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Cost effective tools for soil organic carbon monitoring

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There is increasing demand for data on soil properties at fine spatial resolution to support management and planning decisions. Measurement of soil organic carbon has attracted much interest because (i) soil organic carbon is widely cited as a useful indicator of soil condition and (ii) of the importance of soil carbon in the global carbon cycle and climate mitigation strategies. However in considering soil measurement designs there has been insufficient attention given to careful analysis of the specific decisions that the measurements are meant to support and on what measurements have high information value for decision-making. As a result, much measurement effort may be wasted or focused on the wrong variables. A cost-effective measurement is one that reduces risk in decisions and does not cost more than the societal returns to additional evidence.
A key uncertainty in measuring soil carbon as a soil condition indicator is what constitutes a good or bad level of carbon on a given soil. A measure of soil organic carbon concentration may have limited value for informing management decisions without the additional information required to interpret it, and so expending further efforts on improving measurements to increase precision may then have no value to improving the decision. Measuring soil carbon stock changes for carbon trading purposes requires high levels of measurement precision but there is still large uncertainty on whether the costs of measurement exceed the benefits. Since the largest cost component in soil monitoring is often travel to the field and physically sampling soils, it is generally cost-effective to meet multiple objectives by analysing a number of properties on a soil sample.
Diffuse reflectance infrared spectroscopy is playing a key role in allowing multiple soil properties to be determined rapidly and at low cost. The method provides estimation of multiple soil properties (e.g. soil carbon, texture and mineralogy) in one measurement providing for cost-effective interpretation of soil carbon and other soil quality indicators. The measurement is has high reproducibility over time, across instruments, and across laboratories compared with conventional soil tests. We describe wide-scale application of soil infrared spectroscopy in Africa in studies designed to measure soil carbon stocks and soil quality in landscapes. Future efforts should be directed towards analyzing the decisions that soil carbon measurements are supposed to support, and quantifying uncertainties in all relevant variables affecting those decisions. Only then can truly cost-effective measurement systems be designed.