A new soil health policy paradigm: pay for practice not performance!

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Abstract.

Soil degradation is one of the greatest threats to global civilization with claims that there may be as few as 60 years of harvests left in the world. As such, the concept of soil health has gained increasing interest in recent years. However, despite years of research there is no universally agreed metric or metrics on which policy aimed at protecting or enhancing soil health can be based. Here, we argue that the challenges associated with measuring and monitoring soil health from a policy perspective are an issue of current approach rather than concept of soil health *per se*.

Research into soil health has identified practices that are recognised, by consensus, and based on published scientific evidence, to improve or support soil health. These include crop rotations, reduced or no tillage, organic amendment with composts and manures, use of cover crops etc. Implementation of a different approach to soil policy and farm subsidies based on a "Payment for Practice" policy paradigm would circumvent the intractable issues associated with identifying and implementing a performance-based paradigm predicated on soil health monitoring at the farm scale. Payments based on practice could be dependent on the combinations of practices implemented. Efforts spent on identifying the best practices for a given farming system/environment rather than attempting to find a soil health indicator that will do all things for all people would concurrently provide evidence to policy makers on which to form policy while providing robust guidelines for farmers and land managers. This will facilitate improvement and/or maintenance of soil health through specified practices based on empirical evidence.

The United Kingdom (UK) leaving the Common Agricultural Policy (CAP) as part of Brexit means that new environmental policy is being developed. Here we argue for a new approach to be included in the discussion. While the points made here are UK centric as part of the current discussions, we believe that they are sufficiently universal that many of the points can be applied to policy elsewhere.

Soil degradation is one of the greatest current threats to global civilization (Gomiero, 2016); it has already caused several regional civilizations to collapse or wane during the last few thousand years (Hillel, 2005). More than 75% of soils globally are classed as substantially degraded (Scholes et al., 2018), causing crop yield projections to be reduced by an average of 10% globally, and by as much as 50% in some areas by 2050 (Scholes et al., 2018). This has led to claims that there may be as few as 60 years of harvests left in the world (Arsenault, 2014), or potentially as few as 30-40 harvests in the UK - as claimed by Michael Gove while Secretary of State for the Environment (I.e. the miniser in charge of environmental policy within the UK), if we continue with current farming and land management practices that degrade soils (van der Zee, 2017). Degraded soils, i.e. those with compromised soil health, reduce the resilience of their associated ecosystems and agroecosystems meaning that they are more negatively impacted by environmental perturbations such as drought. Hence, their reduced ability to provide ecosystem services threatens food security, an issue likely to be exacerbated further by climate change impacts (Wheeler and von Braun, 2013).

The concept of soil health - an evolution from the concept of soil quality that also considers the biological rather than just the chemical and physical aspects of soil - has gained increasing traction recently since being coined two decades ago (Doran and Zeiss, 2000). It is now considered to be largely interchangeable with the term soil quality (Bünemann et al., 2018). The development of the soil health concept is largely due to the increased recognition of the importance of soil-based ecosystem services, many of which are underwritten by the soil biota (Wall et al., 2012; Schulte et al., 2014).

Currently there is no government policy that we are aware of that specifically pertains to conserve or enhance soil health. However, in the UK, the Department for Environment, Farming and Rural Affairs (DEFRA) report "A green future: Our 25-year plan to improve the environment" refers to soil health 17 times, highlighting its perceived policy relevance, including claims that the agricultural practices encouraged by current soil policies, i.e. those underwritten by the Common Agricultural Policy (CAP), damage soil health (HM Government, 2018). The report also claims that DEFRA will invest £200,000 in developing a soil health index, further highlighting the importance that The Department places on quantifying and monitoring soil health. This investment is despite more than 15 years of research internationally that has already identified various indices and associated biomarkers (e.g. Huber et al., 2008; Stolte et al., 2016), with limited degrees of success, particularly regarding implementation.

Research efforts into means of quantifying and monitoring soil health are ongoing, with new approaches still being posited as of this year (Rinot et al., 2019). The latest report from DEFRA to touch on this issue states “This [soil health] indicator is not available for reporting in 2019: significant further development work is required” (DEFRA, 2019). However, it has been argued that as the UK moves away from the CAP, post-Brexit, public money should pay for public goods, listing soil health as one such public good (Bateman and Balmford, 2018). So why, after such as concerted research effort, by many actors over many years, is there still a requirement to identify such a soil health index? Why has this not yet been achieved at a policy level? Here, we argue that while quantifying soil health is a useful approach within the research context, for example in terms of quantifying impacts of different approaches/ treatments, and for monitoring changes over time, the quantification of soil health from a policy perspective is not feasible and, more importantly, not required.

Numerous measures have been put forward as indicators of soil health. These include earthworms (Pankhurst et al., 1995; Rochfort et al., 2009), collembola (Parisi et al., 2003; Huber et al., 2008), acari (Ruf et al., 2003), nematodes (Neher, 2001), microarthropod community structure (Parisi et al., 2005), and microbial community analyses (Anderson, 2003) including soil respiration rates (Huber et al., 2008) and microbial community structure (e.g. Cardoso et al., 2013). However, all of these groups of organisms and their functional responses to managements can be highly variable between sites, even under the same management, dependent on soil texture and chemical properties such as pH, as well as climate and sampling season (e.g. Benintende et al., 2015; Rüdisser et al., 2015; Wade et al., 2018). For example, all else being equal, the maximum number of earthworms that are likely to be present in a soil will be lower in a sandy soil than a clay soil (Joschko et al., 2009), and lower in a low pH soil than a soil with a neutral pH (Syers and Springett, 1984). Even different crops can have different requirements such that the same soil may be considered “healthy” for producing one crop type, but not another. Quantification and interpretation of soil health is multifaceted exemplifying the issue in developing soil policy based in this approach.

One often quoted approach to circumvent this issue of high levels of inherent variability is that of benchmarking soils and then measuring improvements (or not) from that benchmark. This would allow tracking of changes in soil health so that those farmers and growers undertaking practices that improve soil health could be rewarded through subsidies and those not undertaking best practice may be incentivised to do so. However, while benchmarking may be useful for research, or for large scale (e.g. national) soil monitoring programs, it cannot be applied effectively to policy that underwrites a farm-level payments program. Even if a single, ideal indicator could be identified, soils are heterogeneous such that individual fields, at best, would need to be benchmarked. There are estimated to be in the region of two million land parcels in Great Britain (CEH, 2007), so that is not feasible from a practical (data collection, storage and analysis), or a financial point of view. Such data collection would also need to occur every few years at best, if not every year, to inform payments further exacerbating this issue. Additionally, the minimum detectable change for a basic soil health indicator, such as change in soil organic carbon (SOC) content – 5% relative change (Huber et al., 2008) - requires a time interval of 10 years to develop in soil monitoring networks (Saby et al., 2008). Analyses based on many of the posited indicators, such as micro-arthropods, nematodes etc., can detect a 15-25% relative change over a 3-year time period (Huber et al., 2008), indicating relatively increased but still low resolution of these indicators for detecting change, particularly if soils are already near their soil health maximums as suggested by these indicators. However, even if this is seen to be an acceptable level or resolution the required level of taxonomic expertise is currently unavailable, and with the lack of taxonomists across most groups (Kim and Byrne, 2006), which is likely to continue for the foreseeable future. DNA sequencing and barcoding (Moritz and Cicero, 2004) may provide a resolution to this issue but more years of research are likely required for most groups before such an approach could be rolled out at a national scale, and costs could remain prohibitive.

Another key compounding issue with the approach of utilizing a soil health index, particularly when combined with identifying improvements from an initial benchmark to guide farm payments and subsidies, is the possibility of incentivizing “slay-for-pay” farming practices. This is because a payment system based on measured soil health improvements is inherently biased against farms with already healthy soils; such farms would have less room for improvement as soils cannot increase their SOC, earthworm or other bioindicators indefinitely, and so may face reduced payments compared to those starting from a lower benchmark. This could drive those farmers already following best practice to deliberately try to reduce the benchmarks for those indicators in their soils, i.e. “slay” the soil health associated indicators, and so maximize their farm payments for subsequent soil health improvements. In addition to the slay-for-pay risk, soil-specific ranges of soil health and rates of soil health increases under a specific policy will vary widely between different soils. What the lower and upper limits of these ranges, or the potential rates of increase, are, is currently not well understood. This means that it would not be a trivial issue to identify which soils are already near supporting near their maximum levels of soil health and those that are far from such a limit.

We argue that the challenge of how to measure and monitor soil health from a policy perspective is an issue of approach rather than concept of soil health *per se***.** While we recognise that research is still required to identify, or perhaps rank, optimum management practices for all farming system/ soil/ climate combinations, research to date has identified practices, many recognised by consensus and based on a large body of scientific evidence, that improve or support soil health. These include (but are not limited to) crop rotations (Dias et al., 2015), reduced or no tillage (Congreves et al., 2015), organic amendment with composts and manures (Goswami et al., 2017; Ozlu et al., 2019), use of cover crops (Bladcshaw et al., 2005), effective residue management (Turmel et al., 2015) use of controlled traffic farming (Gasso et al., 2013), grassing of areas prone to excessive overland flow (Samani and Kouwen, 2002), and the use of multifunctional plant mixtures in field margins and pastures (Barot et al., 2017). While not everything is known for all combinations, the Level of Scientific Understanding (LOSU) for most combinations is sufficient to develop policy. Policy can then be fine-tuned periodically, as new evidence comes in to light based on future research.

Implementation of a different approach to soil policy based on "Payment for Practice rather than Performance" would circumvent the issues detailed previously. Payments could be dependent on combinations of the amount (and type) of organic material returned to soils, the type of rotations used, the amount and type of tillage, use of buffer strips, beetle banks etc. Efforts spent on identifying the best practices for a given farming system and environment combination, rather than attempting to find the golden chalice of a soil health indicator that will do all things to all people, would concurrently provide evidence to policy makers on which to form policy and provide robust guidelines for farmers and land managers to facilitate improvement and/or maintenance of soil health through specified practices based on empirical evidence.

A credible and reliable Measurement/monitoring, Reporting and Verification (MRV) scheme (e.g. Smith et al., 2019), could be readily implemented within this Pay for Practice paradigm. While a national soil monitoring MRV scheme may depend on soil sampling and measurement of benchmark sites, for effective soil policy payments MRV can be most efficiently combined with already utilized systems for farm management. Within the UK at least, and presumably within many national agricultural systems, farms keep audit trails of their amendments and soil management practices so that they are transparent for their suppliers or food standard organisations. Agronomists also have audit trails as part of their FACTS and BASIS recommendations. This would cover the Measurement and Reporting aspects of the MRV scheme. As such it would not involve a complete “systems change” for such information to be made available to, for example, the Rural Payments Agency within the UK, or local equivalents, to allow for verification of compliance with practice tied in with payments. That agency already undertakes spot checks so that practice could continue but with changed goals, monitoring practice and so fulfilling the Verification part of any such scheme.

Moving to the Payment for Practice paradigm would simplify the system, facilitate reporting, and maximize the sustainable use of our soils. It would support the adaptation of agricultural soils to impending environmental changes, protecting food security and other vital soil-based ecosystem services, without the need for expert knowledge at the point of implementation. The soil health paradigm is too important to be left to the experts!

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