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Mitigating greenhouse gas emissions from cultivated peat soils while maintaining agricultural productivity

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Abstract
Historically, to boost food prodution and counteract famine, extensive drainage of peatlands was implemented in Sweden, significantly altering the landscape from 700,000 hectares in 1940 to about 250,000 hectares today. Peat soils, characterised by their high organic content and water retention capacity, play a crucial role in agriculture, particularly in regions like the Island Gotland, providing a resilient environment for crops such as potatoes and carrots. The primary challenge with cultivated peat soils is their significant contribution to atmospheric CO_2 and N_2O levels due to drainage and agricultural practices. The annual subsidence of these soils necessitates regular re-drainage, further complicating sustainable management. This study evaluates various soil management strategies for reducing greenhouse gas emissions without compromising crop productivity. Methods such as adjusting water tables, modifying tillage practices, and utilising soil amendments like sand addition are analysed for their effectiveness in emission reduction. Long-term field trials on fen peat in Gotland since 1976 and more recent experiments in Broddbo provide empirical data on CO_2 and N_2O emissions under different management practices. These include variations in tillage intensity, crop rotation, and the strategic application of soil amendments and fertilisers. Initial results indicate that emission reductions are feasible with specific management strategies, such as incorporating foundry sand to dilute soil carbon content, showing a 20% decrease in CO_2 emissions. However, adjustments like liming and nitrification inhibitors have had inconsistent effects across different trial sites, suggesting that site-specific conditions heavily influence outcomes. While it is challenging to universally apply certain practices due to the unique properties of each peat soil type, strategies that improve carbon capture efficiency and reduce erosion potential—like maintaining a vegetated surface—demonstrate significant potential. This study underscores the complexity of peat soil management and the necessity for tailored approaches to mitigate greenhouse gas emissions effectively while ensuring agricultural productivity.

Keywords: cultivated organic soil, peat, GHG emission, CO_2, N_2O

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