Carbon farming – climate protection or greenwashing?

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'Carbon farming' is very much in vogue right now in agricultural policy and practice. The aim is to bind CO_2 from the atmosphere in the soil over the long term through agricultural measures and thus slow down the climate crisis. Whether and to what extent this is possible is the subject of controversial scientific debate. At the same time, the question arises as to whether it makes political sense to rely on carbon farming.

In spring 2021, the European Commission published its Technical Guidance Handbook on carbon farming, titled 'Setting up and implementing result-based carbon farming mechanisms in the EU'.[77] As a contribution against the climate crisis, CO_2 is to be stored in the soil in a natural way, e.g. through the rewetting of moors and the issuing of CO_2 certificates in agriculture, but also in a technical way. The author of the following chapter also attests to the initiative's positive approaches, but at the same time identifies major gaps. For example, the EU's proposals lack statements on reducing animal numbers, promoting pasture farming or reduction targets for the production and application of synthetic nitrogen fertiliser.

The European Commission's Technical Guidance Handbook on Carbon Farming

As part of the European Commission's Farm-to-Fork strategy[78] , a carbon farming technical guidance handbook was announced. This was published in the Spring of 2021 as part of the EU strategy for sustainable carbon cycles.[79] In order to achieve the goal of storing more GHGs than are emitted by 2050, CO_2 is to be stored partly by natural and partly by technical means. Technical solutions include geoengineering techniques that are not yet fully developed, such as carbon capture and storage (CCS). According to Commission plans, five million tonnes of CO_2 are to be removed EU-wide by 2030 through 'direct air capture', in which released carbon dioxide is to be filtered out of the air. The so-called 'nature-based solutions' include, for example, the rewetting of peatlands (organic soils) and CO_2 certificates for the storage of carbon in mineral soils – i.e. in arable farming. However, the very technical focus of carbon farming and the narrow fixation on carbon storage as the solution for climate protection (instead of systemic climate adaptation), together with the low climate relevance of certain practices, turn an initially promising idea into a misdirected endeavour.

The Commission's Technical Guidance Handbook on Carbon Farming from April 2021 is very detailed. Five key thematic areas were selected: peat restoration and rewetting, agroforestry, conservation and enhancement of organic carbon on mineral soils, grassland and carbon audits on farmed animals. The paper is also very specific about the scientifically well-described shortcomings that exist in implementation:

The storage of carbon is very slow, is decreasing over time, can unintendedly increase emissions in other land due to displacement of agricultural production (carbon leakage), is reversible, and difficult to measure.

The Technical Guidance arrives at similarly critical conclusions as a comprehensive study from the BonaRes project funded by the German Federal Ministry of Research.[80] The difference is that the Commission's paper nevertheless concludes positively on feasibility, while the BonaRes study concludes that CO_2 certificates for agriculture may not be such a good idea after all.[81] The Commission's paper also addresses the considerable technical and legal difficulties for a fair and legally robust compensation structure.

The Commission writes: '*There are two main challenges to the large-scale implementation of results-based carbon management schemes in the EU that should be addressed in the scheme planning phase. These are factors that limit farmer participation and factors that limit the ability of a system to effectively and efficiently deliver a climate impact. Effectiveness in this context means the additional, actual and permanent sequestration of carbon or avoidance of emissions, and efficiency means the consideration of social costs and benefits, including environmental and social externalities, at all stages of planning. Climate impact can be hindered by barriers such as loopholes, inconsistent policies, carbon leakage or negative externalities*.'[82]

Positive approaches and large gaps

It is positive that animal husbandry has been considered in the Commission's text, even if only the management of it and not the measures with the greatest climate potential: the reduction of animal numbers. This issue is consistently excluded. Linking the number of animals to the amount of land available for self-feeding and the promotion of grazing would be extremely important levers for climate protection. This is because, on the one hand, feed imports are responsible for land use changes that are harmful to the climate and, on the other hand, because the enormous inputs of nutrients lead to the eutrophication of ecosystems in the farmed-animals-producing countries.

Organic manure in appropriate quantities is a good means of promoting soil fertility and humus build-up. But organic manure has very different qualities. Residues of pharmaceuticals in excreta coming from factory farming decrease the quality of the build-up of humus. These pharmaceutical residues – particularly antibiotics – in animal excreta are usually disposed of as slurry, manure, or dung – and, in contrast to wastewater, without an intermediate treatment stage on agricultural land. Soil is thus the most important absorption medium.[83] The data available on organic pollutants and pharmaceutically active substances that get into the soil is very unsatisfactory for assessing the risks of using organic fertilisers and organic residues for fertilisation purposes. There are only a few systematically collected data, which, however, are not evaluated nationwide or in Europe.[84]

But in terms of both climate and soil effects, a distinction must be made between types of animal husbandry. Regarding management, pasture farming contributes to climate protection because of the humus stored under grassland.

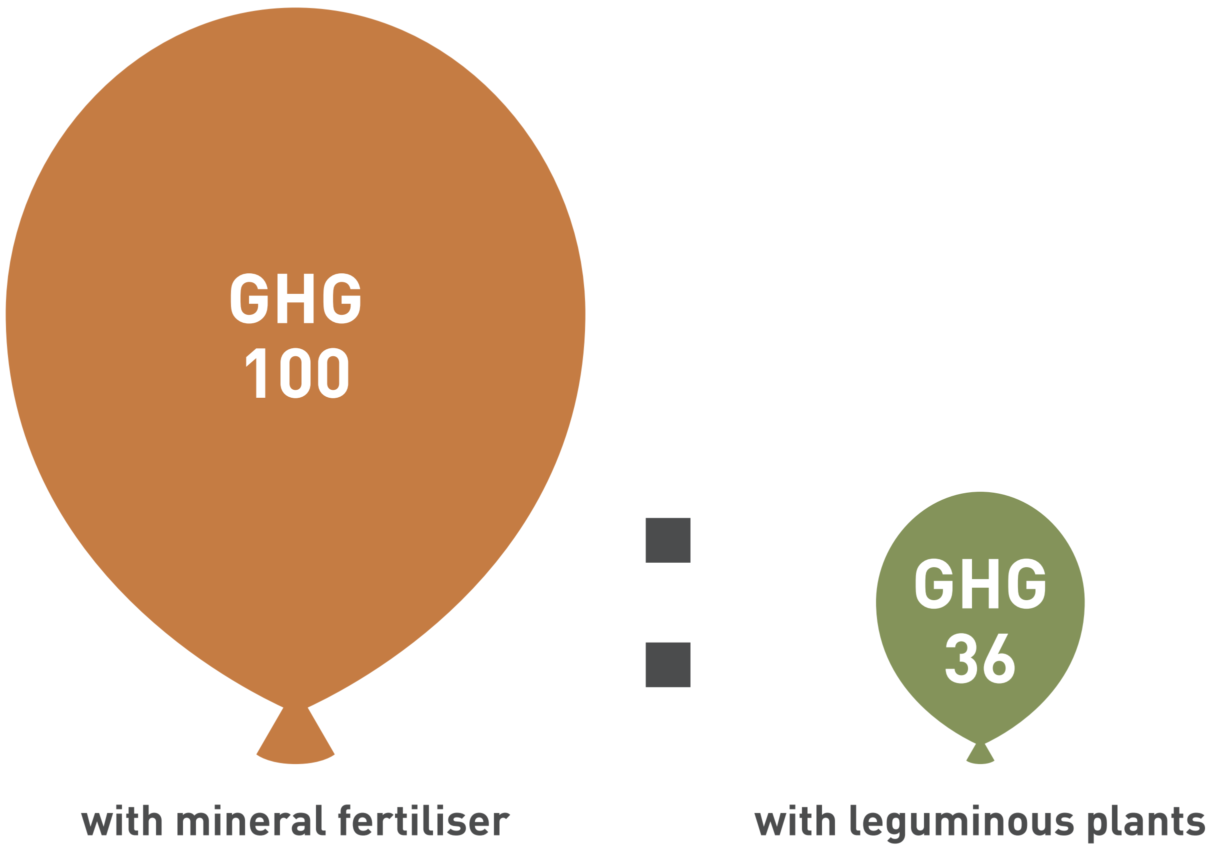
Apart from soils in permafrost areas, peatlands and grasslands contain most of the carbon stored in the soil. Protecting these biomes must therefore be the top priority.

Grassland is the largest biome on our planet next to forest, covering about 40% of the vegetated land area.[85] Ruminants play an important role in protecting grasslands because only grazed grasslands persist, and the more regularly they are grazed, the more humus is built up. Ruminants must be evaluated differently than just according to their methane emissions, because on pasture they are active climate protectors.[86]

What is also completely missing from the Technical Guidance is a reduction scenario for the most climate-damaging practice of agriculture, which is the production and application of synthetic nitrogen fertiliser. Global man-made emissions from agriculture, which are mainly caused by nitrogen inputs to arable land, have increased by 30% over the last four decades.[87]

If the use of mineral fertilisers were to be reduced in favour of nitrogen supply from the air by means of nitrogen-fixing legumes, more than half of the agricultural GHGs would already be saved (Fig. 1) and humus would be built up at the same time.[86,88] In addition, mineral fertilisers impair soil life, leading to soil compaction, erosion, fertility losses and emissions of nitrous oxide.[89]

On the positive side, it can be said that agroforestry systems have a prominent place and that synergy effects such as the promotion of biodiversity, water storage capacity and erosion control are taken into account in the Commission text.



The greenhouse gas potential of nitrogen fertilisation through legiminous plants compared to mineral fertiliser-based fertilisation is proportional to a ratio of 36 to 100.

Source: calculation by the author according to Robertson et al. 2000 in Köpke/Nemecek 2010

Fig. 1: Greenhouse gas potentials of different fertilisation methods[86]

Carbon farming – overestimated?

Sebastian Lakner, Professor of Agricultural Economics at the University of Rostock, Germany, also comments critically on the text: '*Carbon farming as a term promises more than it delivers. There are many political possibilities to improve the climate balance of agriculture and the land use sector. I do not understand why this solution, which is particularly uncertain, complicated and questionable in terms of subsidy policy, is now being resorted to. Agricultural enterprises are obliged by the [German] Soil Protection Act to preserve humus and should have their own economic interest in increasing the humus content of their soils.*'

According to Professor Lakner, if a new subsidy were to be introduced exclusively for carbon farming, *'a goal would be promoted that is actually prescribed by law and that farms, if they manage sensibly, want to achieve themselves anyway'.* A broad-based subsidy would therefore be neither particularly effective nor efficient.[90,91]

Another related unresolved issue in carbon farming and CO_2 credits is how farms that already have a higher humus content than others at the start of the allowance scheme will be assessed. The rate of humus build-up decreases and slows down over time. Committed farms, such as organic farms that have been building up humus for years, would therefore be at a disadvantage, and farms that have not bothered with the humus balance so far would be at a clear advantage.

Humus build-up in practical agriculture always 'just' means raising the build-up and breakdown of nutrient humus to a higher dynamic equilibrium. The higher the surplus of carbon, nitrogen and other elements necessary for the formation of nutrient humus, the higher the new dynamic equilibrium. With the cultivation systems and crop rotations currently practised in agriculture, humus build-up is hardly possible; on the contrary, they lead to humus depletion. If humus is to be built up consistently, crop rotations would have to be extended, catch crops used, hedges and trees planted, and high-quality organic fertilisers used consistently. This would be an enormous effort compared to the current system. On the other hand, a short drought could undo all these efforts through humus depletion.[92]

> **Carbon storage in arable soil has very little potential for efficient climate protection.**[93]

Humus build-up, on the other hand, is of crucial importance for soil fertility, erosion control, groundwater formation and flood protection, and makes agriculture more climate resilient.

This means that it helps agriculture to better adapt to the extreme weather conditions, such as heavy rainfall and periods of drought.[89] However, humus growth as such is not suitable for a carbon farming model with CO_2 certificates.[94] What could be remunerated instead would be best-practice humus-building measures to make soils more climate-resilient. This focus on climate adaptation is urgently needed in arable farming. For climate protection, on the other hand, moorland and grassland protection as well as the renunciation of mineral fertilisers and the reduction of animal numbers are more decisive.

However, as research by Zeit, The Guardian and the investigative platform Source Material shows, the model of compensation certificates is based on a large number of certificates that have no real value or have been significantly overvalued. The reason is that certificates have become a lucrative commodity and, due to the overvaluation, do not compensate for the amount of CO_2 they should.[95]

Numerous German and European non-governmental organisations, such as WWF and ECVC[96,97], have also been critical of the issue of CO_2 certificates because they describe the concept of sustainable humus growth as too narrow.

Permanence of carbon storage – counterproductive for soil life

Due to the above-mentioned problems of accumulating carbon in the soil and keeping it there, the current scientific and political discussions are now focusing more and more on the 'permanence' of carbon storage. Proving this permanence would be the basis for serious certificates. However, this permanence in the storage is not given in the case of natural carbon-supplying substrates (e.g. composts, roots) and contradicts the promotion of active soil life. Soil biota urgently needs *degradable carbon substrates to maintain soil functions. Active soil life means humus build-up but also conversion and decomposition. Good soil properties and healthy plant nutrition as well as biopores for water storage and purification can only be produced with high biological activity.* CO_2 is always released in the process (often referred to as '*soil continuum model -SCM'*[98]). The more stable the carbon in the soil, the less of it is available to soil life.

The fixation on the permanence of carbon storage is therefore not always a possibility in nature and not desirable for the optimal promotion of soil functions from a soil ecology perspective. In this respect, this goal also contradicts the Biodiversity Strategy and the Soil Strategy of the EU Commission, in which the soil microbiome is to be protected and its contribution to the ecosystem services of water storage, water purification and building soil fertility is to be given greater consideration.

Biochar is not an effective substitute

Increasing the carbon content in the soil is not fundamentally synonymous with a sustainable agricultural model and building high-quality humus. If stability is the focus, measures can also be introduced that may have a detrimental effect on soils or are simply nonsensical, such as the use of biochar. It is supposed to be particularly stable, but this has not yet been confirmed in field trials.[99] Several studies also conclude that there is insufficient evidence to support the potential to mitigate climate change.[100,101] This is because, in order to have an impact on the climate, huge amounts of plant carbon would have to be used. For example: to achieve about one percent of Germany's 2030 greenhouse gas reduction target, all of Germany's available biomass would have to be processed into vegetable carbon.[102] An unrealistic scenario. The techniques of balanced crop rotation with diverse deep rooting,[103,104] permaculture, agroforestry, the recycling of organic matter in the form of solid manure, harvest residues as well as quality compost,[105,106] which have been known for hundreds of years and are optimised in organic farming, are clearly preferable in their manifold positive effects. For soil improvement and increasing humus content and fertility, quality compost is particularly well suited and much more effective than plant charcoal. According to current knowledge, roots are the most efficient in building up humus.[104]

Furthermore, there is a permanent pollutant potential in pyrolised vegetable charcoal. During the process of pyrolysis, a large number of aromatic organic substances are formed, largely independent of the starting materials. These include a number of pollutants that are difficult to break down, especially polycyclic aromatic hydrocarbons (PAHs), which are carcinogenic and mutagenic.[107,108,109] These pollutants cannot be completely eliminated because they are too strongly bound to the material. For the same reason, measurement methods do not adequately detect them, which is why compliance with specified limit values has little significance for the actual pollutant load.[110] This implies a potential risk to soils when plant charcoal is applied.[99]

A systemic transition towards sustainability

The health of soils in many parts of the world is at risk, including in Europe, as they have been depleted by decades of intensive agriculture and soil degradation, and are further threatened by climate change. Healthy soils can increase resilience to climate shocks and enhance biodiversity both above and below ground, making them a crucial element in safeguarding our ecosystems and climate change adaptation and mitigation policies and practices, conserving biodiversity, securing our water resources and sustainable development. It is far too short-sighted to turn soils into carbon reservoirs with a questionable 'climate protection argument' and to send armies of certifiers with inaccurate measuring instruments to the fields that may be able to measure carbon, but not humus.

> **The focus must become much broader, namely on systems: agroecological systems, such as organic farming, agroforestry and permaculture, bring systemic solutions that include a variety of positive effects. They are the ones that need to be promoted sufficiently and permanently!**

Carbon farming only makes sense if the goal is a natural humus build-up to promote soil functions and soil biology, the primary aim of which is climate adaptation. Moorland and grassland protection as well as the renunciation of mineral fertilisers and the reduction of animal numbers are of crucial importance for climate protection, much more than carbon sequestration in arable soils. The permanence of carbon storage is difficult even with good management. It must not lead to an impairment or deterioration of the living conditions of the soil microbiome. Potential pollutant inputs from the introduction of carbon enrichment substrates (e.g. pyrolysis charcoal) must be excluded in any case. Charring organic material first instead of incorporating it through land composting does not seem to be effective. Honest 'climate protection certificates' must include the entire farm management. The diverse effects of organic farming as well as agroforestry systems, permaculture and grazing systems for climate protection *and* climate adaptation must be better rewarded.

Building on these relationships between soil carbon and soil health, the next chapter will look at the role of sustainable animal farming, through the 'symbiosis' between grazing and grassland.