EJP SOIL
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CARBOSEQ

Policy Brief
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When does soil carbon contribute to climate change mitigation?

Axel Don, Felix Seidel, Jens Leifeld, Thomas Kätterer, Manuel Martin, Sylvain Pellerin, David Emde, Daria Seitz, Claire Chenu

- EJP SOIL clarifies definitions around carbon (C) sequestration in soils
- C sequestration in soils requires a *global* increase in soil C stocks
- In many European croplands we can only achieve reduced C losses (C loss mitigation), not C sequestration in soils, via improved agricultural management
- Leakage may easily offset positive climate impacts of increased soil C
- Soil C stocks need to be increased (SOC accrual) for climate change mitigation – unchanged C stocks (SOC storage) have no direct climate benefit

Introduction

In climate change mitigation discussions, technical terms are not always used correctly leading to unintended consequences and exaggerated expectations of the role of soil C for climate change mitigation.

Carbon stock, carbon sink - are they the same thing? And does fixing C in the soil, for example by building up soil organic C, automatically lead to climate change mitigation? In public discussions about climate protection, many such concepts often get mixed up.

A recent study shows that even in scientific publications on the subject, technical terms are not always used correctly. This result is illustrated by analysis of 100, recent, international publications, the majority of which misused terms surrounding C and climate change. It isn't just a matter of quibbling over words - imprecise wording can lead to inflated expectations of climate protection measures.

Description of the Issue

Definitions (based on IPCC)

C sequestration in soils: Process of transferring C from the atmosphere into the soil through plants or other organisms, which is retained as soil organic carbon resulting in a *global* C stock increase of the soil.

Negative emission: *Net* removal of CO_2-equivalents of greenhouse gases from the atmosphere

CO_2 can be removed from the atmosphere and stored in the form of soil organic C so that it no longer affects the climate. Increased C stocks *may* lead to so-called negative emissions under the *right* conditions. This is the aim of enhancing soil organic C for climate change mitigation. When C is removed from the atmosphere and stored in the soil as soil C, thereby increasing global soil C stocks, it is called C sequestration in the soil. The key condition

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here is, 'increases *global* C stocks'. Many agricultural fields in Europe are currently losing soil C as a result of climate change or unsustainable management. Measures to increase soil C may, therefore, only serve to reduce or stop C losses, so called C loss mitigation. This is essential from a soil health perspective. However, because C loss still outpaces C accrual in these areas, there is no increase in *global* soil C stocks, and thus there is no C sequestration in the soil. Similarly, without meeting this key condition, negative emissions cannot be generated because, although reduced, emissions still outweigh the increase in soil C.

Climate Change Mitigation without negative emissions

Nevertheless, reduction of emissions via increased soil C stocks results in climate change mitigation. That is, a reduction in the greenhouse gas emissions when compared to a reference year or a baseline scenario. For example, if soil C losses are usually high for a given agricultural field and are now low after implementing measures, then soil C losses are reduced, greenhouse gas emissions have been abated, and thus the climate change impact of that field has been mitigated. However, this is only true if such measures do not produce additional greenhouse gas emissions on-site or elsewhere. Therein lies an often overlooked, but important, consideration for assessing whether or not soil C enhancing measures contribute to climate change mitigation, the indirect increases of greenhouse gases. Some soil C enhancing measures, such as reduced tillage, can simultaneously increase emissions of nitrous oxide from the soil. Nitrous oxide has an almost 300 times stronger climate impact than CO_2, so even small increases of nitrous oxide release can counteract the climate change mitigation effect of soil C enhancing measures. This can even potentially lead to an increase in total greenhouse gas emissions.

Urgent need to use terms more rigorously

Without considering all of the greenhouse gas effects of implementing measures to enhance soil C, it is easy to mistakenly perpetuate biased conclusions regarding their climate change mitigation potential. The analysis of 100 recent international publications on C sequestration in soils revealed that the vast majority of authors used the term incorrectly or ambiguously. Proper use of the terms "C sequestration", "negative emissions", "climate change mitigation", and "soil C accrual" is important to improve communication between the various stakeholders in science, politics, industry, and society. Successful communication not only enhances scientific understanding, but is essential to implementing successful climate change mitigation strategies.

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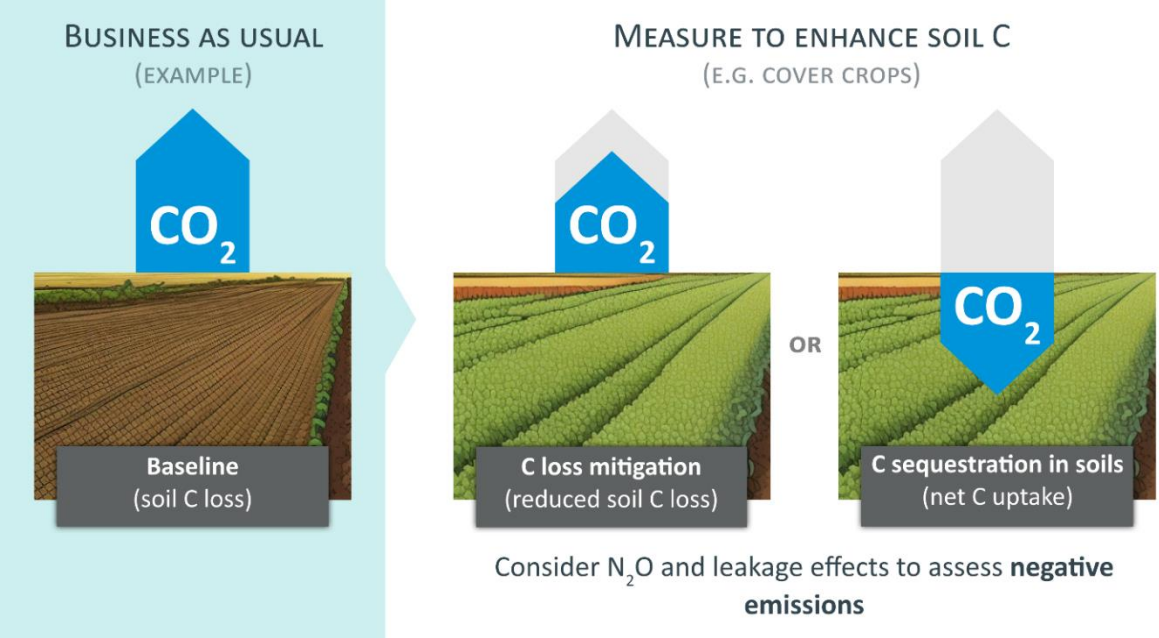
KEY MESSAGES FOR POLICY MAKERS

Recommendation One: Distinguish between C sequestration and C loss mitigation

Increasing C accrual in soils can offset greenhouse gas emissions. However, this increase can only be considered *C sequestration in soils* if soil C stocks are increased at a global scale. In soils that are losing C, measures to enhance soil C may only reduce C losses and thus cannot contribute to C removal from the atmosphere. However mitigating C losses is essential to protect soils and maintain the ecosystem services they provide (Fig).



Recommendation Two: Increased C stocks should not be claimed as C sequestration and climate change mitigation *per se*.

Increasing C stocks (C accrual) other than the atmosphere *may* contribute to C sequestration and climate change mitigation. The simple existence of soil C (stocks) however, does *not* contribute to this.

Recommendation Three: GHG balances must be created and off-site leakages must be accounted for when determining if negative emissions can be achieved with measures that enhance soil C stocks.

Negative emissions are not the same as C sequestration in soils since measures to build up soil C may also affect non-CO_2 greenhouse gas emissions – off-site and on-site. The estimation of these greenhouse gas emissions can be very challenging and often only approximated.

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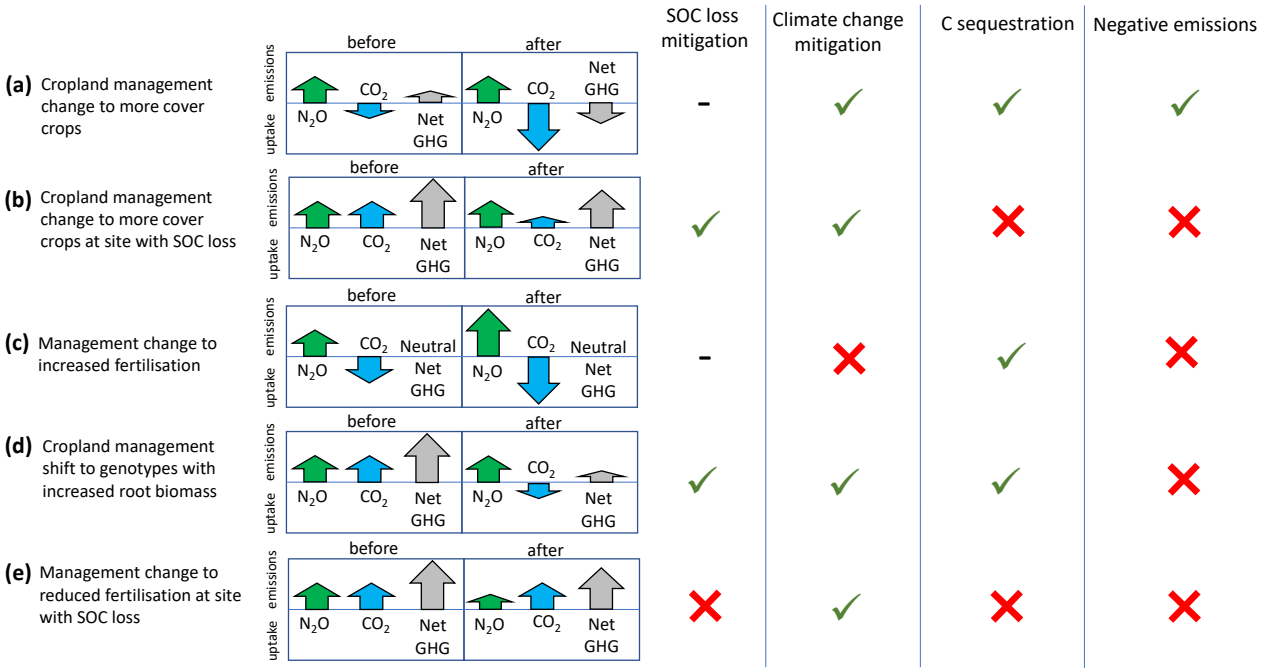
SUPPORTING POLICY

The carbon removal framework of the EU takes some of these aspects into account but is not rigorous enough. "C removal" from the atmosphere is not enough – *net* negative greenhouse gas emissions need to be achieved in order to offset unavoidable greenhouse gas emissions.

METHODOLOGY

Based on definitions established by the IPCC, we established the more rigorous "C sequestration in soils" terminology and analysed the language surrounding this term.

EXAMPLES OF MANAGEMENT CHANGES AND THEIR IMPLICATIONS FOR C SEQUESTRATION IN SOILS AND GHG EMISSIONS



Changes in agricultural management induce changes in soil C. Such changes, in turn, result in shifts to CO_2 and N_2O fluxes. Together, these two fluxes account for the majority of the greenhouse gas balance for an agricultural plot. The examples provided here show that the effects of a measure intended to enhance soil C depend on "before" conditions and may have very different effects on not only soil C, but also climate change mitigation potential, C sequestration, and negative emissions.

REFERENCES

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