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Contribution of nitrous oxide and methan to the overall climate impact of maize on well-drained sandy soils of north-east Germany

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Erosion effects and the influence of organic fertiliser (fermentation residues, FR) on the climate impact and greenhouse gas (GHG) emissions of N_2O, CH_4 and CO_2 were investigated at an experimental field side in the lowlands of north-east Germany during the years 2010 and 2011. This intensively used agricultural landscape is glacially shaped and characterized by well-drained sandy and loamy soils.

Erosion effects on GHG exchange were investigated for energy maize at the CarboZALF-D project site near Dedelow, Uckermark. In addition to a non-eroded haplic luvisol (reference), emissions were measured for three eroded soil types: a) eroded haplic luvisol, b) haplic regosol (calcaric) and c) endogleyic colluvic regosol (deposition side). In a second field trial, the impact of organic fertilization on GHG emissions was assessed for a range of FR fertilization (0-200% N) and compared to a non-fertilized and a minerally fertilized control. Only 70% of the N content of the FR was assumed to be available for plants.

Discontinuous measurements of N_2O and CH_4 were carried out bi-weekly using the closed-chamber method and 20-minute interval sampling. Gas samples were analysed using a gas chromatograph. Gas fluxes were calculated using linear regression, interpolated and finally cumulated. CO_2 flux measurements of ecosystem respiration (R_{eco}) and net ecosystem exchange (NEE) were conducted every four weeks by using a non-flow-through non-steady-state closed chamber system (Livingston and Hutchinson 1995) based on Drösler (2005). Measurement gaps of NEE were filled by modeling the R_{eco} fluxes using the Lloyd-Taylor (Lloyd and Taylor 1994) method and the gross primary production (GPP) fluxes using Michaelis-Menten (Michaelis and Menten 1913) modeling approach. Annual NEE balances were then calculated based on the modeled R_{eco} and GPP fluxes.

All investigated soil types were C sinks, storing up to 9,6 t CO_2eq ha^{-1} yr^{-1}. As expected for this well-drained soils, the climate impact of CH_4 emissions was negligible on all plots with mineral and organic fertilization (-0,05 t CO_2eq ha^{-1} yr^{-1} up to 0,01 t CO_2eq ha^{-1} yr^{-1}). On minerally fertilized plots, contribution of N_2O emissions were very different and varied between 10% and 43% to the overall climate impact (-9,6 t CO_2eq ha^{-1} yr^{-1} to -2,3 t CO_2eq ha^{-1} yr^{-1}). The highest amount was investigated on the deposition plot. For organic fertilization, N_2O emissions increased moderate from 0,02 t CO_2eq ha^{-1} yr^{-1} (non-fertilized control) with increasing amount of fertilizer to 1,5 t CO_2eq ha^{-1} yr^{-1}.

In contrast to N fertilizer application, the contribution of N_2O and CH_4 to the overall climate impact of eroded agriculturally soils in the glacially shaped landscape is very heterogeneous.

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