facilitator: Ben Raskin (Soil Association)

Rapporteur: Tom Sizmur (University of Reading)

Current needs

Current needs on 'soil health' within group #1 were summarised under three headings, with many highlighting the need for further understanding in a specific areas (e.g. gardens, forestry, agriculture). Soil health indicators were the next priority followed by conceptual understanding and information sharing.



Attention in my area

- Greater representation of domestic or residential greenspace in soils research (do these spaces provide a net benefit or cost to ecosystem service delivery?)
- Standard information and tools for assessing soil health under trees
- Can soil health be used as an indicator during abandoned mine reclamation?
- Can we use soil health as scientific evidence of the benefits of conservation agriculture?
- Can we use soil health indicators to determine the long term effect of digestate on soils?

Soil health indicators

- Standard information and tools for assessing soil health under trees
- Simple tools
- Developing visual evaluation of soil health methods and linking them to management practices
- Can soil health be used as an indicator during abandoned mine reclamation?
- Can we use soil health as scientific evidence of the benefits of conservation agriculture?
- Can we use soil health indicators to determine the long term effect of digestate on soils?

Greater conceptual understanding

- Integrating and coordinating ideas
- What is soil health
- If we use soil biota as an indicator of soil health then are we measuring a symptom or a beneficiary?

- Impact of climate change on soil health

Information sharing

- Access to evidence based practice
- Greater information availability
- Data sharing

What do we need to know?

- More funding for applied research (involving stakeholders from the outset)
- Carrots & sticks from regulators that are well thought through
- Identification of the best indicators of soil health
- Fundamental knowledge about whether greater soil biodiversity leads to greater soil health
- Identification of what management interventions improve soil health
- A clear underlying definition of what soil health is...

What is soil health?

General consensus from the group was that no one 'fit all' definition of soil health currently exisits.

- Does it depend on context?
    - Farmer
    - Forester
    - Golf course manager
- Does it depend on challenge?
    - Flooding
    - Food security
    - Climate change
- Or can we identify an underlying process that serves all these contexts and challenges
    - The ability to support aboveground vegetation
    - The ability to buffer against perturbations (resilience)

Is there an underlying concept which encapsulates what we mean by soil health?

Agreed Actions

Sharing of emerging information on soil health

- Conferences, workshops, leaflets, farm visits
- Jackie Stroud (Rothamsted Research) to lead

Contribute to the GREAT soils project run by the Soil Association, Organic Research Centre and Earthcare Technical Ltd

- Ben Raskin (Soil Association) to lead

Run a conference/workshop to identify exactly what soil health is

- Neville Fay (Treework Environmental Practice) to lead

Soil Health #2

Facilitator: Anne Bhogal (ADAS)

Rapporteur: Danielle Ashton (Environment Agency)

Summary

1. Need a better evidence base to move forward – there is a direction of travel to decrease inputs, but land managers need assurance from the science community that what they are doing will work.
2. Better relationships and links between farmers and scientists
    a. To understand each others' capabilities -broker joint working – access to trial sites
    b. We are not capturing all the good work that is being done on farms now – need to know the baseline
3. Assessment tools – what to measure and when to measure it
    a. Particular stumbling block is sheer complexity of soil biology
    b. Issues of scale which takes base geology into account
    c. How detailed do we need to be spatially ?

Key discussion points

- Indicators for whom and what?
    - Farmers primary interest is in: N,P,K,pH
    - Carbon is as important as N – do we manage this appropriately ?
    - Impacts on structure through mis-management – do we have good measures for this ? – is visual soil assessment sufficient ?/ can we set targets ? – could be a mis-match between 'policy' targets/measures and what is feasible on-farm.

- Do we need to create the environment that allows organisms we need to thrive? Could increase use of novel techniques such as DNA to enable this to happen.

- Where are the gaps in our evidence?
    - Large gap in understanding of soil biology – need to acknowledge complexity, and decide what scale we should be working at / how detailed spatially do we need to be ? – need to take account of base geology at farms, can't expect farmers to achieve targets if their soil will not sustain it.
    - What is an appropriate range of soil organic matter
        1. Does this need to be a very wide range to be useful?
        2. Need to ensure we act before it is too late, don't wait for an extreme decline in organic matter
    - Are there tolerable levels of change we can live with?

  Not all farms (organic vs. inorganic) need the same things, and there is not a one-stop fix for all. Policies and legislation and initiatives are sometimes too restrictive/prescriptive – so uptake is low because there is not a full understanding of the relevance etc.

- What are future needs?
    - There needs to be a transition period between old ways of an=managing land and new – there is a direction of travel to decrease inputs to land over the next 5-10 years, farmers acknowledge that change is required.

- The science/evidence base needs to catch up – change in practice needs to be backed up by evidence it works.
    1. E.g. gap in cover cropping evidence base – need to tell farmers what they can't grow.
    2. Better knowledge exchange – transfer best practice to other operators
    3. Are we capturing all the good work that is going on at farms – links with science community at events such as this are crucial.

- Rebuild farmer confidence in their own knowledge about 'good farming' practice. An increased reliance on science/technology in farming as being the 'answer to all their problems' and 'back to basics' traditional farming strategies/planning and implementation are not being used alongside science and technological advances (e.g. crop rotation that matches the right crops with the right soil). There needs to better integration of both.

Data Access and Visualization

Facilitator: Debbie Clifford (Instutue for Environmental Analytics)

Rapporteur: Barbara Percy (University of Reading)

Summary

1. Interest from the group was mainly in UK national data, with a few of the researchers also interested in international soils data.
2. A "good" data portal would provide a high-level overview but also the ability to drill down for more detailed data.
3. A recurring theme was the necessity of contextual information, such as larger-scale maps, auxiliary information perhaps from other domains (meteorology, archaeology.....) but also the appropriate *metadata* describing the data's provenance.

What do we already know?

Mechanisms/portals for accessing soil data currently available:

- Direct contact with relevant researcher or project
- Heritage Gateway
- JRC soils portal
- Cranfield website
- MAGIC.co.uk
- BGS soils portal
- Global soil map/Digital soil map

What do we need?

- It is unlikely that the community will develop one database that contains all the relevant information for all soil science researchers and end users. Instead, the community should exploit new developments in informatics such as "linked data" that have the potential to allow multiple databases to be combined and queried "on the fly".
- Need to share data within public and private sector organisations.
- It was noted that many communities have the same problems and discussions around data discovery, access and analysis, and that there are many areas of informatics research that could be exploited.
- Data was generally discovered via word-of-mouth, e.g. at conferences and meetings. Different datasets are held in different places, and the situation was contrasted to the US where data appears much easier to find. There is a need for a UK/EU soils data catalogue which points to existing holdings and portals, and the required contextual data.
- The group discussed training needs in visualization, such as in best practice (e.g. choice of plot type, colour scale), how to compare gridded and point data, how to visualize 2d/map data changing over time, and how best to simplify complex data for communication to decision makers.
- The importance of long-term, continuous monitoring was discussed – we often have snapshots when what we need are time series. Better contextual evidence based advice is needed to continue longer term strategies with soils as well as longer term monitoring of how they are working. People involved with soils, whoever they may be, often have to prioritise what

they work on the most, what they want to see in 5 or 10 years. This is where advice can become conflicted at the farmer (or lower level user) of the advice.

- Other communities, most notably climate scientists, have defined "benchmarking" datasets to support their modelling. Soil processes are increasingly important in Earth System models and the soil science community needs to be engaged with international activity here.
- It was emphasised that any tools developed need to be driven by the needs of users; specific examples were farmers and planners. Engagement is needed to advertise tools and expertise to the end user community, to provide training, and to stimulate research with users' needs. It was recommended that this engagement take place on users' "territory" and reflecting their vocabulary.

Other topics mentioned but not discussed in detail were data recovery, data licensing and the availability and take-up of apps e.g. through the UK Soils Observatory portal.

Actions

Joint workshop between the soil science and informatics communities

- Showcase existing projects and propose new ones. The workshop could cover visualization techniques, crowdsourcing and linked data (further suggestions welcome).
- IEA/SRC to lead

Soils data catalogue

- Identify an appropriate body to hold a soils data catalogue and propose this or better-publicise existing catalogues, if available.
- SRC to lead

Training needs for soil scientists

- Potential for IEA to develop and run bespoke courses
- Debbie Clifford to feed back to the IEA

Engage with European efforts establishing benchmarking datasets

- Need to set up 'reference' data e.g. the CODATA initiative.
- All to engage

Foster engagement between researchers and end-users

- Partnership Events, focussed workshops or roadshows e.g. on ecosystem services
- SRC and others to lead.

Pesticides

Facilitator: Robert Isles (Environment Agency)

Rapporteur: Liz Shaw (University of Reading)

Two major topics were raised:

1. Concern over the detection of pesticides in water bodies (particularly rivers)
2. The need for improved knowledge on (long-term) potential impacts of pesticides on soil health and beneficial organisms, and, in particular, the impacts of mixtures ("cocktails") of crop protection products that are co-applied in cropping systems.

Detection of crop protection products (CPPs) in water bodies

- Issue: freshwater ecological impacts and also the burden this then places on water companies for clean up where water is abstracted for domestic use.
- Metaldehyde was highlighted as an active ingredient of particular concern in this respect.
- Current needs in this area are for an improved knowledge of the soil factors and processes that promote/limit pesticide mobility from their site of intended action to water bodies that can then help to inform the development of rational methods to manage for reduced pesticide mobility.

What might be done to reduce CPP movement?

- Reducing CPP applications (i.e. if less CPP is applied in the first place then there will be less CPP in the system to be lost to water bodies): Reductions in applications might be achieved through:
    - Better education of farmers in the calculation of dose rates for a given crop/ situation (many farmers just add the maximum recommended dose rate when maybe a lower dose might have been sufficient).
    - Better use of rotations, for example, the use of cover crops to reduce black grass or novel rotations to reduce metaldehyde use
    - Use of allelopathic interactions rather than reliance on herbicides
- Reducing movement of CPPs through additions of organic matter (including more novel forms – AD, biochar).
    - Many CPPs are quite hydrophobic and prefer to be sorbed to soil organic matter rather than partition to the soil water phase.
    - However, there is the possibility that increased organic matter might lead to reduced efficacy of CPPs through reduced bioavailability (for CPPs that act via soil), or, may actually promote mobility through complexation with the dissolved organic matter phase.
    - As increasing organic matter concentrations in soil appears desirable for multiple soil quality reasons, it would be useful to investigate if an additional co-benefit of increasing soil organic matter is the increased retention of CPP chemicals (without loss of efficacy).
- Enhancing biodegradation (through biostimulation/ bioaugmentation?) but this would need to be carefully timed/ placed so that the enhanced biodegradation did not compromise the efficacy of the CPP.

What do we need?

- Innovative farmers (within 'practical field lab' settings) to try novel rotations/ OM amendments and to share the outcomes.
- Research to examine the impact of OM amendment on the trade-off between CPP mobility and efficacy

Forestry and Peatlands

Facilitator: Rob Jackson (University of Reading)

Rapporteur: Amanda Ingham (Hampshire and Isle of Wight Wildlife Trust)

Summary of areas discussed

- Improve peatland restoration and determine better monitoring for long term benefits and determining the consequences now.
- Improve management and planning of drainage ditches.
    - Need to stop water and prevent leaching in key locations, and to improve carbon sequestration, using more targeted approaches, eg sphagnum. Monitoring must be improved.
- Land use changes to reduce sediment run off and flooding, to deal with nitrate and phosphate issues and diffuse water pollution.
    - Can we determine alternative approaches particularly using existing technology in key areas. Improving communications is key.
- Reduce nanoparticle and microplastic contamination.
    - Consider the impacts of sediment storage and generation of radicals. What regulation is in place?
- Work out a long term plan for improving and maintain soil health and biodiversity.
    - One big issue resides with tenant who don't own land and therefore have no long term responsibility. These people are less likely to "experiment" with the land especially if they need permission from landlord. Should include forestry and woodland management and better surveillance and monitoring. Changes in practice and financial flexibility needed, with a focus on areas that can easily be changed. Also provide demonstrable benefits to business.
- Improve politics and governance around science and policy processes, especially focussing on human interactions.
    - How do we get more social scientists involved and improve communication ahead of time rather than after the occasion. We need capacity building and monitoring.

What we need

1. Improve social science and pure science communication.
2. Work towards carbon capture.
3. Work towards implementing preventative measures underpinned by better communication and innovative approaches.

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