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COMMENTARY

Is 'soil health' meaningful as a scientific concept or as terminology?

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Baveye (2021) provides a robust critique of the proposal by Lehmann et al. (2020) that 'researchers should embrace soil health as an overarching principle to which to contribute knowledge, rather than as only a property to measure.' I would like to contribute to this discussion, making two points. The first is negative, reinforcing the reservations about soil health as an 'overarching principle' as set out by Baveye (2021). But the second is more positive, proposing that soil health has real value as a *means of communication* between soil scientists and non-specialists, especially politicians and policy makers.

As set out by Baveye (2021), it seems meaningless to apply the term 'health' to soil without reference to a specific use or function expected of that soil. The same may be said of soil 'quality', a term that gained popularity among some soil scientists about 20–30 years ago (e.g. Karlen, et al., 1997) and was recently discussed in detail by Bünemann et al. (2018). For example, a soil that forms the basis for a forest ecosystem will almost certainly contain low concentrations of readily available plant nutrients and may well have an acidic pH. Within this context, it would certainly be regarded as 'healthy' or of high 'quality', but if an area of the same soil was used for growing horticultural crops it would be regarded as unhealthy and would require additions of lime and nutrients to achieve satisfactory results. Another soil may have been formed from calcareous parent material and provide the basis for a forest ecosystem comprising a different population of trees and shrubs that thrive under alkaline conditions: one would hardly conclude that this ecosystem, and its underlying soil, is either healthier or less healthy than that in the more acidic conditions. Similarly, within agricultural uses of soils, different crops require different soil characteristics such as pH, nutrient status or physical conditions: think lettuces, winter wheat and grapevines. As suggested by Powlson (2020), perhaps the concept of soil 'suitability' for different uses or functions, introduced by soil surveyors in the 1960s (Bibby & Mackney, 1969; Klingebiel & Montgomery, 1961), is more helpful.

Effective communication between soil scientists and non-specialists is extremely important, especially because there is evidence that many soils globally are suffering from degradation or pollution caused by a range of human activities (FAO & ITPS, 2015; Lal, 2020). My observation is that the *term* 'soil health' achieves resonance with those who are not specialists in the study of soil, especially politicians and policy makers. As an example, the UK Government's recent 25 Year Environment Plan refers specifically to soil health (UK Government, 2018). To my knowledge, this is the first occasion that soils have received this degree of attention from UK policy makers. Similarly, national or regional soil health initiatives of various types are now in place in many parts of the world including India (https://www.india.gov.in/spotlight/soil-health-card#tab=tab-1), USA (https://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health) and the US States of California (www.cdfa.ca.gov/oefi/healthysoils) and New York (https://blogs.cornell.edu/soilhealthinitiative). In 2020 the European Union initiated a policy focus on 'soil health and food' (https://ec.europa.eu/info/horizon-europe/missions-horizon-europe/soil-health-and-food_en). The enthusiasm of those in the policy arena for the term 'soil health' may be because they mistakenly think it represents a welcome simplification compared to the tedious complexity to which soil scientists often revert. It may be misunderstood by them as implying that it is fairly simple to assess the state of soil, perhaps just using a single measurement. I have even heard the term 'dipstick' used by a politician, perhaps thinking that something like a thermometer or pH probe can be used to assess soil health. Even though these possible (or likely) implications are misleading, if using the *term* soil health

is effective in communicating with those having the ability to influence land-use decisions or the management of soils, then it is logical to use it. The alternative is likely to be that these people have little interest in soil, leading to an absence of policies promoting the good management of soils. Another alternative is that they will listen to pressure groups, who are certainly using the term; see Giller et al. (2021) for a discussion of this in relation to organic agriculture and regenerative agriculture. There is therefore a risk that policies affecting agriculture and land use could be overly influenced by the agendas, or prejudices, of particular groups rather than on balanced scientific understanding. For all of the above reasons, I recommend that soil scientists embrace the *term* 'soil health' wholeheartedly and use it enthusiastically where appropriate!

However, we should recognise that the *term* is simply a first step in a conversation—a means of catching the listener's attention, somewhat equivalent to a newspaper headline or a handshake (or elbow bump in these COVID times). Janzen et al. (2021) regard the term as a metaphor, a means of illuminating a subject that is inherently complex and unfamiliar to the hearer. If conversations with decision makers are to be usefully taken further, they will inevitably have to progress into more complex and nuanced considerations. These might include ways of maintaining or increasing soil carbon content (Lal, 2020; Martin et al., 2021; Poulton et al., 2018), addressing trade-offs between different greenhouse gas emissions resulting from altered management practices (Guenet et al., 2021; Lugato et al., 2018; Pärn et al., 2018), the significance of changes in soil biological populations (Bacq-Labreuil et al., 2020), or the risk of soil erosion and the sustainability or otherwise of specific practices (Evans et al., 2020). Even if using the *term* soil health is helpful as a first step in such discussions, there is no escape from delving into greater detail or complexity at the subsequent stage.

The programme now known as the Comprehensive Assessment of Soil Health (https://soilhealth.cals.cornell.edu), developed by Cornell University, is well established and has provided a soil testing service to farmers for several decades. It is based on a suite of chemical, physical and biological measurements, and the farmer is given data on each of these. In addition, an overall 'soil health score' is given, derived by averaging the individual measurements. However, it is noteworthy that the developers of this system appear to place more weight on the individual measurements than the overall score. In the Handbook giving details of the system (Moebius-Clune et al., 2016), after describing the 'overall score' it is stated that '….. it is of greater importance to identify which particular soil processes are constrained in functioning or suboptimal, so that these issues can be addressed through appropriate management. Therefore the ratings for each indicator are more important information'. Thus, even in this well-established and respected soil health assessment system, 'soil health' appears to be used mainly as an umbrella term to summarise the suite of individual measurements.

Similarly, it is noticeable from the farming press and from farmers' interactions on social media that many farmers have adopted the use of soil health terminology. However, it is equally clear that they use it as an umbrella term and rapidly move on to detailed discussion of specific soil characteristics and management practices appropriate for the context. In this respect, and many others, scientists can learn from farmers. If it helps with communication, then certainly use the *term* 'soil health' as shorthand, or an entry-point to consideration of a more specific ensemble of soil issues, functions or measurements. But do not waste effort in attempting to turn soil health into an art form or in trying to convince ourselves, or others, that it is a profound scientific principle.

DATA AVAILABILITY STATEMENT

Data sharing not applicable to this article as no datasets were generated or analysed during the current study.

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