Greenhouse gas emissions from cultivation of energy crops may affect the sustainability of biofuels

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Agro-biofuels are expected to reduce the emissions of greenhouse gases because CO_2 emitted during the combustion of the biofuels has recently been taken from the atmosphere by the energy crop. Thus, when replacing fossil fuels with biofuels we reduce the emission of fossil fuel-derived CO_2 into the atmosphere. However, cultivation of the soil results in emission of other greenhouse gasses, especially nitrous oxide (N_2O). Agricultural activity is the dominant source of N_2O, which is produced by microbes in the soil when the nitrogen availability is high, for instance following fertilization or incorporation of crop residues.

In this study we relate measured field emissions of N_2O to the reduction in fossil fuel-derived CO_2, which is obtained when energy crops are used for biofuel production. The analysis includes five organically managed crops (*viz.* maize, rye, rye-vetch, vetch and grass-clover) and three scenarios for conversion of biomass to biofuel. The scenarios are 1) bioethanol production, 2) biogas production and 3) co-production of bioethanol and biogas, where the energy crops are first used for bioethanol fermentation and subsequently the residues from this process are utilized for biogas production. The net reduction in greenhouse gas emissions is calculated as the avoided fossil fuel-derived CO_2, where the N_2O emission has been subtracted. This value does not include farm machinery CO_2 emissions and fuel consumption during biofuel production. Thus, the actual net greenhouse gas reduction will be lower than indicated by our data. We obtained the greatest net reduction in greenhouse gas emissions by co-production of bioethanol and biogas or by biogas alone produced from either fresh grass-clover or whole crop maize. Here the net reduction corresponded to about 8 tons CO_2 per hectare per year. The worst result was obtained for bioethanol produced from vetch straw where high N_2O emissions outweighed the avoided fossil fuel-derived CO_2.