Soil Health Project Evaluation

Assessing & Expanding Soil Health for Production, Economic, & Environmental Benefits

Prepared for The Foundation for Food & Agriculture Research (FFAR)
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Photo credit: The Nature Conservancy

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Executive Summary

Evaluation of soil health in the North American agriculture sector, while conceptually important, has lacked a unified approach for measuring, interpreting and implementing soil health based agricultural management practices. Unlike more established agricultural practices with proven economic returns, soil health assessment has suffered from a lack of standardized protocols and credible connections to farm profitability. Farmers and landowners, despite recognizing the importance of soil health, have been working with disparate testing methods and conflicting guidance from various laboratories and advisors. Thus, stronger evidence is needed to clarify how soil health measurements translate into tangible outcomes—such as improved crop productivity, economic returns, and environmental benefits—which may incentivize farmers to adopt soil health practices. The Foundation for Food & Agriculture Research's (FFAR's) investment in "*Assessing & Expanding Soil Health for Production, Economic, & Environmental Benefits*" represented a strategic effort to address these fundamental challenges through rigorous scientific validation and practical application.

FFAR awarded the collaborative grant, which lasted from November 2017 to November 2021, to Dr. C. Wayne Honeycutt at the Soil Health Institute, working in partnership with The Nature Conservancy and the Soil Health Partnership. The $22 million investment ($10.4 million FFAR funding, $11.1 million matching funds) enabled the partners to focus their research and outreach efforts on establishing scientifically credible soil health evaluation protocols. The funding supported extensive data collection from 124 long-term research sites across North America, comprehensive laboratory analysis through multiple testing facilities, and stakeholder engagement across the agricultural value chain.

Project Outcome Highlights

Soil Health Measurement Advancements

- Conducted a comprehensive evaluation of soil health measurements through the North American Project to Evaluate Soil Health Measurements (NAPESHM). Spearheaded by SHI, 2,029 soil samples were analyzed using over 30 different test protocols to identify the most responsive and practical indicators. This data was used to validate and establish a minimum suite of three core soil health measurements—**soil organic carbon, aggregate stability via slaking image analysis, and 24-hour carbon mineralization potential**—now referenced in USDA NRCS CEMA-216 conservation guidelines.

- Developed standardized measurement techniques including **improved mid-DRIFTS sample preparation methods** and **carbon-sensitive pedotransfer functions** for plant-available water capacity.

- Established productivity relationships through **multiple field studies linking soil health indicators to crop yields**, primarily in semiarid dryland systems across the northern Great Plains.

Scientific Reach and Policy Influence

- Generated **30 peer-reviewed publications, 997 citations, and 29 policy references across 6 countries;** findings cited in U.S. House of Agriculture Congressional hearings on regenerative agriculture.

Economic and Operational Benefits

- Modeling suggests potential cumulative farmer cost savings of **$326M–$10.5B** over 10 years from adopting the streamlined suite of soil health tests.

Network and Adoption Momentum

- Expanded the Soil Health Partnership from 80 farmers up to 220 farms across 16 states, with **38% of farmers** adopting SHI-recommended tests and **37% of Certified Crop Advisors** now recommending aggregate stability testing.
- Increased **Certified Crop Advisor** confidence in soil health measurement tests recommended by the SHI.

Technological Advancements

- **SLAKES, a free smartphone application** which measures aggregate stability using slaking image analysis, was validated by SHI and has been downloaded over **6.0k times across 80 countries**, extending FFAR-funded science to global soil monitoring communities.

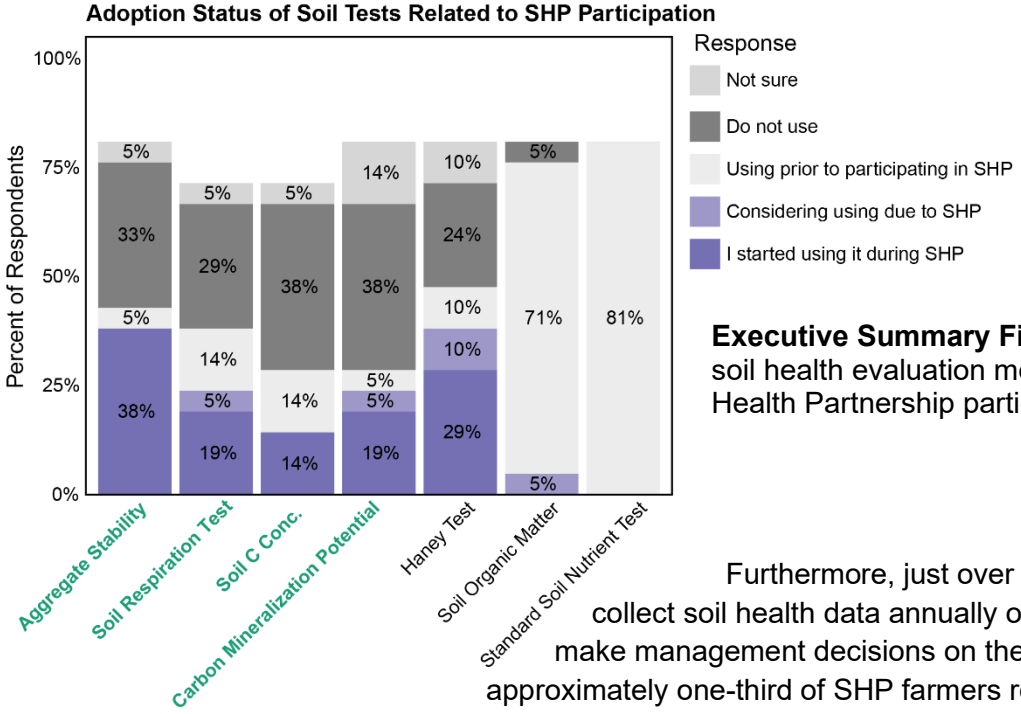
- In partnership with the Conservation Technology Information Center (CTIC), TNC developed a **comprehensive map of soil health practice adoption** in North America using earth-observing satellite data.

This research culminated in SHI's recommendation of a minimum suite of three soil health measurements: soil organic carbon concentration, aggregate stability via slaking image analysis, and 24-hour carbon mineralization potential. In addition to the three measurements, SHI developed a pedotransfer function (an equation) that uses soil organic carbon and particle-size information to more accurately predict plant-available water capacity. When this predictive water-holding metric is used alongside the three core lab measurements, SHI effectively recommends a suite of four soil health indicators. These recommendations have been translated into practical guidance for farmers, crop advisors, and soil testing laboratories through multiple dissemination channels. The standardized approach has the potential for more consistent soil health assessment across the agricultural sector and lays the foundation for policy integration.

The FFAR investment has generated scientific and practical impact. The project produced 30 peer-reviewed publications that have been cited 997 times globally, with adoption spanning 80 countries through tools like the SLAKES smartphone application. SHI's recommended soil health evaluation protocol has informed USDA NRCS Conservation Evaluation and Monitoring Activity guidelines (CEMA-216), indirectly influencing federal soil health policy as this program is available to growers in all 50 US states. Commercial soil testing

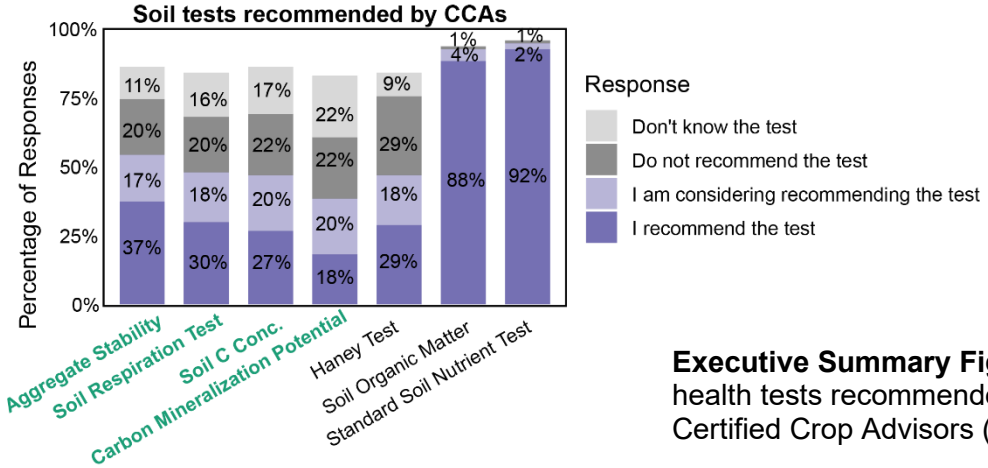
laboratories have increased their soil health testing capacity, with reported growth ranging from 13% to 150% between 2019 and 2024. It is, however, difficult to attribute these increases in adoption directly to the sole influence of this project, as there are many overlapping initiatives surrounding soil health.

Adoption of soil health test evaluations recommended by SHI by farmers suggest farmers are measuring aggregate stability of their soils at higher rates compared to other soil health tests due to their involvement in the Soil Health Partnership (ES Figure 1).

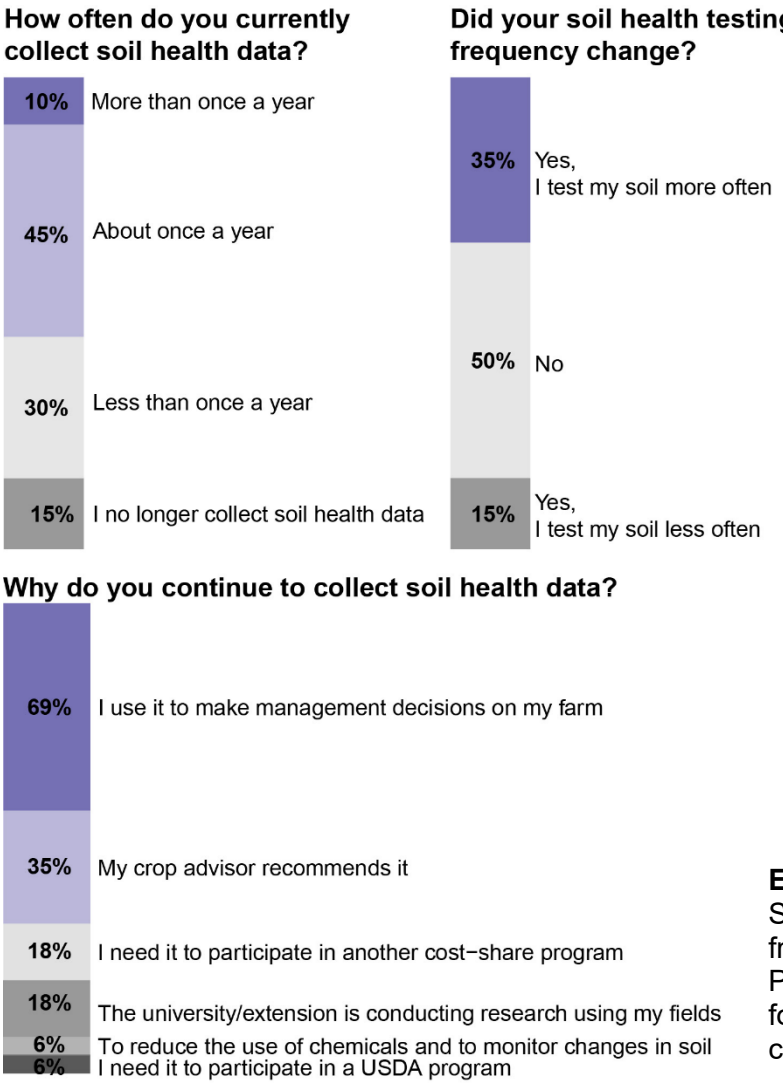


Executive Summary Figure 1. Adoption of soil health evaluation measurements by Soil Health Partnership participating farmers.

Furthermore, just over half of SHP farmers collect soil health data annually or more frequently to make management decisions on their farm, with approximately one-third of SHP farmers reporting they collect soil health data because their Certified Crop Advisors recommend it (Executive Summary Figure 3). Aggregate stability is now recommended by 37% of surveyed Certified Crop Advisors (Executive Summary Figure 3). In fact, SHP farmer soil health testing adoption rates reflect the recommendations reported by surveyed CCAs (ES Figure 2), highlighting the important relationships between Certified Crop Advisors and farmers.



Executive Summary Figure 2. Soil health tests recommended by surveyed Certified Crop Advisors (CCAs).



Executive Summary Figure 3. Soil health data collection frequency of surveyed Soil Health Partnership farmers and reasons for continued soil health data collection.

Significant limitations remain in translating soil health measurements to economic outcomes. While the project successfully established relationships between soil health indicators and crop productivity in specific geographic contexts, critical gaps persist in demonstrating clear economic returns to farmers and connecting soil health evaluation to environmental benefits such as water quality improvement or greenhouse gas emission reductions. The Soil Health Partnership network, despite initial success in expanding farmer participation, was not sustained beyond the funding period, highlighting challenges in long-term farmer network program viability.

The research has nonetheless provided the agricultural sector with the most scientifically rigorous and widely applicable soil health evaluation framework to date. The standardized three-measurement approach offers a practical balance between scientific validity and implementation feasibility, addressing the field's previous challenges with inconsistent measurement protocols. While economic linkages remain incomplete, the established productivity relationships and policy integration provide a foundation for future market development and incentive programs that could drive broader adoption of soil health practices across North American agriculture.

Summary of Impact

Overall, FFAR funding accelerated the standardization and institutionalization of soil health measurement, yet it had limited direct impact on large-scale behavior change among farmers. Uneven regional adoption of practices and continued reliance on non-SHI-recommended tests (e.g., the Haney test) indicate that economic and interpretive barriers still constrain farmer-level adoption. Our assessment suggests that engagement in initiatives such as the Soil Health Partnership influences farmers to adopt new soil health testing strategies when supported by a network of peers. Meanwhile, the uptake of SHI's recommended soil health measurements by laboratories, Certified Crop Advisors, and policymakers demonstrates a strong overall impact of the project's scientific outputs and educational outreach efforts.

In summary, the project successfully advanced the science and infrastructure of soil health evaluation, establishing technical and institutional foundations for broader adoption—though translating these scientific advances into widespread on-farm practice change remains an ongoing challenge.