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ARE GREENHOUSE GAS FLUXES LOWER FROM LEY OR PERENNIAL FALLOW THAN FROM ARABLE ORGANIC SOILS?

BACKGROUND

Cultivated peatlands significantly contribute to agricultural greenhouse gas (GHG) emissions, especially in northern Europe. International efforts, including the Paris Agreement, aim to reduce these emissions and strengthen carbon sinks. While various mitigation strategies exist, such as rewetting and changing crop types, their effectiveness remains unclear. IPCC emission factors suggest lower CO_2 emissions from grasslands compared to croplands on organic soils, but existing data may not accurately represent the effects of switching from annual to perennial crops due to varying site characteristics in many studies.

This study presents findings from a systematic review comparing GHG emissions from organic soils under annual and perennial cropping systems. It focuses on experimental designs that allow direct comparisons.

OBJECTIVE

The objective of this review is to assess whether converting peat soils from arable production to grassland reduces GHG emissions. The study focused on finding comparable cropland and grassland sites. Though Nordic-focused, data from various regions were considered for relevance to boreo-temperate climates. The review question is: "What is the effect of permanent grasslands on the flux of greenhouse gases from agricultural organic soils?“

PICO Elements:

Population: Organic soils in temperate and boreal climates, often drained peatlands.

Intervention: Permanent or cultivated grassland, or land set aside without raising the groundwater level. Rewetted grasslands and woody energy crops are excluded.

Comparator: Various crop rotations with annual crops, considering different management practices.

Outcome: Flux of CO_2, N_2O, or CH_4.

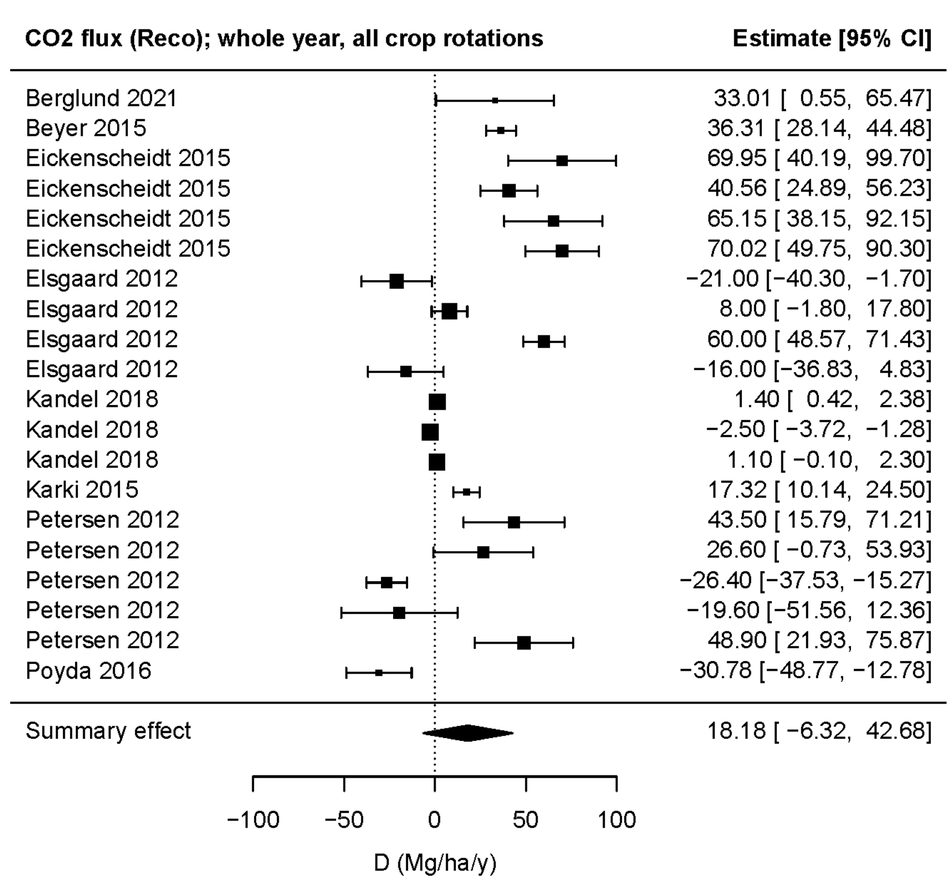
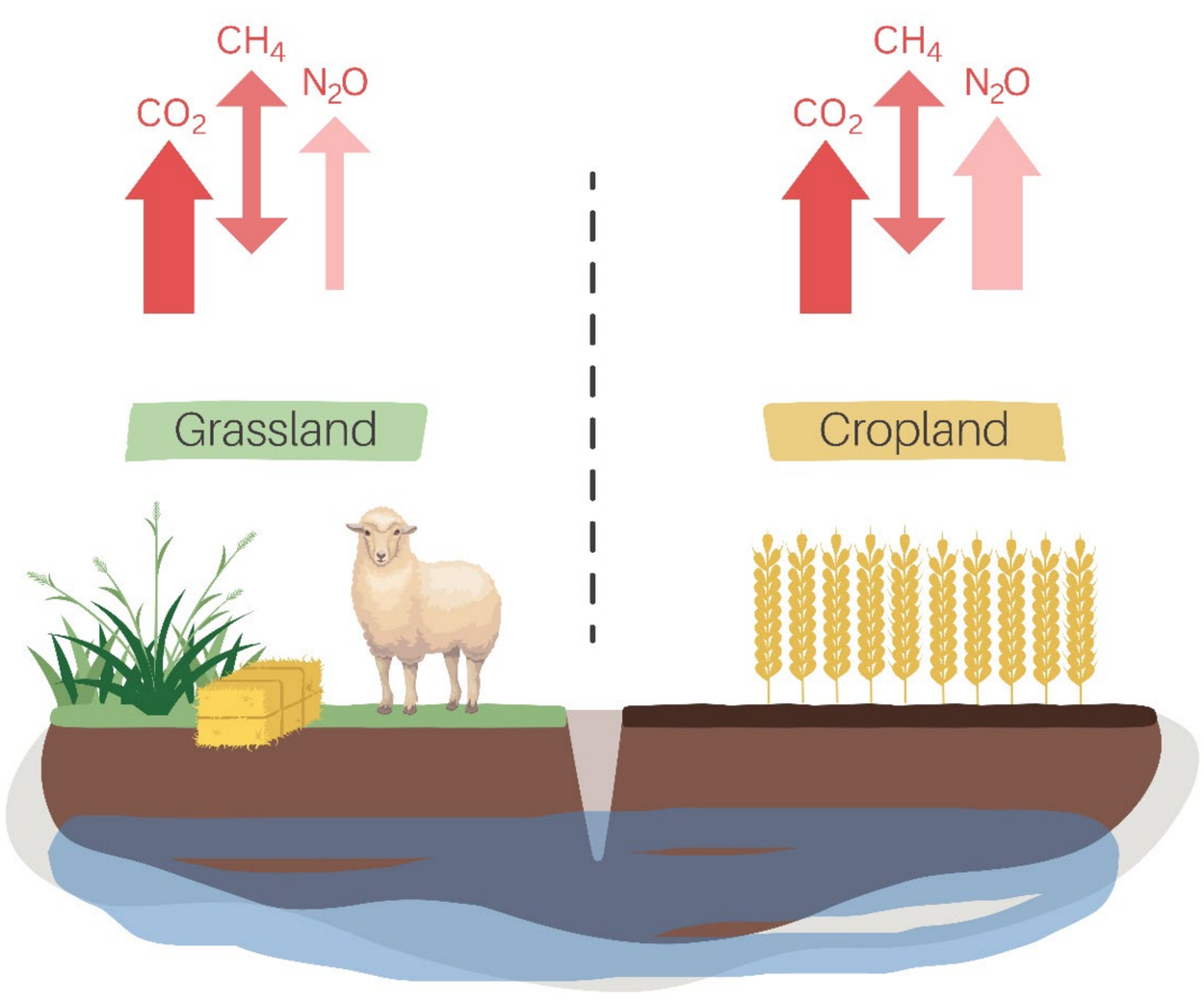


Figure 1. Forest plot of mean differences in CO_2 flux (Ecosystem respiration, R_{eco}). Square size indicates study weight based on inverse variance. Repeated references are due to some studies having multiple sites or multiple comparators and/or interventions. Raw mean difference (D) is grassland flux minus comparator flux.



METHOD

The literature search used five bibliographic databases, four grey literature sources, and Google Scholar. A total of 10,352 unique articles were retrieved through our literature searches, and 18 articles, comprising 35 comparison studies, were considered relevant to answer the review question. A two-step screening was carried out: 1) title/abstract screening (896 double-screened) and 2) full text screening with two reviewers. Critical appraisal was done by ≥2 reviewers. Meta-analyses compared grasslands to croplands using raw mean difference.

CONCLUSION

Our study found no significant difference in CH_4 or CO_2 emissions between croplands and grasslands on organic soils, suggesting land-use change alone may not reduce emissions (Figure 1). Grasslands showed lower N_2O release, but this difference depended heavily on two studies. Water table depth emerged as a key driver of CO_2 emissions, more so than crop type. Soil organic carbon content and density were weak predictors of emissions, while factors like phenolic compounds and microbial activity might be relevant indicators. We recommend considering multiple variables beyond crop type to improve GHG emission estimates in cultivated peatlands. Future research should develop methods incorporating water table depth, peat properties, soil organic carbon quality, and microbial community structure. This approach could lead to more accurate assessments and better management of GHG emissions in these ecosystems.

Authors: Alena Holzknecht[1], Magnus Land[2], Jacynthe Dessureault-Rompré[3], Lars Elsgaard[4] Kristiina Lång[5] & Örjan Berglund[1*]

1. Department of Soil and Environment, Swedish University of Agricultural, Sciences, Box 7014, 750 07 Uppsala, Sweden
2. Formas, Box 1206, 111 82 Stockholm, Sweden
3. Soil and Agri-Food Engineering Department, Laval University, 2325 Rue de L’Université, Québec City, Université Laval, Canada
4. Department of Agroecology, Aarhus University, Blichers Allé 20, 8830 Tjele, Denmark
5. Natural Resources Institute Finland (Luke), Latokartanonkaari 9, 00790 Helsinki, Finland

Örjan Berglund
*Presenting Author

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