TRUESOIL (ID 110)

True SOC sequestration: understanding trade-offs and dynamic interactions between SOC stocks and GHG emissions for climate-smart agri-soil management

Coordinator

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Project partners

Country	Organization
Argentina	Instituto Nacional de Tecnología Agropecuaria
Belgium	Université Catholique de Louvain
Chile	University of Chile
Ethiopia	Mekelle University
Finland	University of Helsinki
France	Institut national de recherche pour l'agriculture, l'alimentation et l'environnement
Indonesia	Universitas Negeri Makassar
Ireland	University College Dublin
New Zealand	University of Otago
Norway	Norwegian University of Life Sciences
Portugal	University of Aveiro
Spain	Universidad de Granada

Summary

Agricultural soils are depleted in organic carbon (OC) and have the potential to sequester substantial amounts of C, contributing to climate change mitigation. An increase in soil organic carbon (SOC) has additional benefits, including improvements in soil fertility, water retention and texture, which supports crop productivity and biodiversity. Restoring and maintaining SOC can be achieved by adopting management practices which increase C sequestration and stabilize C in the soil matrix. Common management practices for increasing SOC include the use of external or internally recycled OC inputs (e.g., organic amendments/fertilizers, biochar, plant litter, residues), alternative cropping options (e.g., continuous green cover, cover crops) or measures that reduce OC losses (e.g., reduced tillage, adapted grazing). Conversely, these management practices have the potential to increase greenhouse gas (GHG) emissions by stimulating decomposition of previously sequestered C and N increasing CO2 and N2O emissions. Mechanisms and drivers behind increased GHG emissions and their interactions with OC sequestration under different soil and climatic conditions are not well constrained, partly because little is known about how abiotic and biotic factors control the extent to which soils can store OC. Quantifying negative side-effects of increased soil C sequestration on GHG emissions is necessary to develop appropriate management options that reduce GHGs while increasing soil C stocks.

The main goal of TRUESOIL is to assess how GHG emissions from agricultural production systems are influenced by varying OC inputs for contrasting soil types and climates (i.e. boreal, temperate, Mediterranean and semi-oceanic). We will elucidate the roles of different abiotic and biotic factors in OC storage and the extent to which these factors impact on GHG emissions, in particular N2O, given its high warming potential and large uncertainty in flux estimates. Many C-augmenting management interventions are known, or have the potential, to modify soil N cycling leading to enhanced N2O emissions. To understand potential trade-offs between OC storage and GHG emissions, we combine intensive measurements of GHG fluxes with carbon-nitrogen cycling studies and microbiological

analyses. Comparison of soils that are SOC saturated with those that continue to accumulate SOC will aid in the identification of the major drivers. Using rainfall exclusion experiments, we will also examine the future impact of reductions in precipitation on interactions between SOC accumulation and GHG emissions.

TRUESOIL will establish a data repository of past and ongoing research on management-climate interrelationships between GHG emissions and soil SOC sequestration; it will also provide information on the factors likely to influence trade-offs between SOC sequestration and GHG fluxes, including pedoclimatic conditions, management interventions, soil microbial community composition and C/N budgets (WP1). The repository will serve as basis for overall project activities; examine the impacts of rainfall exclusion on SOC sequestration and GHG emissions (WP2); investigate the role of microbial communities in SOC sequestration and N2O emissions (WP3); and use modelling studies to examine C-N interactions and tradeoffs to identify management options that can maximize SOC sequestration whilst minimizing impacts on soil GHG emissions (WP4). TRUESOIL will then synthesize the scientific outcomes and translate them to climate-smart management practices (WP5) which will be disseminated and communicated among the scientific community, stakeholders and the general public (WP6). This project will lead to an increased understanding of how environmental factors and management control OC sequestration, SOC persistence and stabilization and how this is linked to GHG emissions, opening up new possibilities for soil-specific and climate mitigation strategies.

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