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Which cropland greenhouse gas mitigation options give the greatest benefits in different world regions? Climate and soil specific predictions from integrated empirical models

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Major sources of greenhouse gas (GHG) emissions from agricultural crop production are nitrous oxide (N2O) emissions resulting from the application of mineral and organic fertiliser, and carbon dioxide (CO_2) emissions from soil carbon losses. Consequently, choice of fertiliser type, optimising fertiliser application rates and timing, reducing microbial denitrification and improving soil carbon management are focus areas for mitigation. We have integrated separate models derived from global data on fertiliser induced soil N2O emissions, soil nitrification inhibitors, and the effects of tillage and soil inputs of soil C stocks into a single model in order to determine optimal mitigation options as a function of soil type, climate, and fertilisation rates. After Monte Carlo sampling of input variables we aggregated the outputs according to climate, soil and fertiliser factors to consider the benefits of several possible emissions mitigation strategies, and identified the most beneficial option for each factor class on a per hectare basis. The optimal mitigation for each soil-climate-region was then mapped to propose geographically specific optimal GHG mitigation strategies for crops with varying N requirements.
The use of empirical models reduces the requirements for validation (since they are calibrated on globally or continentally observed phenomena). However, since they are relatively simple in structure, they may not be applicable for accurate site specific prediction of GHG emissions. The value of this modelling approach is for initial screening and ranking of potential agricultural mitigation options and to explore the potential impact of regional agricultural GHG abatement policies. Given the clear association between management practice and crop productivity, it is essential to incorporate characterisation of the yield effect on a given crop before recommending any mitigation practice.