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Soil pH management without lime, a strategy to reduce greenhouse gas emissions from cultivated soils

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For decades, agricultural scientists have searched for methods to reduce the climate forcing of food production by increasing carbon sequestration in the soil and reducing the emissions of nitrous oxide (N2O). The outcome of this research is depressingly meagre and the two targets appear incompatible: efforts to increase carbon sequestration appear to enhance the emissions of N2O. Currently there is a need to find alternative management strategies which may effectively reduce both the CO_2 and N2O footprints of food production. Soil pH is a master variable in soil productivity and plays an important role in controlling the chemical and biological activity in soil. Recent investigations of the physiology of denitrification have provided compelling evidence that the emission of N2O declines with increasing pH within the range 5-7. Thus, by managing the soil pH at a near neutral level appears to be a feasible way to reduce N2O emissions. Such pH management has been a target in conventional agriculture for a long time, since a near-neutral pH is optimal for a majority of cultivated plants. The traditional way to counteract acidification of agricultural soils is to apply lime, which inevitably leads to emission of CO_2. An alternative way to increase the soil pH is the use of mafic rock powders, which have been shown to counteract soil acidification, albeit with a slower reaction than lime. Here we report a newly established field trail in Norway, in which we compare the effects of lime and different mafic mineral and rock powders (olivine, different types of plagioclase) on CO_2 and N2O emissions under natural agricultural conditions. Soil pH is measured on a monthly basis from all treatment plots. Greenhouse gas (GHG) emission measurements are carried out on a weekly basis using static chambers and an autonomous robot using fast box technique. Field results from the first winter (fallow) show immediate effect of lime on soil pH, and slower effects of the mafic rocks. The plots with mafic rock powders have lower CO_2 and N2O emissions as compared with calcite and dolomite. The experiment will be continued for several years under conventionally managed continuous grass, and is unique in its kind allowing to compare different strategies for pH management on GHG emissions.