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Management matters: Testing a mitigation strategy of nitrous oxide emissions on managed grassland

Kathrin Fuchs (1), Lukas Hörtnagl (1), Werner Eugster (1), Patrick Koller (1), Florian Käslin (1), Lutz Merbold (1,2)

(1) Department of Environmental Systems Science, Grassland Sciences Group, ETH Zurich, Universitätsstrasse 2, 8092 Zurich, Switzerland (kathrin.fuchs@usys.ethz.ch), (2) Mazingira Centre, International Livestock Research Institute (ILRI), P.O. Box 30709, 00100 Nairobi, Kenya

The magnitude of greenhouse gas (GHG) exchange between managed grasslands and the atmosphere depends besides climate predominantly on management practices. While natural or extensively managed grasslands are known to function as GHG sinks, intensively managed grasslands are characterized by substantial nitrous oxide (N_2O) emissions diminishing their sink function.

One potential N_2O mitigation strategy is to reduce the required amount of nitrogen (N) fertilizer input by using biological nitrogen fixation (BNF) via legumes. However, the effect of legumes on nitrous oxide emissions is still not fully understood. In this study we quantify net GHG fluxes from two differently managed grassland parcels (mitigation, control) and relate our results to productivity (yields). In addition, we aim at revealing the influence of various driver variables on N_2O exchange.

Our experimental setup consisted of an eddy covariance tower that measured the net exchange of the three major anthropogenic GHGs, nitrous oxide (N_2O), methane (CH_4) and carbon dioxide (CO_2). Both grassland parcels can be covered with this tower due to two prevailing wind directions. GHG flux measurements were accompanied by measurements of commonly known driver variables such as water filled pore space, soil temperature, soil oxygen concentrations and mineral N to disentangle the soil meteorological influence of N_2O fluxes from human drivers.

Following organic fertilizer application, we measured elevated N_2O emissions (>1 nmol m^{-2} s^{-1}) at the control parcel and unchanged N_2O emissions at the treatment parcel. Net annual fluxes were 54% and 50% lower at the experimental parcel in 2015 and 2016, respectively. Annual yields did not significantly differ between parcels, but were slightly lower at the experimental parcel compared to the control parcel.

Significantly lower nitrous oxide fluxes under experimental management indicate that nitrous oxide emissions can be effectively reduced at very low costs with a clover-based management. Long-term effects on the N budget, implications for the quality of animal feed as well as potential consequences at the farming system level (i.e. manure management) need further evaluation.