SOIL HEALTH TESTING: A COMPARISON OF METHODS

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The importance of understanding your soil is a value that farmers know well. To produce high-quality and abundant yields, farmers must be well versed in the science of soil health. Today hundreds of different soil tests can provide information that helps farmers properly manage their farms. Some tests are more widely used by farmers based on years of research and their ability to test various chemicals or soil properties. Because these tests tend to be more expensive, farmers also use smaller tests that only look for one aspect of soil. Whatever farmers wish to find out about their soil, there is a test that is perfect for them. While standard soil lab tests are wildly popular, on-farm technology and new soil sciences are also making impressive strides. Expanding development in soil technology will provide economic and educational benefits for farmers. New testing can quickly and efficiently expand soil management methods and improve soil health like never before. The necessity and advance in soil testing practices has the ability to protect the future of our agricultural system and the health of our environment.

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1. Cornell Soil Health Test

The Cornell Soil Health Test (CSHT), sometimes referred to as the Comprehensive Assessment of Soil Health (CASH), is one of the most common soil tests used in the United States today. It is based on the Soil Management Assessment (SMA) framework three-step analysis. SMA was created by the Cornell Cooperative Extension in 2006 as a way to measure soil health. It provides standards of soils' chemical, biological and physical expectations for the Northeast United States. It identifies the weaknesses in the soil samples to properly recommend healthy soil management. This test looks at chemical, physical and biological factors that can affect soil. CHT evaluates the physical components of the soil which extractants test do not. Since 2006 this testing method has made some changes as to what they assess since in their protocol. This has to do with the overall criteria of healthy soil changing and what they feel should now be tested.

Cornell offers three soil tests. The Standard Plus Test is the most expensive package and includes the most amount of assessments available. It costs $130 per sample and is recommended for USDA-NRCS projects, research, organic production, vegetable crops, diagnostic testing, and home gardens. Cornell also offers two cheaper soil tests: the Basic Test and the Standard Test. The more expensive the package, the more testing options are provided in the package. The Cornell tests are very popular, particularly in the northeast, because the test was developed for this region, and it has been considered reputable by farms, universities, and the USDA. The level of test purchased depends on what the landowner feels is important to know about their soil, and the cost. This may also vary by the crops and the area of the farm.

CSHT can test a wide variety of soil properties that fall under the categories: physical, biological, and chemical. Testing the physical properties of soil, such as texture, porosity, soil hardness and aggregate size, CSHT can measure the ability of soil to store water, eliminate runoff and support crops. CSHT also tests biological aspects of soil, such as the nematode population, organic matter and active carbon. By testing biological components of soil, CSHT can measure the amount of carbon, disease or microbial activity present in the soil. Finally, the CSHT tests chemical aspects of soil which always consists of potassium and phosphorus ratio for all its tests. Accurate information about the level of nutrients in the soil can inform farmers how to best adjust chemicals in the soil or add cover crops to better help the crops and overall soil health.

	BASIC	STANDARD	STANDARD PLUS
COST PER SAMPLE	$70	$110	$130
RECOMMENDED USE	CROPS, DAIRY FARMS, LAWNS	ORGANIC, VEGETABLES, PROBLEM DIAGNOSIS, HOME GARDENS	USDA-NRCS PROJECTS, RESEARCH, ORGANIC, VEGETABLE, PROBLEM DIAGNOSIS, GARDENS
SOIL TEXTURE			
PH			
ORGANIC MATTER			
EXTRACTABLE PHOSPHORUS (p)			
EXTRACTABLE POTASSIUM (k)			
MICRONUTRIENTS			
WET AGGREGATE STABILITY			
SOIL RESPIRATION			
ACTIVE CARBON			
TOTAL CARBON			
TOTAL NITROGEN			
SURFACE, SUB-SURFACE HARDNESS INTERPRETATION			
AUTOCLAVE-CITRATE EXTRACTABLE (ACE) PROTEIN TEST		PREDICTIVE VALUE FOR PROTEIN	LAB TESTS PROTEIN
PREDICTED AVAILABLE WATER CAPACITY			

2. Haney Soil Test

The Haney Soil Test is another one of the most used soil tests in the United States. It measures the carbon dioxide release from microbes and is used to determine the total carbon and nitrogen ratios in the soil. This test is extremely useful to determine when to use cover crops and what nutrients are lacking. The Haney test is an extractor test, but unlike Melich-3, it uses HO2 and H3A to extract the nutrients for assessment. H3A can more accurately measure nitrogen in the soil as well as nitrate and ammonium. Since these two tests will derive different results, both are sometimes used to evaluate a single soil plot.

3. Melich-3 Test

The Melich-3 test (M3) is the third version of the Melich tests. Although the first version of the test is still available and in use today, the second version is hardly ever found in use because of its highly corrosive nature and it was deemed a failure by University of Florida's extension. Of the three versions, Melich-3 is the most advanced and commonly used today. The Melich test is a type of extraction test, adding acid to soil in order to extract certain chemicals. By adding the acid, the test is able to identify the chemicals that were removed from the soil sample. According to the University of Arizona Cooperative extension, the Melich-3 Test does not properly represent certain nutrients. Sulfur and nitrogen are difficult nutrients to get an accurate reading on due to the inability to detect the rate of decomposition.

GENERAL AND LOCAL TESTING

Most labs conduct tests for basic nutrients like soil pH, phosphorus, potassium, calcium, and magnesium, salinity, organic matter content, and soil texture. If not all in one test they might offer these in another array of tests. Labs will make certain tests more available depending on the area. Some regions of the U.S may need to add more fertilizers or their soil make up is different depending on the climate of the area. For example, “the majority of laboratories in the western United States do not offer the Mehlich-3 extraction method. The Mehlich-3 method is effective in extracting available phosphorus from the acidic soils found in many parts of Alaska, but it is not suitable for the alkaline soils that dominate many western states. Alaska will be taking care of their soil differently than the areas where they typically send their soil test. Thus, farmers need to be aware of their soil health as that can help them to indicate what type of tests and fertilizers needed for their land. There are soil testing labs in every state of the United States. It is common for university extensions to conduct testing themselves such as Colorado state university. However, others such as the University of Alaska Fairbanks serve more as informative sources and will therefore recommend that soil samples are sent to labs for testing.

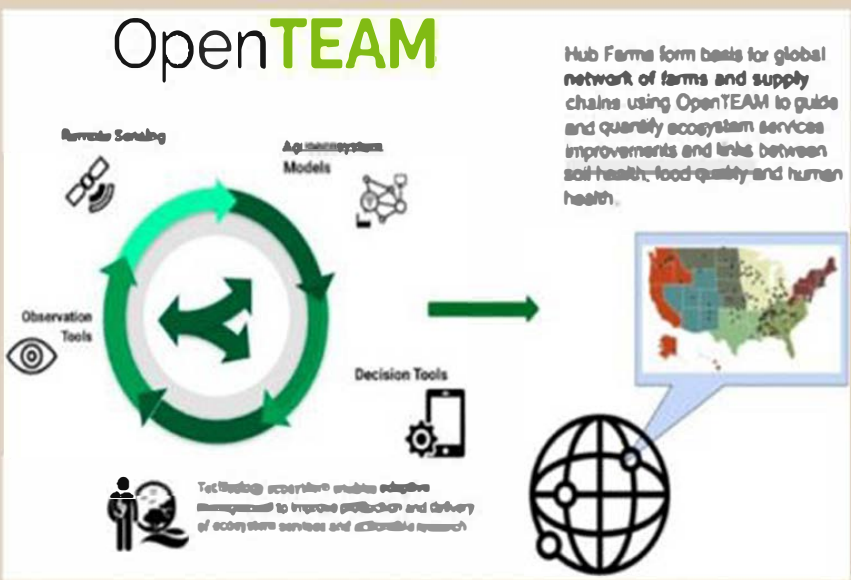
INNOVATIVE TOOLS FOR SOIL TESTING

The development of new soil metrics opens up the opportunity for improving soil health, economics and ecosystem. Three specific Soil metrics use modern technology and science to display results. These tools are fast and yet still highly accurate, therefore these newer forms of agriculture devices are capable of changing the lives of farmers and our environment.

1. Open TEAM

OpenTEAM, which stands for open technology ecosystem for agriculture management, uses new technologies to monitor soil health and provide data to farmers quicker than other soil tests can. OpenTEAM measures carbon retention in real time , provides predictive data, records soil management practices, and utilizes digital sensing. The program uses technology to expand access to healthy soils knowledge and makes data more easily shareable amongst farmers across the world. This technology is currently being tested on farms and is expected to be available world-wide in coming years.

OpenTEAM offers unique features. Implemented primarily based on farms, the data OpenTEAM collects is all accessible on one device. This is useful and efficient for farmers to stay aware of their soil health. An additional feature that makes OpenTEAM so special is the social network and hub program. When ready, this will provide interconnection to farmers all over the world. Ultimately, the program will create a one stop place to share research, tools, and give and receive help with farming practices. Members must be selected to participate in the OpenTEAM networking and hub program. Hubs will be the institutions using the OpenTEAM technology who will eventually share their findings. Companies and nonprofits may be required to pay to be involved in the Hub. To be a part of the Network, OpenTEAM encourages that applicants are familiar with soil testing, willing to provide feedback to OpenTEAM workings group, test new tools developed and create a profile through the company.



2. Microbiometer

In 2019, Judith Fitzpatrick opened the farming community to her revolutionary soil testing technology, which was officially patented in 2019. Fitzpatrick's microbiometer microbe test, evaluates the microbial biomass and fungal to bacterial ratio in soil and is particularly effective in recommending cover crops. It is faster than any other method on the market presently. Due to its 20-minute testing time, farmers can now test the microbes of their soil without having to send out samples to a lab which could take weeks to deliver results. According to Prolific Earth Sciences, which holds the microbiometer patent, microbes start dying after leaving the soil, and so onsite testing is more accurate and economically efficient. Testing microbes can provide indicators of harmful and beneficial organisms that are present in the soil and consequently, help inform on-farm management decisions and practices. Having healthy microbes in the soil supports the plants, and soil structure. Low levels of healthy microbes can limit the effectiveness of healthy soil practices despite the use of soil management activities.

Microbiometers test the soil by separating microbes from the soil. These microbes, which were just attached to the soil, remain floating in the reagent liquid that is provided with the test. Using smartphone technology, the test's app scans microbes and results are depicted through different colors of those microbes' membrane. The color of the microbes determines the status of the microbes in the soil. A standard starter kit that offers the capacity for 10 tests costs $135. Refills vary between $100-750 depending on the number of refills purchased. As of now, this technology is under a patent and thus, similar tests cannot be purchased else. There are no commercial at-home tests that can compare to the microbiometer.

3.CO2 Burst

Solvita uses a unique form of chemistry to measure the amount of CO2 respiration in the soil called CO2 bursts. Unlike other companies distributing a similar method Solvita receives results in 24 hours instead of 3-4 days, making Solvita's version the most popular version of CO2 burst test. Solvita's research claims assessing samples more often in a shorter period of time receive the same results as studies that go on for longer and there is no reason to do so. The test mimics a disturbance to the land by re-wetting dry soil. A carbon chromatography gel is added to the soil followed by a quick use of water hitting the sample. The test uses the microbes in the soil to measure the active carbon. Microbes release CO2 in cellular respiration. Therefore, the amount of the CO2 can determine the biological health of the soil. CO2 respiration is an indicator of carbon sequestration and overall soil health. A digital color reader is required to measure the accumulation of carbon in the container where the sample is being tested. One order of Solvita CO2 burst costs $195 and the digital color detector which has a multipurpose use amongst other Solvita's tests is around $2,000. The test and the detector recommended for laboratories and not individual farms or persons. This method has been used in support of other tests such as the Haney soil test to measure active carbon.

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