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BOOK OF ABSTRACTS

C-arouNd: Refining Soil Conservation and Regenerative Practices to Enhance Carbon Sequestration and Reduce Greenhouse Gas Emissions

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While the last 60 years have seen significant progress in global food production with inorganic fertilizers, plant breeding, and pesticides, this has come at a cost to soil health. This intensive agriculture has led to a reduction in soil organic carbon (SOC) stocks, increased greenhouse gas (GHG) emissions, and ultimately contributed to global warming. Agriculture and land-use change are responsible for nearly 20% of global GHG emissions, making it a significant source of nitrous oxide (N2O) due to synthetic nitrogen fertilizers and methane (CH4) due to livestock activity and rice cultivation. This project aims to evaluate the influence of conservationist and regenerative agricultural practices on carbon (C), nitrogen (N), and phosphorus (P) cycling, soil biodiversity, and GHG emissions, with a particular focus on long-term SOC stocks and the processes governing carbon persistence. To achieve this, the project has established a consortium of long-term field experiments that assess the impact of different cropping systems and agricultural practices on soil properties. Participants from 12 countries are involved, contributing a total of 37 field sites with varying chronosequences or contrasting agricultural management practices. At 26 sites established for at least 10 years, estimates and scenario models of potential N2O, CO2, and CH4 emissions from cropping, pasture, and forest systems will be generated using the best available IPCC or local emission factors. Additionally, GHG emissions will be directly measured at a subset of these sites. The project is building a global database of C and N stocks, bulk density, soil fertility, and GHG emissions across diverse ecosystems and under different agricultural management practices. This will allow researchers to determine how climatic conditions, net primary production of the cropping systems, and soil type influence C and N stocks, nutrient dynamics, and GHG emissions. The ultimate goal of the project is to recommend best

management practices for food crop production that promote soil carbon accumulation, particularly mineral-associated organic matter (MAOM), without increasing GHG emissions. This will contribute to the long-term sustainability and resilience of agricultural systems. As promised in the project deliverables, the Long-Term Experiment (LTE) metadata has already been organized in a FAIR repository. Additionally, the protocols for soil sampling, laboratory analyses, and site characteristics are being prepared for publication. Furthermore, soil carbon sequestration is being quantified across all fields (or planned for future sampling), and in some experiments, greenhouse gas emissions are also being measured. This includes African dark earths and surrounding ecosystems, where both carbon sequestration and GHG emissions are being quantified. PhD students have also begun field trips to Norway for soil sampling.

Keywords: soil carbon persistence, agriculture intensification, sustainable development, nutrients cycling, carbon storage

Abstracts of Poster Presentations

Long-term crop residue management effects on the greenhouse gas fluxes: an Austrian case study

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Most cropland soils rely on crop residues as their sole source of carbon, especially in cereal production. In the context of climate change mitigation, incorporating these residues into the soil (instead of removing them) is one popular soil management strategy to enhance the carbon input on agricultural land.

Usually, it is observed that crop residue incorporation leads to higher soil organic carbon (SOC) stocks. However, higher carbon in the soil may also modify the N_2O and CH_4 fluxes, since these gases are produced by microbial processes mediated by carbon availability. The effect of residue management on non-CO_2 GHG fluxes has not been comprehensively assessed, what prevent us from estimating the overall effect of management strategies on the soil greenhouse gas (GHG) balance.

Here, we monitored GHG fluxes from a long-term experiment in the Marchfeld, a productive agricultural area in east Austria. In this experiment, two crop residue management strategies have been compared since 1982: removal of residues vs incorporation.

We used static manual chambers to estimate CO_2, CH_4 and N_2O fluxes between cropland and atmosphere. In parallel, soil environmental conditions and soil nutrients were investigated. We captured flux information between 902 days with a temporal resolution of approximately 21 days between measurements. Within this period the field had a rotation of winter wheat, sorghum, and triticale.

We observed a large interannual variability in N_2O fluxes, from no effect to higher emissions following incorporation of residues. Cumulative N_2O emissions were enhanced by incorporating residues compared to the removal treatment. Nevertheless, this amount is relatively minor compared to the currently higher SOC stocks in the first 25 cm in the residue incorporation scenario. While our case study illustrates a trade-off scenario between GHG fluxes and SOC storage in temperate croplands, the trade-off is only a small fraction of the long-term climate mitigation benefit by incorporating residues.

Keywords: nitrous oxide, long-term field experiment, static chambers, climate change mitigation, soil C and N pools.