EJP SOIL has received funding from the European Union's Horizon 2020 research and innovation programme: Grant agreement No 862695

Trying to answer burning questions on functional diversity and soil carbon that keep awake agroecologists overnight

EJP SOIL AGROECOseqC

Dylan Warren Raffa*[1], Elena Testani[1], Sebastien Fountaine[2], Isabelle Bertrand[3], Skaidrė Supronienė[4], Bruno Huyghebaert[5], Marga Ros[6], Sara Sanchez-Moreno[7], Alessandra Trinchera[1]

***presenting author:** dylan.warrenraffa@crea.gov.it

1 Consiglio per la ricerca in agricoltura e l'analisi dell'economia agraria - Centro di ricerca Agricoltura e Ambiente (CREA-AA). Via della Navicella 2 – 00184 - Rome (Italy)
2 UCA, INRAE, VetAgro Sup, Unité Mixte de Recherche sur Écosystème Prairial (UREP), Clermont-Ferrand, France
3 UMR Eco&Sols, CIRAD, INRAE,IRD, Montpellier SupAgro, Universite´ de Montpellier, Montpellier, France,
4 Mikrobiologijos laboratorijos vedėja, vyriausioji mokslo darbuotoja - Lietuvos agrarinių irmiškų mokslų centras - Instituto al. 1, Akademijos mstl., 58344 Kėdainių r. sav. (Lithuania)
5 Department of Sustainability, Systems & Prospective-Unit of Soil, Water and Integrated Crop Production, Walloon Agricultural Research Centre,Gembloux, Belgium
6 Department of Soil and Water Conservation and Organic Waste Management, Centro de Edafologia y Biologia Aplicada del Segura, CEBAS-CSIC, P.O. Box 4195, Murcia 30080 (Spain)
7 Dept. of the Environment and Agronomy -National Center Institute for Agricultural and Food Research and Technology Crta. Coruña km 7.5 28040 Madrid, Spain

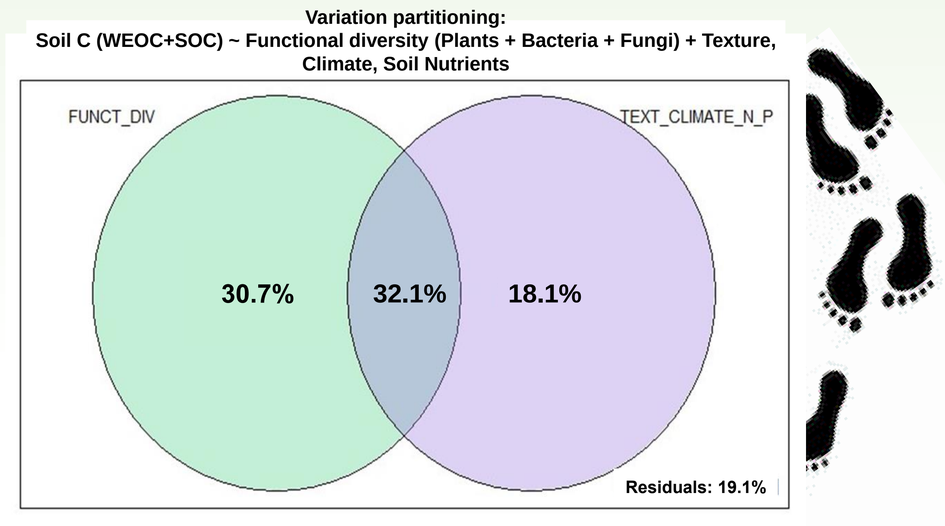
Introduction

Plant and soil biodiversity are crucial for soil health and ecosystem stability, influencing key ecosystem services. Recent studies on functional biodiversity highlight the role of soil life and plant assemblages on soil carbon dynamics. However, the mechanisms of these interactions and how farmers can manage agrosystem biodiversity to balance environmental and productivity goals are still unclear. This work presents the preliminary results of the project AGROECOseqC, aiming at (i) exploring the relations between functional diversity and soil carbon, and (ii) explore how farm management affects specific functional groups related to soil carbon dynamics. The dataset, generated from six AGROECOseqC experimental sites (IT, FR (2), ES, BE), included soil chemical-physical data, phytosociological survey of plant communities, and Next Generation Sequencing Analysis for soil bacteria and fungi. The dataset addresses the main research questions, with a subset from the Italian site evaluating the effects of farming practices on specific functional groups. Functional plant traits and functional microbial groups were assessed based on soil cover and the relative abundance of bacteria and fungi, respectively.

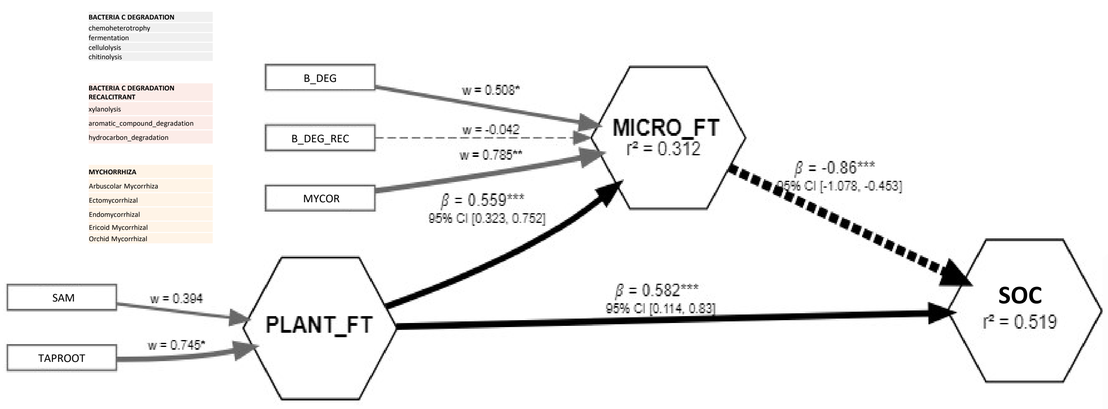
1. Is functional diversity relevant in explaining the variation of soil carbon in agricultural fields?

Preliminary results showed that microbial functional groups and plant functional traits explained about 31% of the total variance. Soil texture, climate and soil NO_3^-, NH_{4+}, P_{av} (mg/kg) explained about 18.1% of the total variance.

Method: Variation Partitioning (vegan package, R)



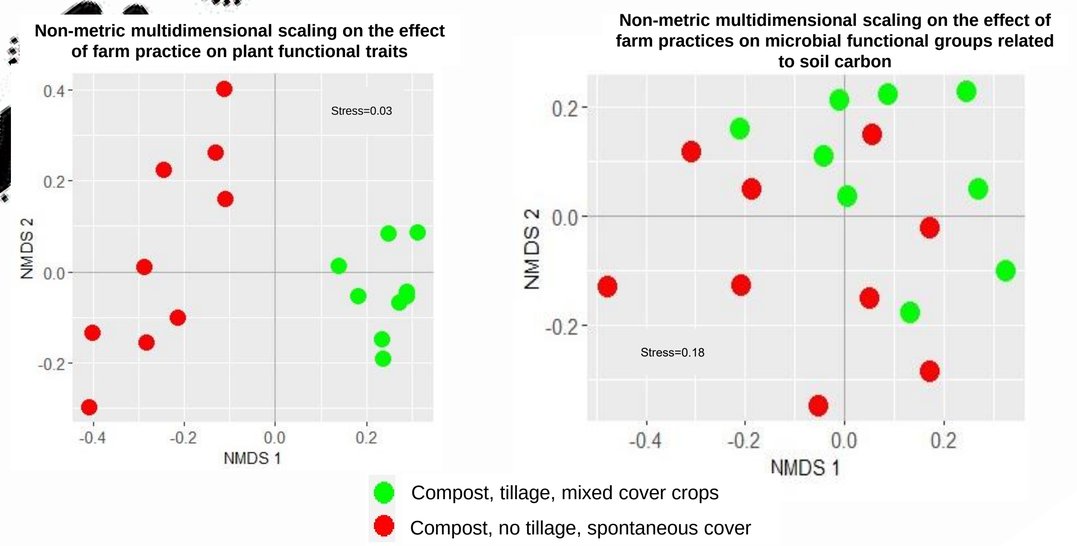
2. Given the complexity of the functional microbial groups and plants' traits, how do they interact in the context of SOC dynamics?



The Support Arbuscular Mycorrhiza and Taproot plants' traits directly affected soil organic carbon. Those plants' traits also affected microbial functional groups, particularly bacteria groups involved in carbon degradation and mycorrhizal fungi. The selected microbial traits showed a negatively effect on soil carbon.

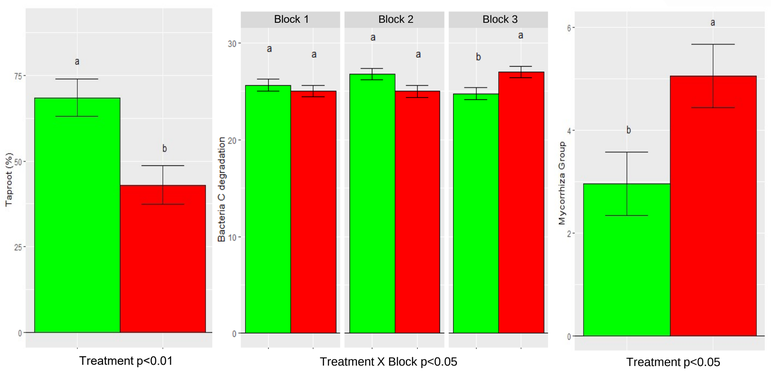
Methods: PLS-SEM (seminr package, R)

3. Do farming practices affects plants and microbial functional groups?



Yes, they do. In the Italian site, we found that the combination of cover crops and tillage significantly affected the plants and microbial functional groups related to soil organic carbon, compared to spontaneous grassing under not tillage.

Method: NMDS (vegan package, R)



At the farm level, cover cropping and tillage increased the percentage of taproot plant species, decreased C-degrading bacteria (only in one block), and decreased mycorrhizal fungi, as compared to spontaneous grassing + tillage.

Method: linear mixed effect model (nlme4 package, R)

Perspectives for stakeholders and policy makers

We demonstrated the relevance of functional biodiversity on soil carbon dynamics. We further showed that farming practices modulate functional diversity and therefore can be used to leverage ecological process to improve farming systems functionalities. Overall, this functional approach is a valuable tool for exploring how plant and soil microbial biodiversity impacts soil health and ecosystem services. Understanding these interactions can help both at the field and the landscape level, in developing strategies for managing biodiversity to combine environmental and productive goals.