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Understanding the influence of soil compaction on greenhouse gas emissions

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Soil structure plays a crucial role in determining greenhouse gas (GHG) emissions from agricultural activities. Changes in soil structure, such as compaction, can alter the factors that govern GHG fluxes, leading to an increased potential for emissions. The extent to which soil compaction explains GHG emissions is still under investigation. To address this knowledge gap, a two-year experiment was conducted in Northeast Italy to examine the influence of soil compaction on GHG emissions. The experimental site comprised of 20 lysimeters representing five different cultivation systems, each with four replicates: bare soil (BS), conventional (CV), conventional + with cover crop (CC), conservation with shallow compaction (0-25 cm, CA1), and conservation with deep soil compaction (25-45 cm, CA2). Maize was cultivated as the main crop in 2022, followed by grain sorghum in 2023, with solid digestate (300 kg N ha^{-1}) originated from mixed agricultural waste used for fertilization. Winter wheat served as a cover crop where necessary. Continuous automatic measurements of CO_2, N_2O, and CH_4 emissions were collected using a non-steady state through-flow chamber system and an FTIR gas analyzer, enabling the capture of up to seven fluxes per day for each replicate. Additionally, water-filled pore space (WFPS) and soil temperature were continuously monitored in the 0-30 cm soil profile using Time Domain Reflectometry (TDR) sensors and thermocouples. Cumulative CO_2 reached its peak under CV, followed by CC. Notably, observable N_2O emissions were predominantly detected in the two weeks following fertilization with peaks reaching 0.8 kg N-N_2O $ha^{-1}d^{-1}$ under CC, while CA1 and CA2 exhibited lower emissions. Conversely, CH_4 emissions were negligible, and the soil primarily acted as a sink. The study provides crucial insights for sustainable agriculture by highlighting the impact of soil compaction on GHG.