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Modelling soil carbon sequestration with biochar using RothC

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In the context of climate change mitigation, technologies for removing the CO_2 from the atmosphere are key challenges. Most recent scenarios from integrated assessment models require large-scale deployment of negative emissions technologies (NETs) to reach the 2 °C target. Among them, technologies for increasing organic carbon content in soils (SOC) have been developed. In the 15th IPCC special report on Global Warming of 1.5 °C, biochar and pyrogenic carbon capture and storage have been credited as promising negative emission technology. In fact, soil carbon sequestration (SCS) and biochar have a large negative emission potential (each 0.7 GtCeq. yr^{-1}) and they are expected to have lower impact on land, water use, nutrients, albedo, energy requirement and cost, and thus fewer disadvantages than many other NETs.

SCS can be assessed using soil carbon dynamic models, such as RothC, as suggested by IPCC. However, studies on the inclusion of biochar in RothC are still scarce. Furthermore, most of these studies are based on the results of laboratory experiments and do not account for the effects of biochar on SOC degradation (the priming effect). The use of laboratory data can be problematic, since they may not adequately represent field conditions, especially due to the lack of long-term field studies.

The aim of this work was to assess and predict how biochar influences the soil C dynamics, by modifying the RothC model to simulate the findings of a long-term field experiment on biochar application to a short coppice rotation in Italy. We first modified the model to include two stocks of C input into the soil: the labile and the recalcitrant biochar pools. We also included a parametrized function to account for the priming effect on SOC dynamics in the soil. Secondly, we calibrated the model parameters with the data obtained from the field experiment. Finally, we validated the model results by estimating the remaining biochar amount in the site after 10 years from application, using an isotopic mass balance.

The results confirm that biochar degradation can be faster in field conditions in comparison to laboratory experiments; nevertheless, it can contribute to substantially increase the C stock in the long-term. Moreover, the modified RothC model allowed to assess the SCS potential of biochar application in soils, at least in the specific conditions examined, and could represent a flexible tool to assess the effect biochar as a SCS strategy in the long-term. We are exploring the possibility to use data from other long-term field experiment to move in that direction. The results of this study could be added to the Italian biochar database, providing new knowledge about a topic that needs

to be explored.