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Farming Techniques that Protect the Planet

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A new generation of farmers and scientists is discovering ways to sequester carbon in the soil while improving crop yields. This approach could be a significant factor in addressing two of humanity's major carbon-related problems.

The Carbon Dilemma

First, there's an excess of carbon in the atmosphere. Since the industrial age began, atmospheric carbon dioxide concentrations have risen by about 50%, from 280 parts per million to nearly 420 parts per million in 2023. While fossil fuel combustion is a primary contributor, agriculture also plays a significant role, emitting around 13.7 billion tonnes of CO2 or equivalent greenhouse gases annually. More than one-quarter of global greenhouse-gas emissions come from food production. Secondly, soil carbon levels have drastically declined due to intensive farming practices aimed at feeding the growing population. An estimated 133 billion tonnes of carbon, or about 8% of total organic soil carbon, has been lost from the top 2 meters of soil since agriculture began 12,000 years ago. One-third of this loss has occurred since the Industrial Revolution in the 1800s.

Agriculture's Potential as a Carbon Sink

This imbalance suggests that agriculture, currently a carbon source, has the potential to become a carbon sink, altering the climate-change trajectory. Recharging soil organic carbon stocks by enhancing natural processes that draw and convert CO2 into soil carbon is relatively straightforward. The Intergovernmental Panel on Climate Change (IPCC) synthesis report highlights the significant potential of carbon sequestration in agriculture, estimating it could contribute about 3.5 gigatonnes of CO2 or equivalent greenhouse gases per year. This amount surpasses the emissions of the entire European Union in 2022, with only the conversion of current energy supplies to solar or wind energy or the reduction of natural ecosystem destruction being greater contributors. The challenge lies in ensuring these methods are implemented quickly and cost-effectively to help achieve global net-zero carbon emissions by 2050.

Agricultural practices such as ploughing release carbon dioxide into the atmosphere.

Techniques for Increasing Soil Carbon

Increasing soil carbon doesn't require high-tech solutions. Plants naturally extract CO2 from the atmosphere through photosynthesis, converting it into carbohydrates and oxygen. This carbon is then integrated into the soil as plants shed leaves, branches, flowers, or fruit, are consumed by other organisms, or decompose after dying. However, certain human practices hinder this process. Tilling, especially deep ploughing, breaks up the soil, releasing CO2 into the atmosphere and increasing the risk of erosion by wind or water. Reducing or eliminating tilling through no-till or zero-till agriculture can help keep carbon in the soil. This method involves planting seeds or seedlings with minimal soil disturbance, leaving crop residues from the previous season in place. This approach has mixed results, with variations depending on climate and soil type, but it does reduce fuel consumption, lowering emissions. Another technique is growing cover crops alongside the main crop, maintaining root structures and their carbon contributions. In a study of Australian vineyards, allowing grasses to grow between grapevines increased soil organic carbon by nearly 23% over five years. This practice is gaining traction in North American vineyards and is well-established in Europe. Enhanced weathering, which involves adding ground-up silicate rock to soil, is another method. The minerals in the rock interact with atmospheric CO2 to form carbonates, sequestering carbon in the soil. A study in the US corn-belt region found that applying crushed basalt to maize and soybean fields sequestered an additional 10 tonnes of CO2 per hectare per year while boosting crop yields by 12-16%.

Agroforestry and Soil Carbon Sequestration Limits

Deforestation for cattle farming is another major contributor to agricultural sector emissions. Agroforestry, integrating trees into farming systems, can mitigate this by increasing soil and tree biomass carbon sequestration, providing windbreaks and shade for cattle. Despite its potential, soil carbon sequestration has limits. It cannot absorb all the carbon released from geological sources and has a finite capacity. The question is how much carbon can be sequestered in a given area of land.

Measuring, Monetizing, and Incentivizing Carbon Sequestration

Rattan Lal, director of the Lal Carbon Center at Ohio State University, suggests that with a switch to non-fossil-fuel energy sources, agriculture could achieve a positive soil carbon budget by 2100, sequestering about two gigatonnes of carbon per year. Some studies estimate this number could be as high as 4-5 gigatonnes annually. Given global emissions are around 35 gigatonnes per year, this is a significant proportion. However, measuring soil carbon accurately is challenging due to geographical variability and natural fluctuations. It often takes around five years to observe detectable differences in soil carbon levels.

Cultivating Change

Despite uncertainties, soil carbon sequestration is a hot topic for emission reductions. Governments are keen on capitalizing on carbon credits from agriculture, which can be used to offset emissions from other sectors while improving soil health. Marit Kragt, an agriculture and resource economist, emphasizes the need for cost-benefit analyses to overcome sociocultural barriers to changing farming practices. Farmers often adopt carbon-positive practices not for credits but to regenerate their environment and address climate change impacts on their livelihoods.

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