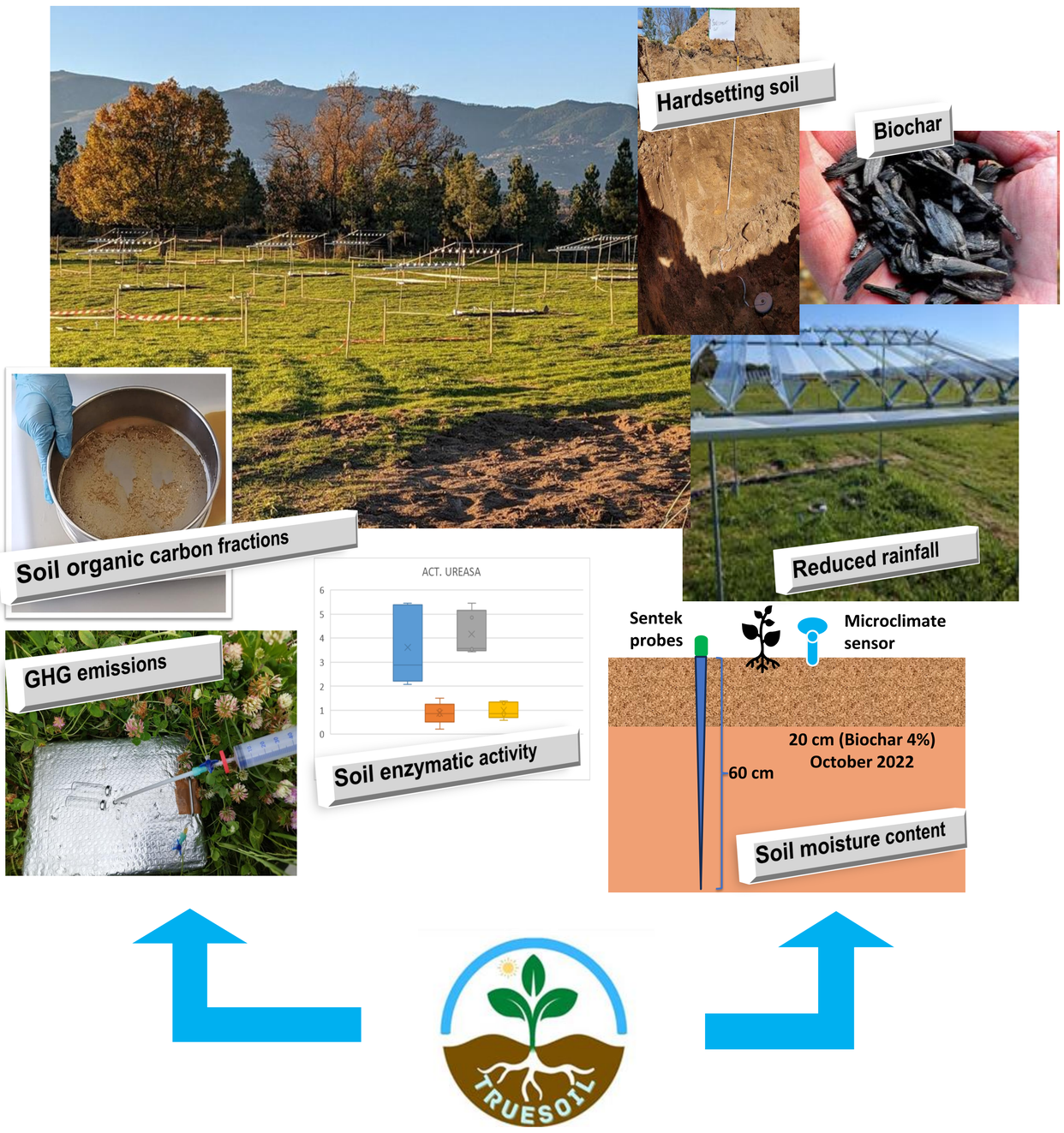


Organo-mineral interactions in a hard-setting Portuguese pasture soil

Zahra Khodaparast[1], Ana Catarina Bastos[1], Filipe Oliveira[2], Oscar Gonzalez-Pelayo[1], Hugo Braas[1,3], Marie van Hoeyweghen[1,3], Liliana Simões[1], Antun Jelincic[1], Behrouz Gholamahmadi[1], Ana Luísa Caetano[1], Isabel Campos[1], Jantiene Baardman[3], Tiago Domingos[4], Marjan Jongen[4], Frank Verheijen[1]*

(1) Centre for Environmental and Marine Studies (CESAM), Department of Environment and Planning (DAO), University of Aveiro, 3810-193 Aveiro, Portugal
(2) Aveiro Institute of Materials (CICECO), Department of Materials and Ceramic Engineering, University of Aveiro, 3810-193 Aveiro, Portugal
(3) Soil Physics and Land Management Group, Wageningen University, The Netherlands
(4) Instituto Superior Técnico-ID & Terraprima, Lisbon, Portugal

*Presenter: Email: verheijen@ua.pt

INTRODUCTION

Hardsetting soil becomes hard and difficult to cultivate when dry due to the breakdown of soil structure during wetting and drying cycles (reduced flocculation during the drying phase), often linked to loamy soils with higher sand contents and low soil organic matter contents. **This study examines how adding biochar can improve soil properties in hardsetting Portuguese pasture soil under current and future rainfall**. The study further explores root penetration, the pyrogenic C by FTIR, SOM quality by DSTGA, SOC by dry combustion, and organic matter fractions over a three-year field experiment.

FIELD SITE & METHODOLOGY

The field site is a biodiverse sown pasture at the Quinta da França farm (N 40.2732 W 7.4189) in Covilhã. The two-factor experiment, i.e. biochar amendment and rainfall reduction, has four treatments: i) no biochar natural rainfall; ii) no biochar reduced rainfall; iii) biochar natural rainfall; iv) biochar reduced rainfall. The plots are installed in a random block design with five replicates (20 plots of 3 m × 3 m). The rainout shelters reduce rainfall as is predicted for future climate change (2070), i.e. 50% reduction.

Table 1. The topsoil characteristics (SOM: soil organic matter; EC: electrical conductivity; AAP: average annual precipitation; AAT: average annual temperature)

WRB	Cambisol developed over granites
Soil texture	Sandy loam (c:s:s) 18:17:65
SOM (%)	4.5
pH	5.6
EC ms cm^{-1}	77
Bulk density g cm^{-3}	1.4
Altitude masl	441
AAP mm	800 -1000
AAT °C	13

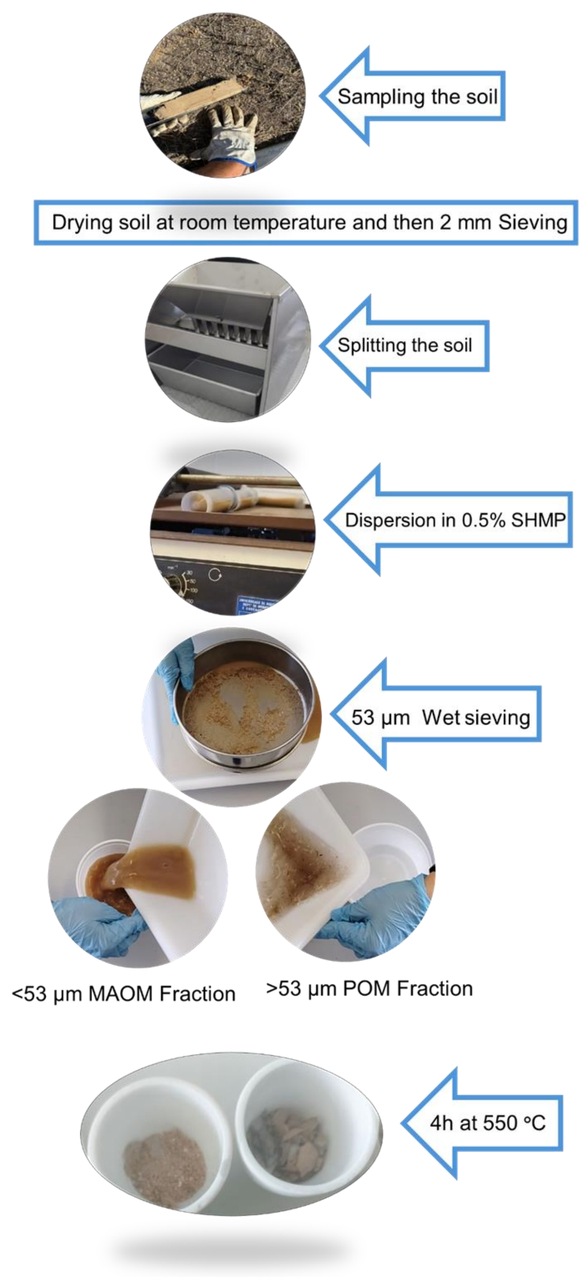
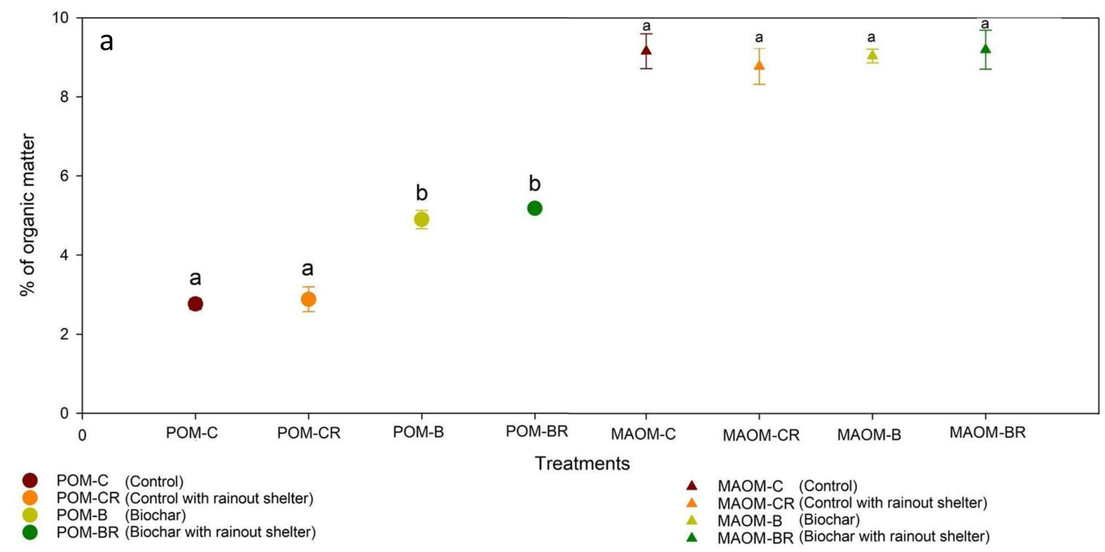


Figure 2. The SOM fractionation for POM and MAOM is based on the methodology suggested by ongoing EJP SOIL projects (Leuthold et al., 2023).

RESULTS



- The **subsoil** (20-40 cm) exhibited **significantly lower organic matter** in both the MAOM and POM fractions compared to the **topsoil** (0-20 cm).
- **Reduced rainfall** had **no significant** effect on the percentage of soil organic matter in both the **MAOM and POM** fractions, regardless of biochar application.
- **Biochar application significantly increased** the percentage of soil organic matter in the **POM** fraction but had **no notable effect** on the **MAOM** fraction.
- **Biochar application significantly decreased** the ratio of MAOM/POM.

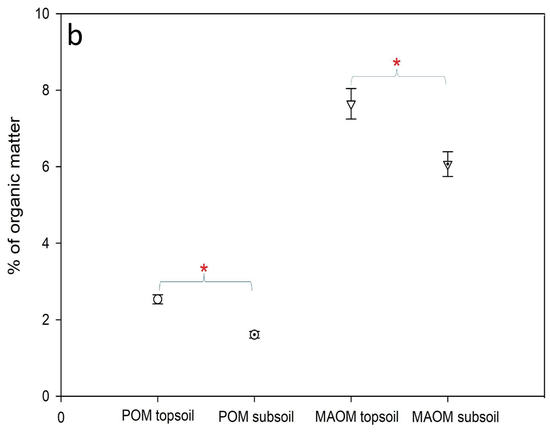


Figure 3. The percentage of soil organic matter in two soil fractions, particulate organic matter (POM) and mineral-associated organic matter (MAOM), measured in the field soil: a) on September 2023 in four different treatments for POM and MAOM, and b) on September 2022 topsoil and subsoil. The treatments that don't share the letter have significant differences (p-value <0.05). The red asterisk indicates the significance (p-value <0.05).

Table 2. MAOM/POM ratio after one year of biochar application to the soil under natural rainfall and rainfall-reduced conditions. Treatments that don't share the same letter have significant differences (p <0.05).

Treatments	MAOM/POM ratio (mean± Std Dev)
Control	3.3 ± 0.3 **a**
Control with rainout shelter	3.3 ± 0.9 **a**
Biochar	1.9 ± 0.2 **a, b**
Biochar with rainout shelter	1.8 ± 0.2 **b**

Have fine biochar particles not been incorporated into soil aggregates after 12 months? Follow up FTIR PyC analyses to confirm ?

ACKNOWLEDGEMENTS

We acknowledge financial support to CESAM by FCT/MCTES (UIDP/50017/2020+UIDB/50017/2020+LA/P/0094/2020), through national funds. We further acknowledge FCT for the funding of project SOILCOMBAT (PTDC/EAM-AMB/0474/2020), POLLINATE (PTDC/EAM-AMB/1509/2021), as well as of authors Z.K. (BPD/UI88/7260/2023), F.V. (CEECIND/02509/2018+2023.06689.CEECIND), and A.C.B. (art. 23º DL57/2016 of 29 Aug amended by DL 57/2017 of 19 July, OE). EC's EJP Soils program is acknowledged for funding of TRUESOIL (EJPSoils/0001/2021).

REFERENCES

Leuthold, S. J., Haddix, M. L., Lavallee, J., & Cotrufo, M. F. (2023). Physical fractionation techniques. In *Encyclopedia of Soils in the Environment, Second Edition* (pp. V2-68-V2-80). Elsevier.