Soil carbon restored

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DR LAURA BENTLEY

The conclusion of a nationwide survey suggests UK farmers have reversed the trend of falling carbon levels in arable soils, potentially reducing their impact on climate change. *CPM* gets exclusive insight from one of the team that carried out the work.

By Mike Saull

Sceptics said it was impossible, others that it'd take many years, but against all the apparent odds soil carbon levels look to be increasing and experts suggest positive, on-farm actions are the likely explanation.

While there are no laurels to rest upon just yet, the good news is that UK soils appear to be more sustainable and in better shape as a result.

Furthermore, in research published in the European Journal of Soil Science, it suggests that after prolonged, historic decline, soil carbon levels are starting to increase.

Looking in more detail, initial analyses since the start of a survey some 40 years ago showed that soil organic carbon (SOC) was being lost at a rate of 0.16t/ha every year. However, during the 15 years to 2022, cropland soils have annually accrued 0.17t/ha of SOC on average – that's equivalent to 0.74 mega tonnes of carbon across the UK every year.

According to Dr Laura Bentley, the environmental scientist who fronted the work, this data clearly demonstrates that topsoil properties can be restored. "It offers real hope that a concerted effort by land managers can halt, and potentially reverse, SOC loss from cropland soil," she says.

LONG-TERM APPROACH

The Countryside Survey, carried out by the UK Centre for Ecology and Hydrology (UKCEH) has been examining soils for almost 50 years as part of the world's longest running national monitoring programme.

"It's a unique audit of the national resources of the UK countryside, and the scientific methods employed allow us to compare the results from previous surveys and pick up trends," explains Laura.

Previous conclusions from past surveys have shown that there was an 11% loss of cropland topsoil carbon ▶

Soil restoration

Data from a long-term study demonstrates that topsoil properties can be restored, states environmental scientist, Dr Laura Bentley.

▶ between 1978 and 2007 – equating to around 5t/ha of organic carbon stocks.

These latest results come from a survey round carried out between 2019-2023, which tested more than 300 randomised and representative soil samples collected from arable and horticultural soils across the UK.

The survey team collected samples from 0-15cm depth taking a standard volume 5cm diameter core from the topsoil zone. Soil organic matter levels were assessed by standard 'loss on ignition' techniques in a furnace and – prior to being placed in the furnace – the researchers also assessed the bulk density of the soil samples.

"We're pretty confident that we have a suitable sample size that's nationally representative of the different cropland types found in the UK. As a result, while levels of carbon vary and not all sites showed a positive increase, the national mean for both tests is statistically robust," says Laura.

"What we've found is a reversal of the trend, with levels back to where they were 15 years ago, and, to the best of our knowledge, this is the first set of data to provide evidence of the positive effects of recent farming practices on soil carbon."

Alongside the higher soil organic carbon levels found, the soil analyses show that bulk density has significantly decreased from the levels found in 2007 by 0.04-0.06g/cm^2 of soil. "You'd expect such a response resulting in more open, less compact soils as the higher levels of soil carbon will help to stabilise soil structure," she adds. "It's another positive indication that soil health is improving as a result."

Bucking trends

Paul Hallett, professor of soil physics at Aberdeen University and president of the British Society of Soil Science, says the survey results go against common perception.

SUSTAINABILITY FOCUS

Laura suggests that the diverse range of sustainable land management techniques now being practiced by UK farmers is likely to be behind much of the increased levels of carbon in soils, although this has yet to be confirmed.

"These include the use of cover crops, more use of temporary grassland and switching to perennial crops and legumes. While there's no 'one-size fits all' approach to sustainable land management, such techniques can work in tandem when tailored to suit the farm and soil," she points out.

"While national estimates for the uptake of sustainable land management practices aren't available, a previous survey of 600 farmers suggests that 92% are engaging with these techniques. We think it's likely they've played a part in contributing to the improvements seen."

Laura believes that the move to reduced tillage and minimal cultivation to establish crops may have also helped in stemming

carbon loss from soils. Evidence from other surveys suggests that 40% of UK farmers now practice some form of reduced tillage – up from 25% in the 1980s. In reducing soil disturbance, less carbon will be released and lost from the soil system; similarly, the greater organic matter content will help reduce soil density.

Additional data also shows that wheat and barley straw removal peaked in the 1990s. This, combined with the increasing predominance of wheat over barley on farm, means the likelihood is that straw is more commonly left in the field, again which could contribute to building carbon reserves and the looser soils found in the survey.

While some farmers are introducing organic manures to their cropped soils and where they do, this can have a major effect on soil carbon levels. The researchers point out that Defra figures suggest that since 2007, the number of crops receiving manure has decreased nationally, so this isn't likely to be a significant contributor to the national average.

Laura emphasises that the survey only confirms carbon benefits in the top 15cm of soil. As a result, some could argue the positives might be restricted to this zone where farmers are increasingly focusing their efforts, and that there could be stratification with less carbon than being sequestered below the topsoil.

However, she points out that the effects in this upper zone alone are significant and there are other studies looking at the soil at greater depth where the use of deeper-rooted crops – including cover crops – is helping improve health and soil stability below the zone sampled in UKCEH's survey.

Looking at the bigger picture, Laura adds that high levels of SOC are an important part of the soil's capacity to function and support growth, and levels are built up over thousands of years. "Yet it's estimated that one-third of global soils are rapidly losing this resource. As a result, the ability of soils to support agriculture, strong biodiversity and flood and drought resilience, has diminished."

Across vegetation and soil, 94% of GB's organic carbon reserves are in the soil and it's important that they're kept in the ground and not the atmosphere in order to minimise climate change, she states.

Data set

Randomised and representative soil samples were collected from arable and horticultural soils across the UK as part of the UKCEH Countryside Survey.

And according to Laura, high levels of soil organic carbon loss from cropland soils are widely acknowledged as a potential contributor to climate change as well as compromising soil and ecosystem health. In fact, stabilising and reversing the loss of organic matter from cropland soils is a challenge for all nations to meet the United Nations Sustainable Development Goals.

"Looking at climate change policy and reducing our carbon footprint, scientists estimate that soils could potentially hold 5-10% of the total additional carbon required to help meet our climate change targets and it's important to boost these reserves.

> ***"It's heartening to have data to prove that the positive efforts taken during the past 10-12 years have worked."***

"To our knowledge, this data is the first to indicate a reversal of soil carbon loss in cultivated topsoils at a national scale and comes following a period of reported increased sustainable land management uptake, so it's good news not just for croplands in Great Britain, but also the rest of the world," champions Laura.

She confirms that the Countrywide Survey is now in its next monitoring cycle and will be reporting on trends across a range of farming and broader land habitats.

"Farming isn't an easy job and there are a lot of pressures to deliver on a range of targets. So it's great to see these positive trends on carbon in this latest dataset. While we can't confirm why they're being seen, it's a good sign for soil health in the round and probably reflects an increase in awareness on farm backed by regenerative agricultural practices."

OPTIMISM

Paul Hallett, professor of soil physics at Aberdeen University and president of the British Society of Soil Science, adds that the results go against common perception, offering hope that some modern farming practices may be starting to reverse long-term trends in declining topsoil organic carbon.

"This is a consequence of the widespread adoption of conservation practices, including a significant switch to minimum tillage. It's also good news for soil health and biodiversity, while with more accruable biomass in the top 15cm of soil, there'll potentially be a reduced requirement for fertilisers, a greater ability to absorb and hold water, and a reduced risk of erosion.

"We do have to be slightly guarded as the research is limited to the top 15cm; we require more hard scientific data to confirm any significant evidence, particularly from the point of view of wider carbon trading or storage.

"The UK and nations globally require greater investment – particularly in surveys of this nature – to obtain a deeper understanding of the drivers and impacts down the ▶

entire soil profile," stresses Paul.

Hutchinsons' Dick Neale supports the view that the recent on-farm adoption of soil improvement measures could explain the increase in soil carbon found in the survey. "The results don't surprise me in the slightest, but it's heartening to have data to prove that the positive efforts taken during the past 10-12 years have worked on a national scale.

"Soils and soil improvement is very much at the forefront of our engagement on farm, and have been ever since we launched our healthy soils assessment service back in 2015. One of the first courses any new entrant to our business goes on is soils, and we now have an on-going training cycle that updates all our agronomists on management, nutrition and microbiology."

Dick believes farmers have responded positively and wholeheartedly to the focus on better soil husbandry. "You only have to look at the fact that attendance figures at Groundswell are now 10-fold what they were 12 years ago.

"While you can, see, feel and smell the improvements in soil condition during the past decade, the problem has been to quantify these changes. This Countryside Survey goes some way towards doing that."

And like Laura, he believes that no single management change is responsible, rather a mix of techniques. "Incorporating straw, reducing ploughing and mixing up cultivations have all made a significant impact, but anything that adds organic matter or boosts natural soil recovery processes will play a part.

"Other improvements have come from forced changes where we've had to use stale seedbeds and shallow tillage to halt blackgrass, and the use of cover crops has meant less carbon is burned-off and more is introduced to the system," he comments.

According to Dick, while no-one wants to ban the plough as there are times when it's required, systems should never go back to deep inversion wholesale. "I'd advise continuing to add carbon to the soil, sometimes removing but other times leaving straw, and using digestate and other materials appropriately.

Collective action

Hutchinsons' Dick Neale believes farmers have responded positively and wholeheartedly to a focus on better soil husbandry.

"You can visibly see the benefits on farm over time and data such as this confirms trends have been reversed and that we're bringing soil back to life."