The impact of soil properties and farming practices on water accessibility - the soil as a dynamic environment in the context of climate change

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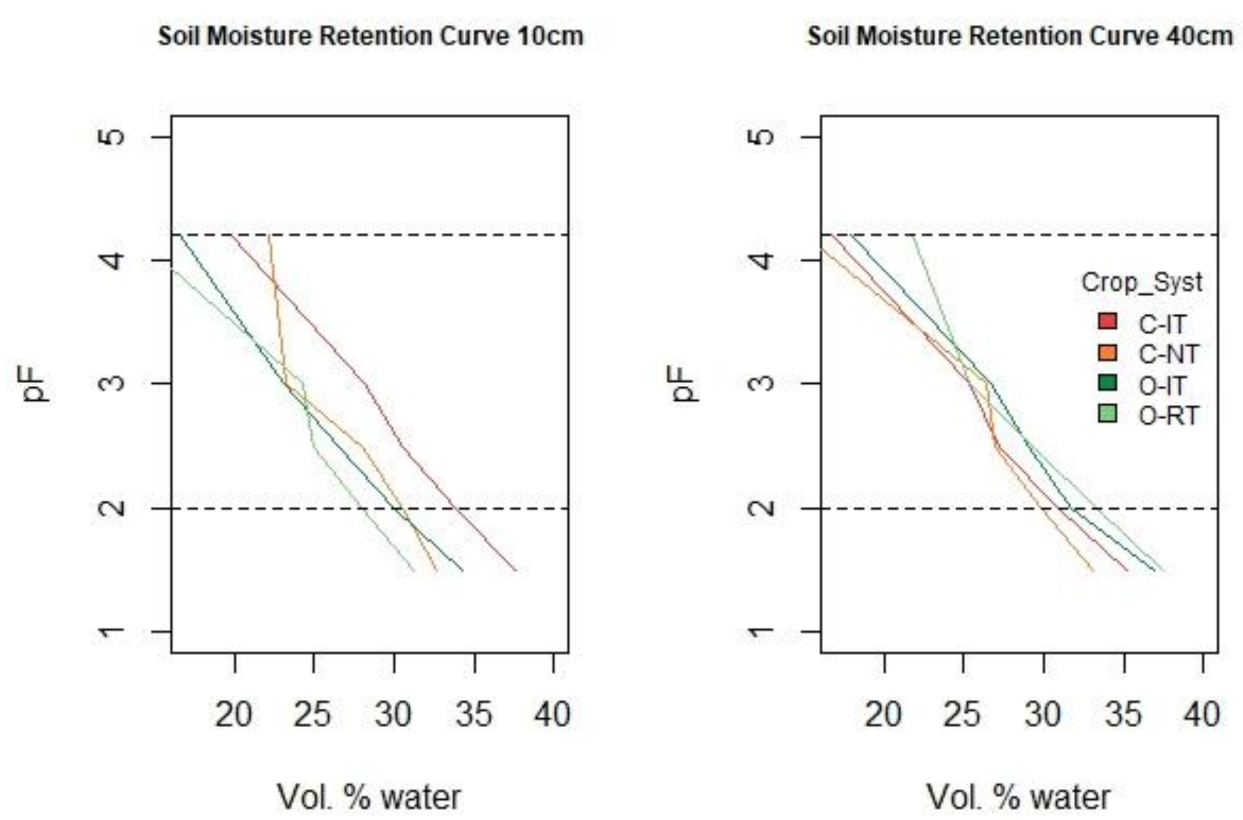
Summary: The soil is a dynamic environment and influences many processes such as biomass production, nutrient cycling and carbon sequestration. Management practices, such as ploughing and organic matter input, can directly affect the physical structure of the soil, and therefore its functions. The RELOAD project, in which the chapter here presented is inserted, aims at understanding the mechanism behind cropping systems responses to climate change, more specifically, regarding drought stress. Within the scenario of climate mitigation and adaptation, understanding the interactions between soil properties and climate is imperative. Hugar et al 2012 nicely stated that "…soil hydraulic property governs soil metabolism", meaning that the water dynamic, just as the blood in our body, is very important to regulate and allow process to occur within the soil. Therefore, the interaction of soil properties might interfere in the severity of stress for plants and ultimately in the resilience of systems. Therefore, we need a deeper understanding on how common management practices affect soil structure and water dynamics, in order to adapt to and act against climate change impacts.

Preliminary results



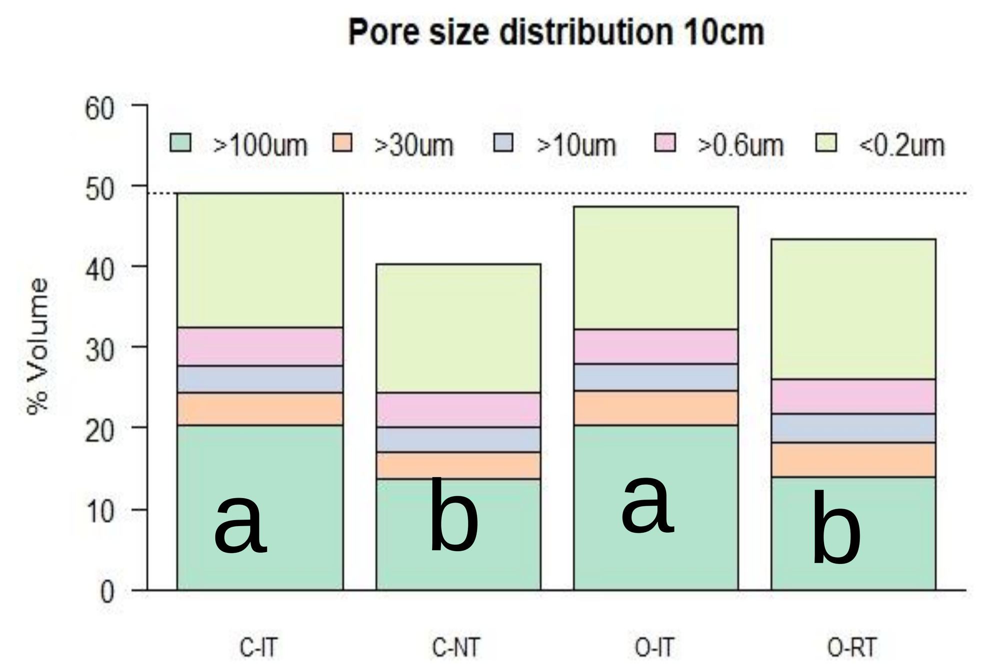
C-IT Conventional Intensive Tillage

C-NT Conventional No Till

O-IT Organic Intensive Tillage

O-RT Organic Reduced Tillage

What am I seeing here? This is the water retention curve (SWC) of our loamy soil. Measurements were taken in 2017, 8 years of each management type. The lower horizontal line at the graph represents the field capacity (the water below it is lost to gravity). The upper line is the permanent wilting point (above that, water is not plant available). The space in between shows the water retained in each of our cropping systems soil. Does it mean that Conventional Intensive tillage system holds more water? No, this water might not be readily available to plants!



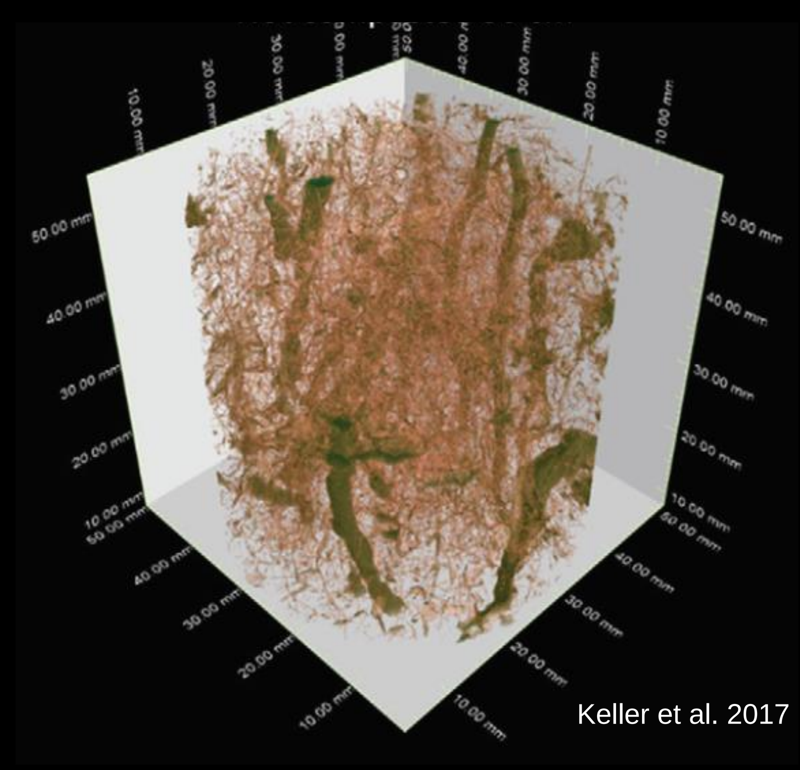
Why not? The SWC graph on top tells us more about the potential water in the soil, and how much "energy" the plants need to spend to remove this water from the pores in the soil than about water availability for plants. Note that the water will be more strongly bind to smaller pores, It is just like trying to drink from a glass with a large or a narrow straw. When we take a closer look at the distribution of the pore sizes in the different farming systems, at the graph above, we see that the volume of large pores is different among the tillage treatments. Tilled systems had more large pores than the conservative tillage. However, we still don't know **how are these pores distributed.** Large pores are responsible for up to 70% of the water that infiltrates the soil, therefore their importance, but if they are not well connected, for example, will a higher volume be translated into better performance of soil functions?

Next steps

Our investigation is still not finished. In order to better understand the dynamics of water in the soil and its accessibility to plants, we need a deeper understanding of the pore network and the interacting factors that affect how available the water is for plants.

1. Micro computed tomography images: pore network structure and connectivity

Why? By scanning these undisturbed cores we can have a better idea of the natural distribution of the pores, how connected they are, and whether it differs from one cropping system to the other, for example.



2. Biological engineers: type and abundance of earthworms.

Why? The network structure is resulting from cropping practices, but also biological activities, such as the growth of roots and soil fauna activities, especially earthworms.
In addition

3. Plant available water assessment: least limiting water range (LLWR).

Why? This analysis combines the gas permeability, water content and resistance to penetration, resulting in a range of ideal growth conditions for plants.

Conclusion:

1. Further analysis (i.e. LLWR) need to be performed to assess the water availability potential for the different cropping systems
2. A better description of the pore network will increase our understanding of the management impacts on water accessibility for the plants

References: Watson and Luxmore 1986, Hatfield 2011, Holzkämper and Fuhrer 2015, Rabot et al. 2018

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