Soil health physical examination

TEAGASC researchers at Johnstown Castle and Oak Park, along with collaborators from UCD, have developed soil physical health tools to use at field or national monitoring network scales.

As part of keeping healthy, we visit our doctor now and then to undergo a mixture of physical and chemical testing. The results of these tests give us an overview of our health and track a course of action where needed. Repeating such tests is prudent in terms of preventing or managing problems. This approach is also valid for soil health: without repeatedly physically examining soil structure and chemically testing soil, the health status of our soil will remain an unknown.

How do we define soil health?

Soil quality is a soil's ability to provide a range of different services through its capacity to perform specific functions under changing management and climatic conditions. Recently, this term has been replaced by 'soil health', defined as the continued capacity of soil to function as a vital living ecosystem that sustains plants, animals and humans. Developing knowledge and understanding of factors affecting soil health, and monitoring the trends in soil health over time, are essential to better manage and protect our agricultural soils for future generations. The physical component of soil health is important and we need tests (indicators and tools) to map it.

Physical factor assessment

Researchers at Teagasc Johnstown Castle and Oak Park, along with colleagues at UCD, recently investigated different types of soil physical indicators as part of the Department of Agriculture, Food and the Marine (DAFM)-funded Soil Quality Assessment Research (SQUARE) project. Soil structure is a key physical factor that supports all other soil functions. The decline in soil structural quality, which leads to soil degradation, compaction and ultimately reduced plant growth, is often the consequence of more intensive management practices. This can also lead to reduced capacity for water to infiltrate and drain through the soil, to store water and to purify water in the landscape.

Physical health tools

While there are a number of tools for measuring soil structural quality, both for research and advisor use, such as soil bulk density, cone penetration resistance and soil shear strength, these are generally just measuring a single characteristic, which may not suffice for the range of complex soils on our farms.

Visual examination of soil structure (VESS) techniques are considered key for scoring the physical status of the soil (Emmett Booth *et al.*, 2016). They consist of manually breaking down a sample of soil by hand to visually assess features such as, but not limited to, aggregate size, shape and strength, pore structure and root distribution. The SQUARE project developed two VESS tools for Irish soils called GrassVESS and DoubleSpade (DS) (Emmett Booth *et al.*, 2018). GrassVESS, as the name suggests, was developed for grasslands. This method assigns a separate score to the grass root mat to account for the protection effect that this has on the lower soil layers and also adds a more user-friendly flow chart approach to aid consistent scoring. The DS method brings visual assessment techniques down to the important transition layer at 20-40 cm deep, where much of the 'damage' may be caused beneath the cultivation layer on arable cropped soils. Our research has shown the sensitivity of these techniques. DS and GrassVESS assessment were more effective than traditional quantitative tools in determining the impact of management and also had the potential to indicate

Examination of soil structure in the field using visual tools.

deterioration in soil structure quality at a point before a crop effect was measured, potentially acting as an early warning mechanism. Knowing soil structure quality allows management actions to be taken to avoid damage. This can include restricting animal and machinery traffic when soils are vulnerable or wet, working with lighter axle loads and lower ground pressures, changing headland machinery practice to reduce soil stress and, in some cases, adopting remediation measures.

The use of these tools is described in the 'Soil Structure ABC' manual, which can be accessed for free on the Teagasc website: https://bit.ly/ABC_SOILSTRUCTURE.

Tools for a national monitoring programme

Other responsive and sensitive soil physical tools for longer-term monitoring of soil physical health have been identified (Bacher *et al.*, 2019). This process involves taking intact soil cores and other soil physical measurements at key locations across the country. The data is modelled to develop soil water retention curves. The high-resolution data developed can be used to detect even slight changes to soil physical quality. Such indicators are even sensitive enough to pick up changes in soil physical quality due to earthworm movement. While these techniques are too slow to be deployed at an individual farm level, they could be used as part of a monitoring programme to map the condition of our national soils over time.

What next?

We will need long-term monitoring of soils to detect changes in soil health over time. Such a network will act as an early warning system before problems arise on farms. Simultaneously, we need practical management solutions for protecting the health and quality of our agricultural soil or for remediating soils that have been previously damaged. Our knowledge transfer service, in contact with farmers daily, will play a crucial role in implementing these tools in practice.

Acknowledgements

Teagasc Walsh Scholars Jeremey Emmett Booth and Matthias Bacher, along with Nick Holden and Olaf Schmidt of UCD, are also involved in this research.

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