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Greenhouse gas budget of an extensively managed grassland on drained peat soil in the Irish Midlands

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Grassland-based agriculture in Ireland contributes over one third of national greenhouse gas (GHG) emissions, and the LULUCF sector is a net GHG source primarily due to the ongoing drainage of peat soils. Rewetting of peat-based organic soils is now recognised as an attractive climate mitigation strategy, but reducing emissions and restoring the carbon sequestration potential is challenging, and is not always feasible notably due to agricultural demands. Nonetheless, reducing carbon losses from drained organic soils has been identified as a key action for Ireland to reach its climate targets, and carbon storage associated with improved grassland management practices can provide a suitable strategy to offset GHG emissions without compromising productivity. However, research is still needed to assess the best practices and management options for optimum environmental and production outcomes. While grasslands have been widely studied internationally, data on organic soils under this land use are still scarce. In Ireland, despite their spatial extent and relevance to the national emission inventories and mitigation strategies, only two studies on GHG emissions from grasslands on peat soils have been published.

Here we present results from a grassland on a drained organic soil that is extensively managed for silage production in the Irish midlands. Continuous monitoring of Net Ecosystem Exchange (NEE) of carbon dioxide (CO_2) using eddy covariance techniques, and weekly static chamber measurements to assess soil derived emissions of methane (CH_4) and nitrous oxide (N_2O) started in 2020. The seasonal CO_2 fluxes observed were greatly dependent on weather conditions and management events. The grassland shifted from a carbon source at the beginning of the year to a sink during the growing season, with carbon uptakes in April and May ranging from 15 to 40 µmol CO_2 m^{-2} s^{-1} and releases in the order of 5 µmol CO_2 m^{-2} s^{-1}. Following the first harvest event in early June, approximately 2.5 t C ha^{-1} was exported, and the sink capacity took around one month to recover, with an average NEE of 10 µmol CO_2 m^{-2} s^{-1} during that period. Carbon uptake then reached a maximum of 25 µmol CO_2 m^{-2} s^{-1} in August. After the second cut in mid-September, which corresponded to an export of 2.25 t.ha^{-1} of carbon, the grassland acted once again as a strong carbon source, losing almost 30 g C m^{-2} in a month, before stabilising and behaving as an overall small source during the winter period.

In summary, this grassland demonstrated high rates of carbon assimilation and productivity that translate in a strong carbon sink capacity highly dependent on the management. The biomass harvest is a major component of the annual budget that has the potential to shift the system to a net carbon source. Moreover, while initial measurements of CH_4 and N_2O fluxes appeared to be negligible, some management events were not assessed due to national COVID 19 restrictions on movement, which might have impacted the sink strength of the site studied.