THEME 2

A novel approach for on-farm assessment, prediction and management of SOC

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INTRODUCTION

The term Soil Health is gaining more prominence than the conventional concept of "soil quality". Commonly accepted indicators of soil health include a combination of: microbial biomass C and N, soil respiration, enzyme activity, macro-aggregate stability, water retention, infiltration, pH, Electrical Conductivity, Cation Exchange Capacity, potentially mineralizable N, plant available nutrients, and active and passive pools of soil organic matter (SOM). Although several methods exist to quantify different fractions of SOM, the active fraction, and total SOC are considered to be composite indicators of soil health. The Active C (or labile C) is important to ensure greater biological diversity, and recycling of essential nutrients in soil. Passive C fractions are important with respect to buffering capacity and water and nutrient holding capacity of the soil. Rapid, reliable field-assessment techniques for active C, and farmer-friendly SOC prediction and management tools are virtually non-existent.

OBJECTIVES

The objective of this study is to assess and demonstrate the feasibility of SOC, and its active fraction as core indicators of soil health/quality, and develop a framework for a decision support tool for on-farm assessment, prediction, and management of SOC.

METHODOLOGY

A field test for active C: A colorimetric test based on dilute (0.02 M) solution of slightly alkaline potassium permanganate (KMnO4) that reacts with most readily available (active) forms of SOC is one of the most reliable, rapid and easy to adopt method (go.osu.edu/SoilTestKit).

A tool for simulating SOC dynamics: We developed the "OSU SOM Calculator", a spreadsheet tool to predict long term SOM dynamics in response to different agricultural management scenarios (go.osu.edu/SOMCalculator).

Overall soil quality/health index: A soil health index (SH_{index}) is derived, using deductive and inductive additive approach (Aziz *et al.* 2013), that considers "higher or lower values of crop or soil properties (selected by a principal component analysis) are better indicators of soil health.

Framework for a soil health decision support tool: We integrate the field assessment technique for active C with the OSU SOM Calculator into a decision support tool that may assist in management of on-farm soil health.

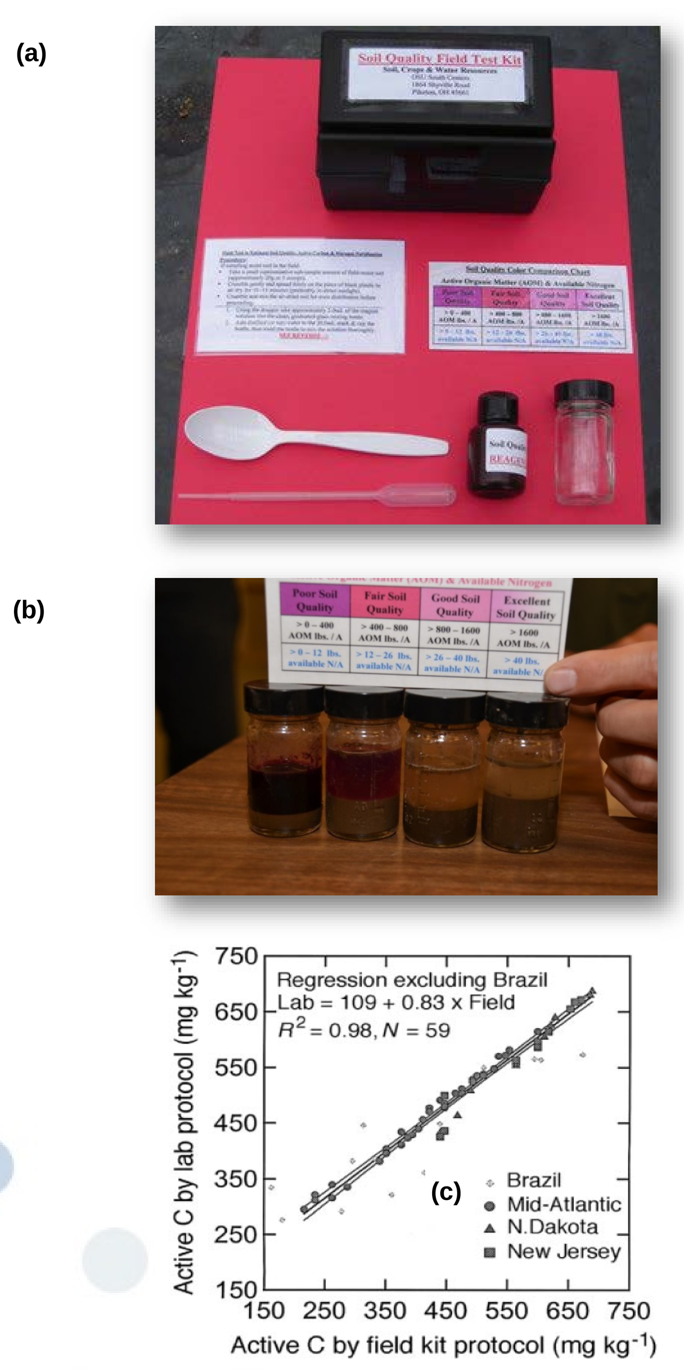


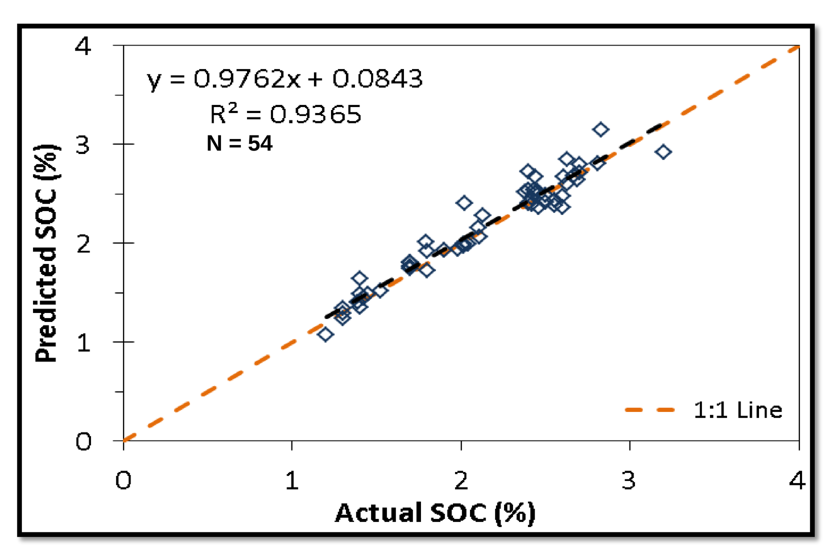
Fig. 1 (a+b+c): Field kit for in-situ active C test (a) contents of the kit (b) sensitivity to active SOC (c) Accuracy and reliability of field-kit compared to lab protocol

MAIN RESULTS

Validation of field-test kit for active SOC: The active C measured by field kit showed a strong correlation (R^2 = 0.98) with the laboratory based protocol over a wide range of soils, management, and more closely related to biological soil properties.

Validation of SOM calculator: A good agreement between observed and predicted SOC (R^2 = 0.937) based on data from 12 field experiments, representing a range of soils, crops and management in Michigan, Illinois and Ohio.

Total SOC, Active SOC and SH_{index}: regression analysis based on 1000+ soil samples gives empirical relationships between the SOC and SH_{index} and active C and SH_{index} for a range of soils, agronomic practices, and regions. Thus total and active SOC can be used as reliable indicators of overall soil health and overall soil quality.



Graph 1: Performance evaluation of OSU SOM Calculator using simple linear regression

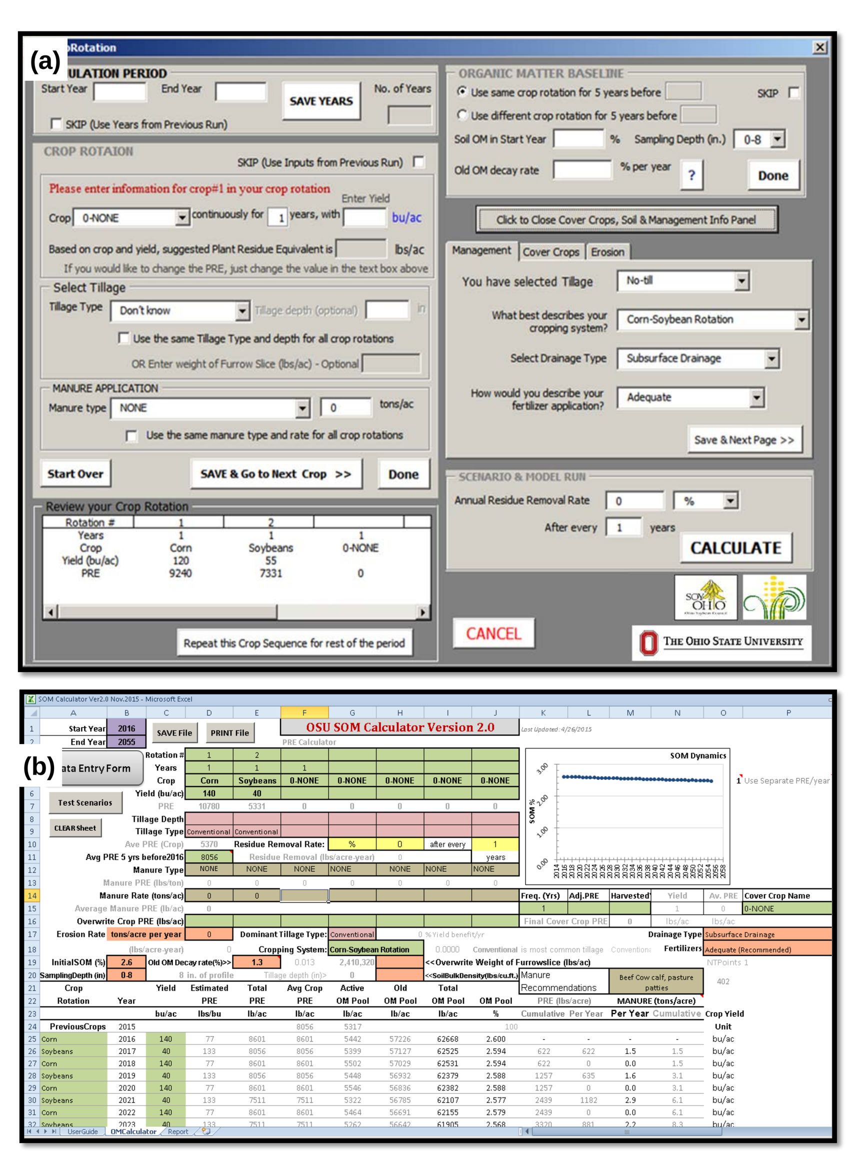
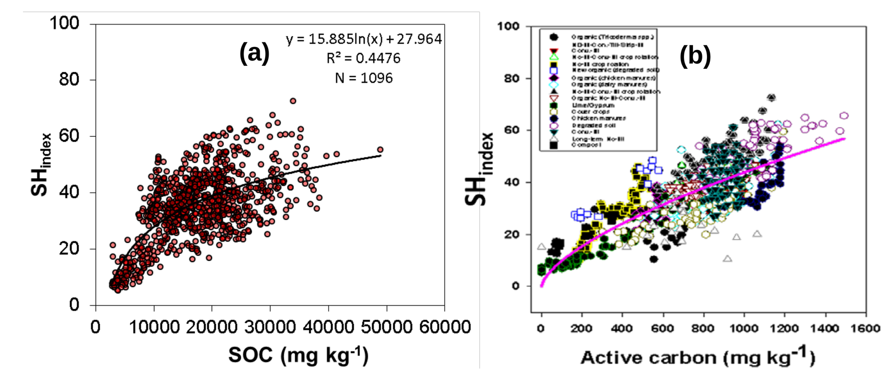


Fig. 2: The OSU SOM Calculator consists of (a) a user-friendly interface, and (b) a comprehensive spreadsheet with options to select crop rotation, management (tillage type, cover crops, drainage, manure application etc.), and residue removal rates



Graph 2: Empirical relationships between the (a) total SOC and SH_{index} and (b) active C and SH_{index} for a range of soils, agronomic practices, and regions

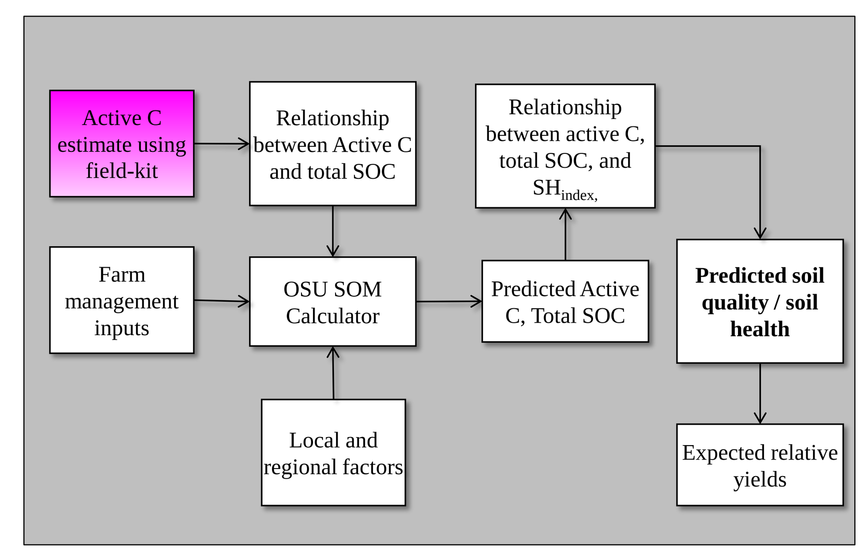


Fig. 3: Framework for a soil health decision support tool: The field-kit helps establish a reliable baseline with respect to active C, and total SOC. The SOM calculator can then help compare different future management scenarios and predict their effects on SOM dynamics over short- to long-term

CONCLUSION

While the policy framework for SOC management may benefit from the vast availability of research data and complex simulation models, their complex and highly scientific nature limits their use for on-farm decision making. The farm-scales management of SOC involves several local decision variables that relate to natural factors (e.g. soil type) as well as management options (e.g. tillage versus no-tillage, crop rotation, cover crops). This study demonstrates development of a framework that integrates science-based reliable techniques and tools for on-farm assessment, prediction and management of SOC. The framework provides an effective tool for management of SOC at local/regional scales, while the assessment technique (field-kit for active C) ensures its global relevance outside the system boundaries.