ORNL, Los Alamos pioneer new approach to assist scientists, farmers

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Sustainable farming, initially adopted to preserve soil quality for future generations, may also play a role in maintaining a healthy climate, according to researchers at the Department of Energy's Oak Ridge and Los Alamos national laboratories.

ORNL and LANL scientists are exploring the large potential of the earth's soils to sequester carbon, with estimates claiming that new land-use practices could greatly reduce U.S. carbon emissions by as much as 25 percent. But exactly which practices are the most effective is still unclear, and a research paper published in the *Soil Science Society of America Journal* shines some light on this topic by introducing an easy-to-use field-portable approach to measure the carbon content of soils.

"This is a tool one could use to measure changes in soil carbon over time and try to establish whether soil carbon stocks are increasing or decreasing as a result of land-use practices," said lead author Madhavi Martin of ORNL's Environmental Sciences Division. "Although it is possible to measure these properties in the laboratory, the simplicity and portability of the device allow researchers exponentially greater flexibility to conduct their investigations."

The paper describes the adaptation of Laser Induced Breakdown Spectroscopy, or LIBS, a technique that once made Martin something of a celebrity when she used it confirm the common origin of two separate pieces of firewood - evidence that eventually led to a confession in a 2006 Texas murder case. LIBS works by measuring the light emitted

when a small portion of the sample is annihilated with a laser pulse, a flash that provides an elemental fingerprint of virtually any substance under examination.

The challenge for the authors was configuring the experimental design to ensure accurate measurements of carbon regardless of soil characteristics. To accomplish this, the authors acquired a varied set of soil samples with different sand, silt and clay compositions from the Natural Resources Conservation Service and tested them against numerous laser wavelength and energies.

"We found that LIBS is a promising technique that provides a robust method for the sampling of soil carbon, relying solely on technology that can be taken to the field," Martin said. "Crop scientists, carbon managers and instrument developers should find these results encouraging."

With new techniques such as LIBS to assist them, researchers hope they can eventually identify the agricultural practices that provide the maximum benefits to farmers and the climate alike. Intensive farming is a double-edged sword as it can greatly enhance crop production in many areas of the country. Often, however, this comes at the expense of soil health in addition to accelerating the rate of climate change, according to the researchers.

Twice as much carbon is stored in the soils of the world as in the atmosphere, thanks to centuries of decomposition of plants and other organic matter. Fertile (high carbon content) soil is necessary for the growth of large healthy crops. However, fertile soil is also a favorite target of naturally occurring bacteria.

Fortunately for farmers and plants, the majority of carbon beneath our feet is physically protected from bacteria in what scientists call soil aggregates. A large portion of that carbon is concentrated near the earth's

surface and therefore highly vulnerable to changes in land use. When a soil's aggregate structure is disturbed, such as through intensive farming, the organic matter it protects becomes accessible to soil microorganisms that use it as an energy source, releasing the stored carbon back into the atmosphere as the greenhouse gas CO_2.

"Disruption of soil structure is estimated to contribute to a 50 percent loss of soil carbon," said Chuck Garten, a soil scientist at ORNL. "When the microstructure of the soil is disturbed, it breaks down the aggregates allowing large losses of soil carbon as a result of microbial decomposition."

This lesson was learned the hard way by many American farmers when pressure for production leads to serious soil degradation through erosion and nutrient losses. Intense farming by pioneer farmers in the first 30 years of settlement depleted the organic matter in the U.S. Great Plains by more than 50 percent with soil productivity falling more than 70 percent during the same period.

Eventually, better agricultural practices were adopted and production recovered. Still, grassland and forest soils continue to lose 20 percent to 50 percent of their original carbon content within the first 40 years of cultivation while tropical climates that practice shifting cultivation or slash and burn agriculture can lose their fertility within two to three years. Farmers make up for the loss by simply moving to new fields or replenishing carbon stocks with the use of manures and other organic wastes.

Source: Oak Ridge National Laboratory (news : web)