Soil Carbon Capture

The United Nations estimates by 2030, global soil carbon sequestration can potentially mitigate around five gigatonnes of carbon per year.

Soil is the skin of our planet. This thin layer of living material holds roots, water and nutrients, as well as a myriad of organisms and organic matter. To truly see the biodiversity it holds, one must look down; below the surface of the soil.

The Food and Agriculture Organisation (FAO) estimates that 1/3 of our world's soil is degraded, meaning it's less able to grow crops. Instead of absorbing carbon, it emits it into the atmosphere. Yet, a World Resources Institute report shows global food demand is set to rise as much as 50 per cent by 2050.

Businesses can support farmers in their supply chain to transition to regenerative agriculture. This can restore soil health, reduce pollution, help meet global demand and capture carbon.

The soil can sequester carbon, improve biodiversity, recharge aquifers, boost rural economies, and most importantly for the future of humanity, stabilize the climate.

Restoring soil through regenerative agriculture, including organic no-till cropping, holistic planned grazing, and agroforestry,can provide food, water, and climate security for present and future generations.

Nature-positive solutions benefit people and wildlife.

Nature can act as a natural carbon sink. Mangrove trees,for example, sequester carbon far more effectively and permanently than terrestrial forests. Alternatively, CO_2 can be sequestered by cultivating algae, which can be harvested and processed to produce useful products like biofuel and protein-rich animal feed.

What is Soil Organic Carbon Sequestration

Soil Carbon Sequestration is the process of transferring CO2 from the atmosphere into the soil in the form of organic carbon.
This process begins with photosynthesis, where plants convert atmospheric carbon dioxide into organic compounds.
These compounds are then incorporated into the soil through plant residues and root exudates.

SOC in the carbon fraction of soil organic matter, derived not only from plants but also from animals and microorganisms. Another source of these compounds is the by products of animal and microbial activity.

But carbon is not just a constituent of the soil; it is the lifeblood that maintains the soils's vitality. It improves soil structure, promotes the proliferation of beneficial soil organisms, enhances nutrient and water retention, and boosts its fertility.

For instance, a 1% increase in SOC can enhance the soil's water capacity by up to 20.000 gallons per acre.

The process continues as organic compounds are incorporated into the earth through dead plants or leaves. These materials eventually decompose and transform into SOC with the help of subterranean organisms.
Increasing the soil's organic carbon content lock effectively away CO2 from the air, turns out to be a natural way of mitigating climate change.

Ecosystem Management Using Livestock: Embracing Diversity and Respecting Ecological Principles

Agricultural land is a scarce resource globally and will continue to encounter challenges to sustainably increase food production in the face of global change. Adaptations that make use of livestock should ideally incorporate agroecological principles (e.g., improved circularity), while limiting feed-food competition. However, they should also remain respectful of the diversity of ecosystem contexts, availability of resources, and the various social and economic needs of local populations.

"Ecosystem management using livestock: embracing diversity and respecting ecological principles, Animal Frontiers, Volume 13, Issue 2, April 2023, Pages 28–34"

Evaluating the impacts of alternative grazing management practices on soil carbon sequestration and soil health indicators

The objective of this study was to identify the impacts of alternative grazing management practices, including heavy continuous (HC), light continuous (LC), and adaptive multi-paddock (AMP) grazing, on SOC and soil health indicators at the ranch and watershed scales in the Lower Prairie Dog Town Fork Red River Watershed in Northwest Texas. ...

The study results indicated that when grazing management at the study ranch was changed from the current AMP grazing to hypothetical HC grazing, simulated average annual SOC decreased from 84 to 81.8 Mg/ha (a 2.6% decline). At the watershed-scale, when the grazing management was changed from the baseline HC grazing to AMP grazing, the simulated average annual SOC increased from 35.6 to 38.3 Mg/ha (a 7.5% increase) ...

These results indicate that compared to HC, AMP grazing performed better with respect to SOC increase, and improvement of soil ecosystem and hydrological functions at both the ranch and watershed scales in the study watershed. Our findings suggest the need to shift from continuous to AMP grazing in order to improve soil health at multiple spatial scales."

"Evaluating the impacts of alternative grazing management practices on soil carbon sequestration and soil health indicators, Agriculture, Ecosystems & Environment, Volume 342, 2023, 108234, ISSN"

The data

Mowing treatment of soil increased the exposure of litter to UV radiation (+38 %) and therefore facilitated the microbial assimilation of litter C (+20 %) and the SOC formation (+15 %).

Trampling treatment promoted the transformation of litter C to SOC pools by mixing litter and soil (+34 %).
The results suggest that grazing facilitates litter-derived SOC formation by regulating microbial involvement through changes in the microenvironment.

Our study indicates that grazing promotes SOC formation from plant litter, which maintains SOC storage in grasslands. Accurate quantification of the contribution of plant C input to SOC pools in different grasslands under various utilization is the next step to better predict SOC dynamics."

"litter-derived soil organic carbon formation in grasslands by fostering microbial involvement through microenvironment modification, CATENA, Volume 232, 2023, 107389, ISSN"

Scientists estimate that soils, primarily agricultural ones, could sequester over a billion additional tons of SOC each yet.

Grasslands present a significant opportunity for soil organic carbon sequestration, with the potential to absorb carbon equivalent to about 6.5 billion metric tons per year, which is roughly equivalent to offsetting the annual emissions of over 1,400 coal-fired power plants.

As for croplands, they could sequester between 0.90 and 1.85 billion metric tons of carbon per year, accounting for 26-53% of the target set by the '4p1000 Initiative: Soils for Food Security and Climate', a global strategy to leverage soil for climate change mitigation.

Soil- Based Carbon Sequestration

Soils are made in part of broken-down plant matter. This means they contain a lot of carbon that those plants took in from the atmosphere while they were alive. Especially in colder climates where decomposition is slow, soils can store—or "sequester"—this carbon for a very long time. If not for soil, this carbon would return to the atmosphere as carbon dioxide (CO_2), the main greenhouse gas causing climate change.
But converting natural ecosystems like forests and grasslands to farmland disturbs soil structure, releasing much of that stored carbon and contributing to climate change. Over the past 12,000 years, the growth of farmland has released about 110 billion metric tons of carbon from the top layer of soil—roughly equivalent to 80 years' worth of present-day U.S. emissions.

The question is: Can this trend be reversed at the global scale as part of a strategy to help fight climate change?

Storing carbon in agricultural soils

Scientists have estimated that soils—mostly, agricultural ones—could sequester over a billion additional tons of carbon each year.4 This has led policymakers to increasingly look to soil-based carbon sequestration as a "negative emissions" technology—that is, one that removes CO_2 from the air and stores it somewhere it can't easily escape.

Cropland, which takes up 10% of the Earth's land, is a major target for soil-based carbon sequestration. Farmers can add more carbon to agricultural soils by planting certain kinds of crops. For example, perennial crops, which do not die off every year, grow deep roots that help soils store more carbon.

How To Measure Carbon Sequestration In Soil

Measuring soil carbon sequestration is a crucial step for farmers and agribusinesses wanting to reap financial benefits from their efforts.

To do this, they need to employ careful sampling strategies and bring collected soil to a lab to determine its SOC content.

This is not a simple task, as sampling requires a systematic approach to ensure that the samples are representative of the entire field.

Once the samples reach the lab, they undergo a complex process to measure and verify the SOC content.
This involves a variety of techniques and methodologies, as carbon levels can significantly vary both over time and across different field areas.

For instance, the SOC content can differ between the topsoil and subsoil layers, and even within the same layer, it can vary depending on the soil type, climate, and management practices.

Based on the lab results, estimates of soil carbon sequestration are made in comparison to the baseline state. However, given the complexity of SOC dynamics, these estimates are often associated with a degree of uncertainty.

To overcome this challenge, scientists use various change estimation models.

Some of them simulate the processes involved in carbon cycling in soil, such as the decomposition of organic matter, carbon input from plant residues, and its loss through respiration. Others are based on already observed relationships between SOC and influencing factors and use statistical techniques to predict SOC changes on historical data.

There are also hybrid models that combine elements of process-based and empirical models. These models leverage the strengths of both approaches, providing more accurate and reliable estimates of the effects of soil carbon sequestration.

Since businesses want to know possible profits before engaging in any new venture, they can forecast the amount of sequestered SOC using modern AI-powered satellite analytics solutions. For that, they need to take soil samples so that the analytics model could use them as a baseline.

After a certain period of time – the longer, the better for more noticeable changes – the user will need to take only 10% of the initial samples again to validate the model. This approach significantly reduces the time and cost associated with soil sampling, making it a more feasible option for businesses.