Soil Carbon Baselining: Different approaches & Perspectives

Workshop Report, July 2025

Introduction

On the 25th of June, the Land Use for Net Zero, Nature and People Soil Health and Carbon Dynamics Topic Advisory Group (Soil TAG) hosted a workshop on the subject of Soil Carbon Baselining. This workshop sought to address common questions and challenges by exploring different approaches taken by a range of organisations who have carried out soil carbon baselining at different scales and for different purposes.

Environmental baselining is now an important requirement for organisations looking to understand the state of the natural assets in their care, how they change over time and the impact of their interventions. However, the question of how to design a soil carbon baseline and for what purpose is a challenge for a variety of stakeholders – farmers, corporates, governments, and landowners. It raises a range of technical, scientific, and financial questions – including how to balance integrity with costs against an uncertain policy backdrop and changing expectations of what is meant by high-integrity.

The Soil TAG's Soil Carbon Baselining workshop aimed to shed light on the different soil carbon baselining methodologies implemented by different organisations and the purposes that these different methodologies serve.

Case studies and stakeholder insights

Participants heard from representatives of a range of different sectors and organisations working at different scales, using different technologies and methodologies and for different outcomes:

1. **Soil carbon baselining firm** - *Helaina Black*, *Chief Science Officer at Agricarbon*

Helena outlined Agricarbon's extensive experience in soil carbon baselining, having collected over half a million soil samples from 18+ countries since 2021. She emphasized that there is no one-size-fits-all approach to soil carbon measurement, as projects must be tailored to diverse client needs across different land uses and reporting requirements. Black highlighted six critical stages that must be completed before field sampling can start, beginning with understanding how data will be used (scope 3 reporting, voluntary carbon markets, etc.), as this dictates sampling methodology and intensity. Most projects use models for quantification rather than direct measurement of change, making sampling design crucial for feeding these models rather than detecting ground-level changes. She advocated for consistency and harmonization across protocols, particularly recommending the VERA VM0042 protocol, and called for scientific community engagement in the upcoming VERA soil sampling handbook revision.

2. **Food and farming industry** - *Tom White, Regenerative Farming Manager at Yeo Valley Organic*

Tom described Yeo Valley's multi-year journey in soil carbon baselining across their supply chain. Starting in 2015 with basic soil organic matter testing on their own 2000-acre Somerset farm, they discovered massive variation in soil carbon levels, but found encouraging baseline numbers after 25 years of organic farming. This led to expanding their sampling program to 25 farms (16,000 acres) in their network from 2021-2023, combining carbon measurements with soil health observations like worm counts and infiltration tests. After engaging with the Land Sector Removals Guidance draft in 2022, they underwent a major supply chain restructuring, establishing new farmer group agreements for closer collaboration and data sharing.

Moving forward, they're partnering with Agricarbon to monitor soil carbon across their entire supply chain at one-meter depth with high resolution (0.5 tonne minimum detectable difference), viewing it as the most risk-averse approach given current uncertainties about future data requirements.

3. **Conservation charity** - *Felicity Roos, National Consultant for Soil at the National Trust*

Felicity described the National Trust's approach to soil sampling across 250,000 hectares of land with 1,800 farm tenants. The Trust shifted from subjective soil health scoring to data-based approaches over the last five years, but faces significant financial constraints that limit sampling to when required by stewardship agreements or externally funded projects. They use a simplified methodology with three fixed GPS sampling points per field at 15cm depth (spade depth) to ensure consistency across diverse habitats, including visual assessments of soil structure and earthworm counts. Their greatest challenge is cost - both time and labour-intensive fieldwork plus lab expenses - which has created uneven data coverage across their estates. A recurring problem is that funders, including government landscape recovery projects and private sponsors like HSBC, provide vague requirements like "monitor soil health" without specifying desired confidence levels or sampling intensity, meaning the Trust will design sampling strategies based on available budgets rather than scientific objectives. They're now exploring combining strategic sampling with remote modelling to reduce physical sampling costs while maintaining data quality.

4. **National baselining** - *John Gilliland, Chair of ArcZero, lead on creation of the Northern Ireland Soil Nutrient Health Scheme, and Special Advisor at the AHDB*

John discussed the development of the Northern Ireland Soil Nutrient Health Scheme in 2021, which samples 25 cores per field to 7.5cm depth in grassland and 15cm in arable land. Through the ArcZero network of seven farms, he conducted extensive stratification across 86 different land categories, discovering that these landscapes contained over half a million tonnes of carbon. His most recent work with Agricarbon involves sampling to one-meter depth at 17 samples per hectare across five different long-term land uses on his farm, revealing clear benefits of introducing woody species into grazing landscapes. His is also involved in a major £3 million scaling initiative across 36,000 hectares and 170 farms in four sectors (red meat, dairy, pig meat, and cereals/oilseeds) funded by levy payers in England, Wales, and Scotland. The sampling approach uses 1.25-1.65 cores per hectare at four depths in farmland and three depths in woodland, combined with aerial LiDAR and carbon calculator assessments through consultants (ADAS in England/Wales, SRUC in Scotland).

5. **Academia** - *William Blake, Professor of Catchment Science at the University of Plymouth, and member LUNZ OpenLand Project team*

The University of Plymouth's interdisciplinary research team conducted a comprehensive soil health study in collaboration with a regenerative agriculture business in Southwest England. Using a GIS-based sampling strategy that accounted for topographic variability in South Devon, researchers collected 30 samples from each intervention area at depths of 0-10cm and 10-30cm, with each sample comprising 25 composite cores taken via drilling rig. The team followed Global Soil Organic Carbon (GSOC) protocols and conducted holistic soil analysis beyond just carbon content, including measurements sent to accredited laboratories to meet agribusiness needs. Preliminary results revealed significant variability in soil organic carbon even within areas under similar historical management, highlighting the importance of local farmer knowledge and the need for robust baseline data. The study serves as a foundation for ongoing monitoring of regenerative practice impacts and supports the development of sensor technology that could bridge gaps in sample representativeness and empower farmers to collect their own soil data.

Observations and Discussions

The following observations and topics of discussion emerged:

Similarities across different initiatives:

- **Common recognition of complexity**: All initiatives acknowledged that soil carbon measurement is highly variable and context-dependent, with no universal solution. Each emphasizes the need for tailored approaches based on specific objectives and local conditions.
- **Emphasis on baselining as a starting point**: Every initiative stressed the critical importance of establishing robust baseline data before implementing any interventions or monitoring programs.
- **Multi-depth sampling**: Most initiatives sample at multiple depths, though the specific depths vary significantly based on their objectives and land use types.
- **Integration with broader soil health metrics**: Several initiatives combined carbon measurements with other soil health indicators like earthworm counts, infiltration tests, and visual assessments.

Differences between the initiatives:

- **Primary objectives**
  - Agricarbon: Commercial soil carbon quantification for various reporting needs (Scope 3, voluntary carbon markets).
  - Yeo Valley: Supply chain carbon management and risk mitigation.
  - National Trust: Stewardship compliance and grant-funded monitoring.
  - ArcZero: Policy development and behavioural change in farming practices.
  - University of Plymouth: Academic research on regenerative agriculture impacts.
- **Sampling intensity and scale**
  - The scale and intensity of sampling varies significantly, dependent on the funding and focus of the various sampling projects i.e. Yeo Valley's high-resolution monitoring across 16,000 acres vs the National Trust's minimal approach with 3 fixed GPS points per field at 15cm depth.
- **Methodological approaches**
  - Depth ranges: From 7.5cm to 1-meter.
  - Sampling patterns: Fixed GPS points (National Trust), stratified approaches (ArcZero), topographically informed (University of Plymouth).
  - Laboratory standards: Varies from basic organic matter testing to accredited lab protocols meeting agribusiness standards.
- **Geographic and temporal scope**
  - Geographical scale of the initiatives varied – from Agricarbon's global scale, to region and farm specific data being collected by Yeo Valley, the National Trust and University of Plymouth.
- **Technology used**
  - Remote sensing and sensor networks: The University of Plymouth is piloting sensor-based gamma detection to map soil organic matter and moisture.
  - Automated sampling: Arc Zero and Agricarbon have adopted automated systems for higher consistency and lower labour cost.
  - LIDAR integration: Used to measure above-ground carbon and relate it to soil carbon trends.

The following challenges were discussed:

- **Sampling design and cost:** A recurring concern was cost - particularly how sample intensity, depth, and frequency influence it. Projects varied from high-resolution, metre-deep core sampling to simpler spade-depth fieldwork, with costs shaped heavily by logistics rather than just lab analysis.
- **Standardisation and protocols:** While there is no one-size-fits-all, there was strong interest in converging on certain protocols for comparability and future-proofing. Multiple speakers referenced the lack of national guidance, calling for bridging the gap between international protocols (like Verra, IPCC, and LSRG) and UK-specific needs.
- **Measurement vs. modelling:** Most initiatives shared relied on models for quantification rather than direct measurement of change. There was agreement that robust, direct soil sampling is essential - but that modelling will likely play a larger role in the future, especially between sampling cycles. Questions remain about model accuracy, required inputs, and how to reconcile models with field data.

- **Depth and soil stock dynamics:** Speakers explored how sampling depth affects carbon stock estimates, and highlighted a lack of understanding of carbon dynamics over time and across rotations. Seasonal and rotational variability remain under-studied, which impacts confidence in long-term baselining.
- **Scientific and technical gaps:**
    - Lack of evidence on soil carbon response to regenerative practices.
    - Poor understanding of rotational variability.
    - Limited tools for monitoring changes at depth. The need for better audit/verification frameworks and soil sample archiving protocols.
- **Behavioural and social dimensions:** Some speakers stressed the importance of farmer engagement and empowerment. Soil carbon measurement was framed not only as a technical task but as a behavioural and social challenge.

Conclusion

The Soil Carbon Baselining Workshop provided a platform for knowledge exchange between diverse stakeholders and practitioners to discuss the complexity and urgency of improving soil carbon baselining practices across the UK.

During the workshop it was agreed that there is a clear need to clarify the purpose of baselining before designing a method, moving away from standardised approaches towards fit-for-purpose methods within a harmonised framework that allows comparability. The value of long-term investment in both data and stakeholder relationships was also recognised. The scientific community is called upon to provide better evidence, particularly concerning regenerative practices, soil depth variability, and rotational dynamics.

Additionally, there was consensus that baselining must empower land managers, support behavioural change, and contribute to a broader transformation towards resilient, nature-based farming systems. The speakers concluded that there is momentum for collaboration, innovation, and strategic alignment - but that significant work remains to build an integrated, affordable, and scientifically robust soil carbon monitoring system for the UK.