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Mitigating greenhouse gas emissions from managed organic soils in the temperate zone by paddy rice cultivation

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Large areas of European peatlands have been drained for agriculture, but drained organic soils are a strong source of carbon dioxide (CO_2). Reinstalling high water tables would inhibit further peat oxidation and reduce CO_2 and nitrous oxide (N_2O) emissions, but most cash crops do not grow in waterlogged conditions. Paddy rice cultivation could offer a new option for continuing the agricultural use of these soils under wet conditions. However, paddy rice cultivation is known to be a strong source of methane (CH_4), which might cancel out the potential climate benefit from reduced CO_2 and N_2O emissions. The main aim of this study was, therefore, to quantify for the first time the greenhouse gas (GHG) balance of paddy rice grown on organic soil in the temperate climate zone of the Swiss Plateau.

In an outdoor mesocosm experiment, we measured the greenhouse gases CO_2, CH_4, and N_2O with manual chambers on a weekly to biweekly interval for one year. During the experiment, rice (*Oryza sativa L.*) was cultivated under flooded conditions with mid-season drainage on organic soil. As a reference treatment, ley was grown on drained organic soil (water table -100 cm).

Preliminary results from the growing season (April - October) including planting and harvest suggest that the overall GHG balance of paddy rice cultivation on organic soil (9.3 ± 1.9 t CO_2 eq. ha^{-1} including harvest exports) was significantly lower than of ley grown on drained organic soil (27.9 ± 5.0 t CO_2 eq. ha^{-1} including harvest exports). This difference was mainly attributed to the strong reduction in ecosystem respiration under flooded conditions compared to ley on drained organic soil. Paddy rice cultivation was a source of methane (49.2 ± 19.7 kg CH_4 ha^{-1}), while the drained organic soil covered with ley was a CH_4 sink (-0.6 ± 0.1 kg CH_4 ha^{-1}). The flooded conditions in the paddy rice mesocosms significantly lowered N_2O emissions (0.7 ± 0.3 kg N_2O ha^{-1}) compared to drained grassland (4.7 ± 3.1 kg N_2O ha^{-1}). N_2O and CH_4 accounted for 16.0 ± 6.8 % of the total GHG balance in the rice on organic soil treatment, whereas it was only 4.9 ± 2.6 % in the ley on drained organic soil.

Together, we show that paddy rice cultivation on organic soil is a valid alternative to upland

agriculture in the temperate zone and offers significant GHG emission reduction potentials.