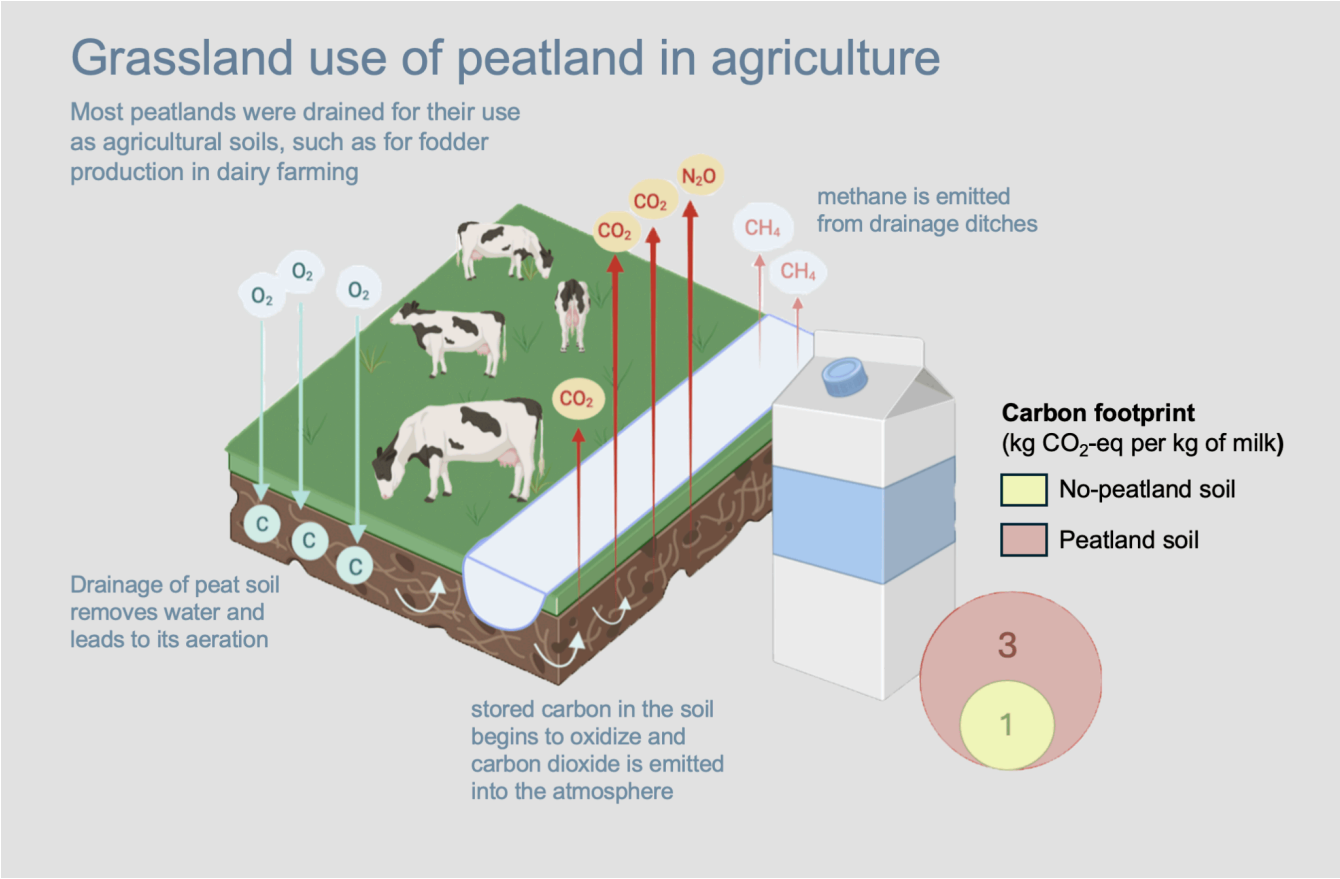
Drained peatlands are a blind spot when calculating emissions from milk production.

Life Cycle Assessment (LCA), assessing the "cradle-to-gate" emissions from milk production, guides both policy and farm-level decisions. When peatlands are turned into pastures, the emissions are commonly not included in the carbon footprint from milk produced on such areas.

Peat soils account for one third of the world's soil carbon, which is approximately twice as much carbon as the biomass of all forests. Most peatlands have undergone extensive drainage for agricultural purposes, turning them from highly important carbon sinks to one of the largest human-induced sources of GHG emissions worldwide.



Emission sources in drained peatlands of agriculture and dairy farming and their potential impact on milks CF. Drainage of peat soil removes water, thus leads to its aeration, so that aerobic decomposition takes place that is accompanied by the emission of GHGs. Along with the drainage, nutrient loss with the received water is observed together with a loss of biodiversity and reduced water retention capacity among many other factors. Finally, the physical collapse of peat soil leads to its shrinkage, resulting in losses of its thickness up to several centimeters per year, whereas methane is emitted from drainage ditches. Finally, the production of milk on drained peat soil is estimated to result in multiple times higher CF compared to milk production on no-peat soil3,49. Illustration by Anna-Lena Müller, using Microsoft PowerPoint.

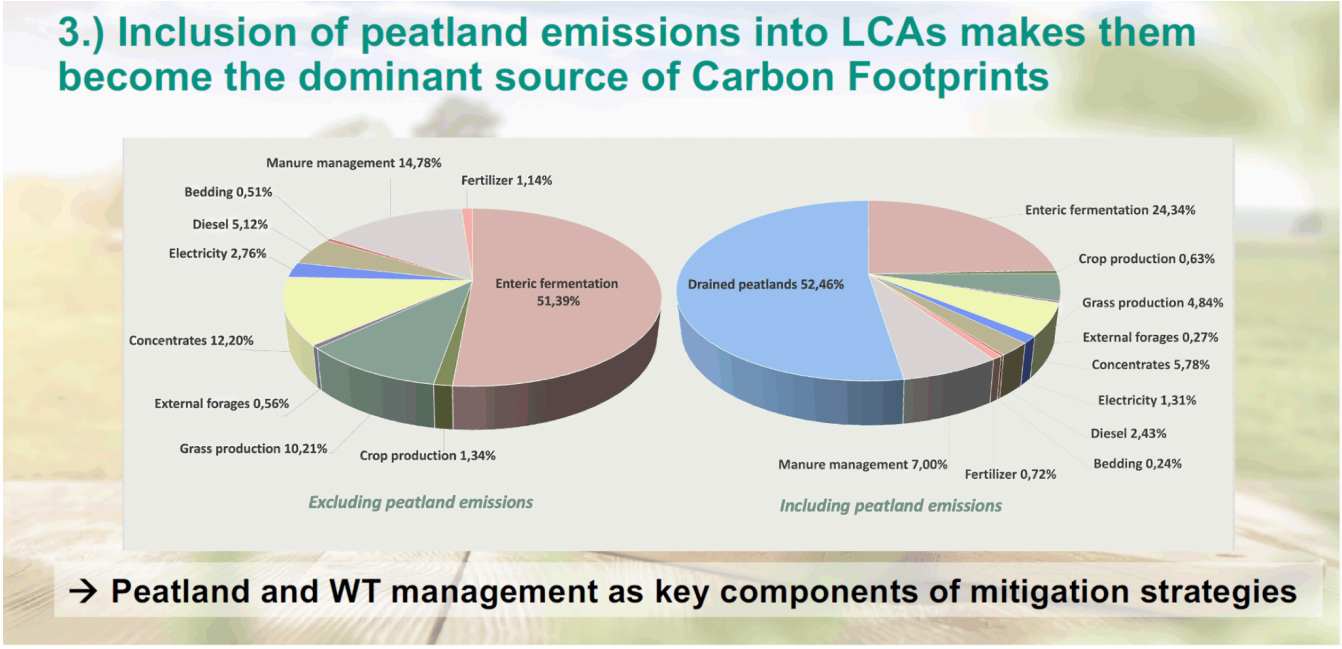
Significant gap in current LCA studies

Recent research led by Anna-Lena Müller at the Karlsruhe Institute of Technology (KIT) reveals that this shortcoming significantly underestimates the climate impact from milk production.

“If these emissions are included in LCA-studies, peatlands always become the dominant emission source from dairy farming,” Müller explains. “It shifts the whole picture. If we’re discussing carbon footprints without considering the impact of drained peatlands, we’ll obtain a distorted picture.”

Müller and her colleagues recently published a literature review of existing LCA studies, with a specific focus on European milk production. It reveals a significant gap in specific LCA studies addressing the role of drained peatlands in milk production. Another study, which is currently under review aims to contribute closing this gap by analysing three structurally distinct dairy farms in the pre-alpine region of Bavaria by considering peatland-derived emissions, using a cradle-to-farm-gate LCA approach.

The research is a part of the research project CircAgric-GHG, that aims to enhance circularity and reduce GHG emissions from farms.



Traditionally, enteric fermentation has been considered the largest source of GHGs in dairy farming. However, when peatland emissions are included, they surpass all other sources. In a case study of three German farms, drained peatlands accounted for over 50% of total emissions, compared to 25% from enteric fermentation. Illustration: Anna-Lena Müller

Higher Carbon Footprint with more specific data

Three different methodologies were applied to estimate peatland emissions from the case study farms:

1. **IPCC Tier 1 default emission factors** – general but widely applicable
2. **IPCC Tier 2 Implied emission factors for organic soil in Germany** – tailored to German conditions, and accounting for variability in emissions based on land use, soil type and water table depth (WTD).
3. **Farm-specific water table depth (WTD) modeling** – using site-specific water table data to obtain farm-specific emission factors.

The emissions on farm level significantly increased the CF from all dairy farms in the study. The highest increase was seen when using the WTD-based approach (3.), that estimates the average water table depths of the

peatland area on each farm.

“Even a few centimeters in water table depth can have a huge impact on CO_2 emissions,” Müller notes. “Methodology matters. The more specific the data, the better.”

The results were striking. Including peatland emissions **at least doubled** the carbon footprint of milk production on average. In upscaled scenarios, with larger areas of the farmland defined as peatland, the footprint did even increase **up to 6.5 times** in one case. This was done to illustrate the potential CF of farms with up to 100 % of their agricultural land relying on drained peat soils.

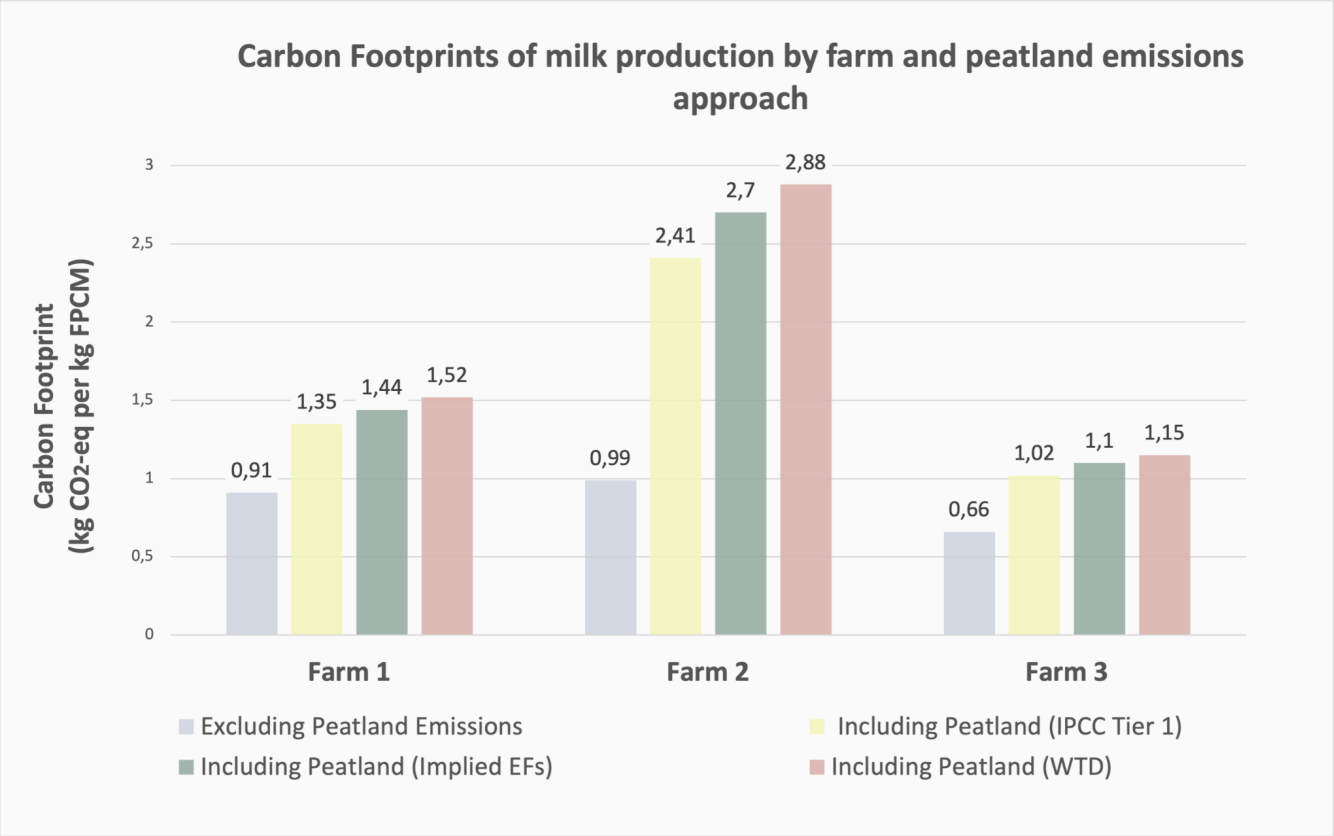
Data Access and Policy Challenges

A major barrier to accurate LCA modelling is the lack of accessible data—especially water table depth at farm level.

“We had to rely on modelled maps and farmer knowledge,” Müller explains. “But access to this data is restricted, even within research institutions.”

Moreover, political sensitivities around peatland use complicate collaboration.

“Some farmers are afraid that sharing data could lead to regulatory consequences,” she adds.



Carbon footprints of milk production (kg CO2-eq per kg FPCM) for the three dairy farms, shown for scenarios excluding and including peatland emissions using different methodological approaches. Illustration: Anna-Lena Müller.

Different reporting systems for peatlands and agriculture

To address these challenges, Müller and her colleagues advocates for a standardized methodology to include peatland emissions in all agricultural LCAs.

The literature review highlights a significant challenge with regards to international climate reporting to the United Nations. Soil and peatland emissions fall under the LULUCF (Land Use, Land-Use Change, and Forestry) sector, which is separated from agricultural reporting.

The authors encourage a critical reassessment of current reporting standards.

“At the very least, peatlands utilized for dairy production must be included in international and national agricultural LCA analysis, only then can we have a transparent basis for decision-making,” says Müller

Anna-Lena Müller, PhD student at the Karlsruhe Institute of Technology (KIT).

Mitigation at Farm Level: Beyond Rewetting

So, what should be done on the ground? Müller highlights some innovative practices already being tested by farmers. These methods either decrease carbon emissions from peatlands, and/or lower the emissions from other sources or the farm:

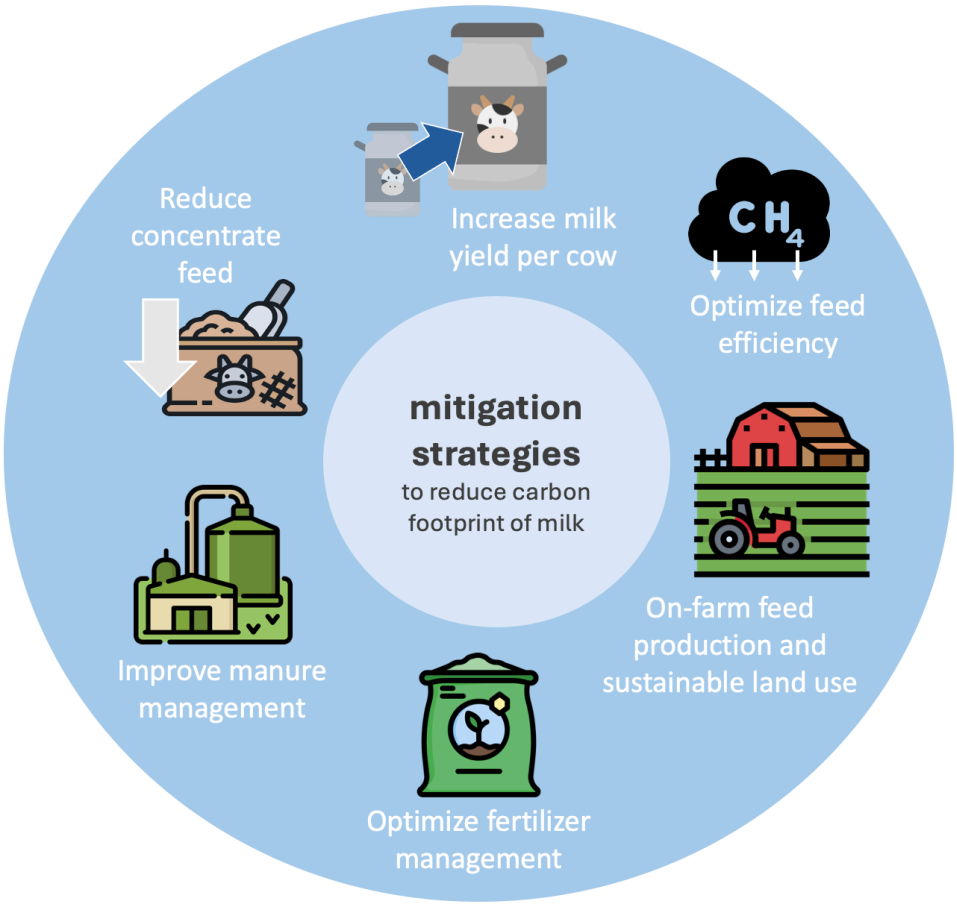
- Rewetting of peatlands, combined with strategic cultivation of clover-grass on the farm’s remaining mineral soils – this approach can

contribute to intensifying feed production to help compensate for a portion of feed loss from the rewetted areas. The strategy also supports local feed sourcing and reduces the need for synthetic fertilizers, as clover naturally fixes nitrogen.

- Paludicultures – growing biomass on rewetted peatlands for construction materials like insulation boards, building panels and roofing or for energy. This allows continued land use with plants that can maintain the water level in the peatland.
- Anaerobic digestion, to reduce methane from manure, combined with biogas residues used as fertilizer.

One farmer in the study, despite operating the most intensive farm, achieved the lowest carbon footprint through a combination of these measures.

"It shows there are other measures that can be combined with rewetting," Müller emphasizes. She calls for supportive policies that ensure farmer profitability while promoting climate-smart land use.



Common mitigation strategies to lower the CF of milk production. The increase of milk yield, optimizing diets and feed efficiency, improve manure and land management are commonly discussed as levers in mitigating the CF of milk production based on LCA approaches. Illustration by Anna-Lena Müller, created using Microsoft PowerPoint.

Müller, AL., Kiese, R. & Scheer C., 2025. Carbon footprints of European dairy darming: the role of drained peatlands in GHG assessments. npj Sustain. Agric. 3, 44. (https://www.nature.com/articles/s44264-025-00085-x)

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