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Can an organically farmed world help to mitigate climate change through carbon sequestration?

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While the agricultural sector is responsible for 20-30% of global greenhouse gas emissions, agricultural lands may also represent an opportunity to mitigate climate change through soil carbon sequestration. In particular, organic farming is often presented as a way of farming that leads to increased soil carbon sequestration in croplands thanks to high soil carbon inputs, especially as animal manure (Skinner et al. 2013, Gattinger et al. 2012).

However, organic farming represents only ~1.4% of the global utilised agricultural area (UAA). In a world where organic farming would expand far above (e.g. up to 100% of the UAA), we expect stringent competition for fertilising materials and therefore, a reduction of organic yields beyond the current organic-to-conventional gap of ~20% (Seufert et al. 2012). Such yield reduction might impact the amount of carbon that returns to soil in form of crop roots and residues and, in fine, the soil organic carbon sequestration of organically managed croplands. The objective of the present study is to estimate to what extent soil carbon sequestration might be affected by organic farming expansion at the global scale.

To answer this question, we combined (i) the GOANIM model that estimates material and nutrient flows in the crop and livestock farming systems under different global scenarios of organic farming expansion and (ii) the RothC model that simulates soil carbon dynamics in agricultural soils. We combined those models with a series of global scenarios representing organic farming expansion together with a baseline simulating conventional – i.e. non-organic – farming systems and soil carbon inputs.

We found that organic farming expansion would negatively affect croplands' SOC stocks at the global scale. We found a reduction of per-hectare soil carbon input in croplands of up to 40-60%. This is due to lower yields in an organic scenario because of nitrogen limitation (up to 60% lower than conventional), reducing the amount of crop residues returning to cropland. Another impact of lower yield is a reduction of feed availability and subsequently a reduction of animal population and manure spread to soil. This reduction of carbon input is lower if farming practices are adapted to foster biomass production and carbon inputs in soils (i.e. cover crops). Such results highlight the

need of systemic approaches when estimating the mitigation potential of alternative farming systems.

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