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Assessing the mitigation potential of agricultural systems by optimization of the agricultural management: A modeling study on 8 agricultural observation sites across Europe with the process based model LandscapeDNDC

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The use of mineral nitrogen (N) fertilizers increase crop yields but cause the biggest anthropogenic source of nitrous oxide (N2O) emissions and strongly contribute to surface water eutrophication (e.g. nitrate leaching). The necessity to identify affordable strategies that improve crop production while improving ecosystem services are in continuous debate between policy decision makers and farmers. In this line, a lack commitment from farmers to enforce laws might result in the reduction of benefits. For this reason, farmers should aim to increase crop production and to reduce environmental harm by the adoption of precision climate smart agriculture tools applied to management practices for instance.

In this study we present optimized strategies for 8 sites (agricultural and grassland ecosystems) with long term field observation across Europe to show the mitigation potential to reduce reactive nitrogen losses under the constrain of keeping yields at observed levels. LandscapeDNDC simulations of crop yields and associated nitrogen losses (N2O emissions and NO_3 leaching) were evaluated against long term field measurements. The sites presented different management regimes including the main commodity crops (maize, wheat, barley, rape seeds, etc) and fertilization amendments (synthetic and organic fertilizers) in Europe.

The simulations reproduced the observed yields, captured N2O emissions and NO_3 leaching losses with high statistical presicion (r2), acurrency (ME) and agreement (RMSPEn).
The mitigation potentials to reduce N losses while keeping yields at observed levels for all 8 sites were assesed by Monte Carlo optimizations of the individual underlying multi year agricultural management options (timings of planting and harvest, fertilization & manure applications and rates, residues management). In this study we present for all 8 agricultural observations sites their individual mitigation potentials to reduce N losses for multi year rotations. The conclusions for each side could result in management strategies to minimize environmental impact when such a model is used to predict best management practice on the site scale.