Agroscope, Agroecology and Environment | WFSC symposium, 2019

Impact of Swiss cropping systems on soil hydraulic properties

Emily Miranda Oliveira[1,2], Raphaël Wittwer[1,3], Yujie Liu*, Qing Sun[1], Ana Katarina Gilgen[1], Valentin Klaus[1], Nina Buchmann[2], Thomas Keller[1,4], and Marcel Van der Heijden[1,3,5]

Affiliations: 1 Agroscope Reckenholz, 2 ETH Zürich, 3 University of Zürich, 4 Swedish University of Agricultural Sciences, 5 Utrecht University

emily.oliveira@agroscope.admin.ch

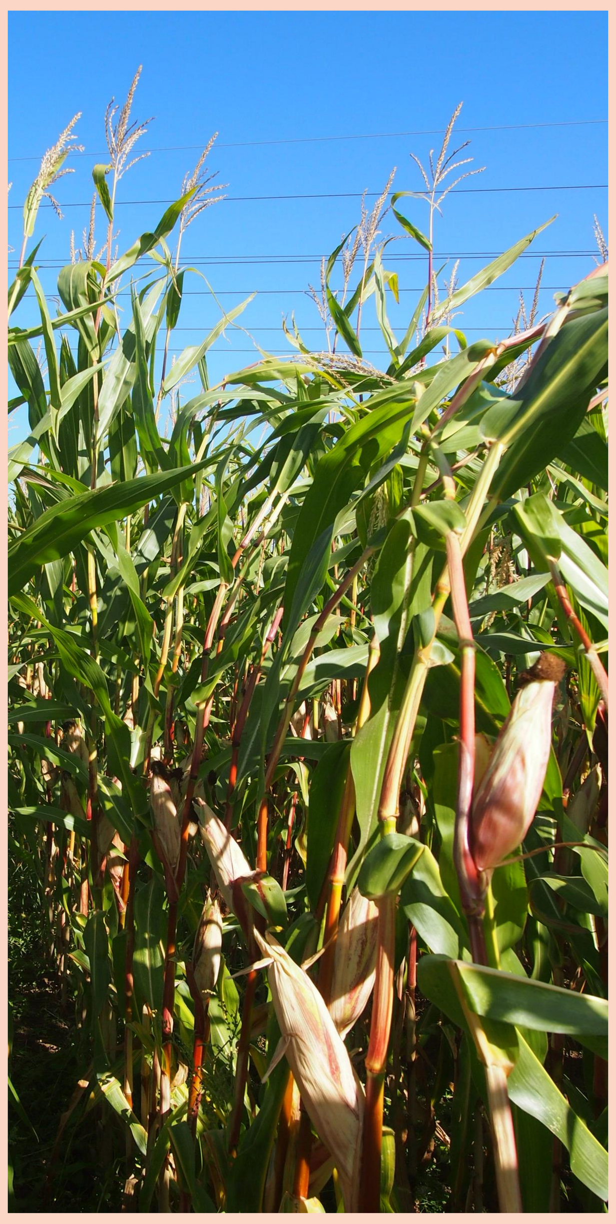
meteorological parameter	tendency to date	tendency future
▪ mean temperature / zero degree line ▪ hot days / heat waves ▪ length of growing season	↗	↗
▪ cold days / cold waves ▪ lake freezing / glacier volume	↘	↘
▪ winter precipitation ▪ heavy precipitation ▪ droughts	→	↗
▪ summer precipitation	→	↘
▪ new snow / snow depth ▪ days with snow cover ▪ snow water equivalent	↘	↘
▪ winter storms ▪ thunderstorms / hail / tornadoes ▪ sunshine duration / fog / Föhn / pollen	?	?

Rationale & Research Questions: summer drought is expected to increase in frequency and duration within the next 50 years (CH2018). Agricultural management such as tillage and organic carbon amendments can largely alter soil structure and influence drought severity (Holzkämper and Fuhrer 2015).

Which arable farming system best buffer against drought stress?

How is the soil structured under different systems?

How could this affect systems responses to drought?



Rain plot 2017

Drought plot 2017

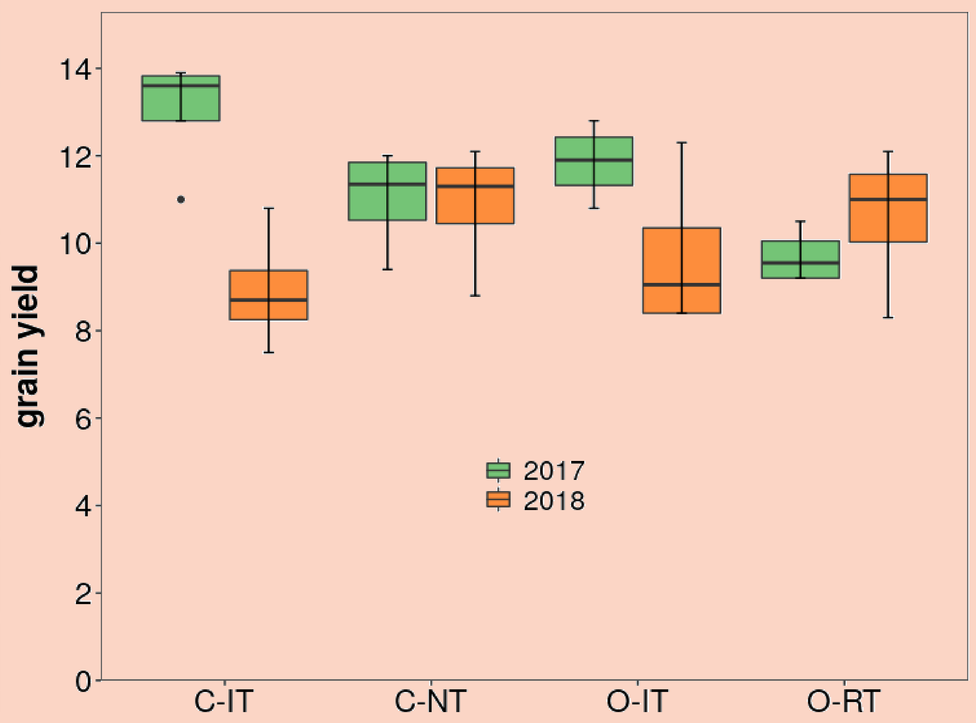


Fig. 1 Silage maize (*Zea mays*) grain yield from the years of 2017 (green) and 2018 (orange). C-IT: Conventional farming with intensive tillage; C-NT: Conventional farming with no tillage; O-IT: Organic farming with intensive tillage; and O-RT: Organic farming with reduced tillage. Note that without drought, in 2017, the C-IT treatment performed better than all others, however, it suffered higher yield loss under drought stress.

According to the Federal Statistical Office (2018) the yield and production costs of major crops and animal feed in Switzerland were affected by the summer drought observed in 2018. It is important to understand the mechanisms behind water availability to the plants and soil organisms, in order to sustain and design well functioning agricultural systems, that are more adapted to predicted climate conditions.

Cropping systems

- **C-IT** Conventional Intensive Tillage
- **C-NT** Conventional No Tillage
- **O-IT** Org. Intensive Tillage
- **O-RT** Org. Reduced Tillage

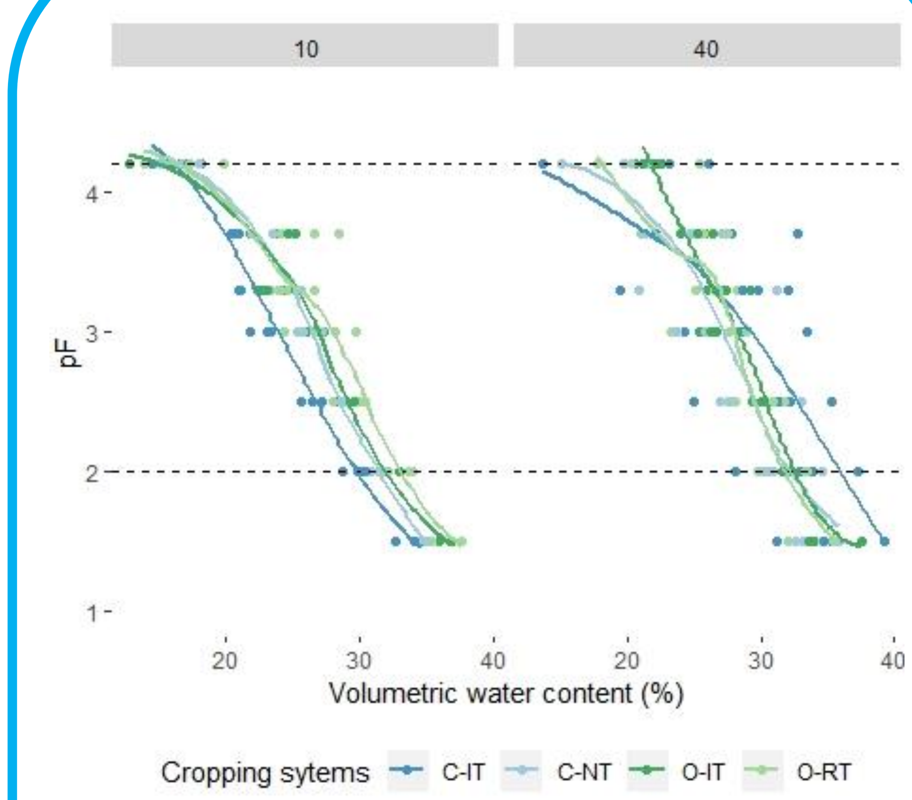


Fig. 2 Although the systems behave similarly regarding the amount of water the soil can hold (and potentially slowly release to plants), the C-IT system tends to have a lower water holding capacity at the top layer (10cm depth). The pF values reflect the size of the pores in the soil. Higher pF represents smaller pores. The lower dashed line is the field capacity (under that line the water is lost by gravity) and the upper line is the wilting point.

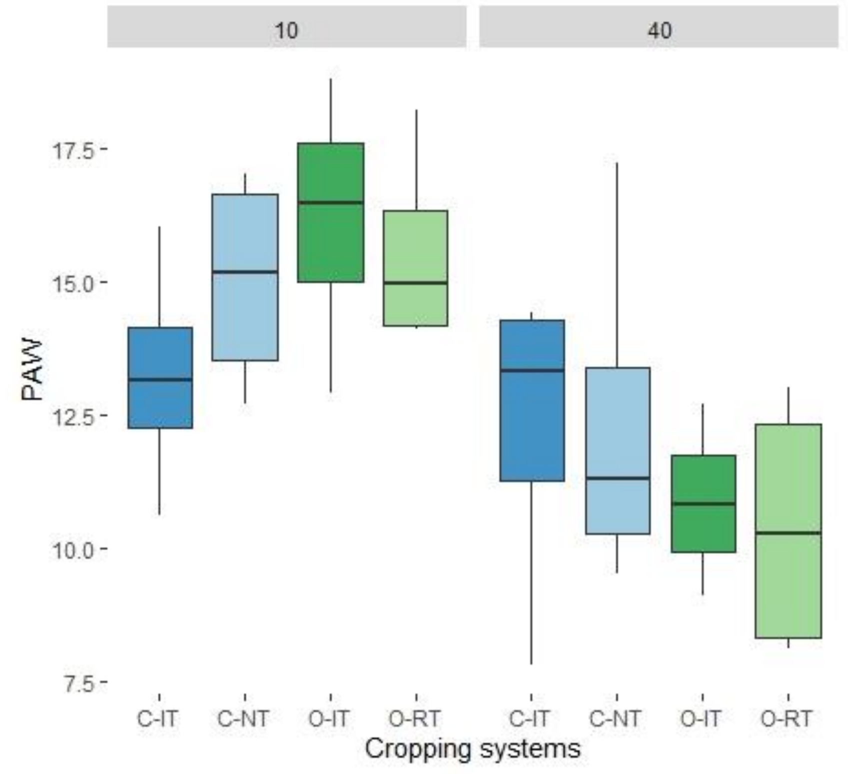


Fig. 3 The water content of the interval between the dashed lines in fig 2. is the plant available water (PAW).That is the water accessible to the plants. Keep in mind that smaller pore sizes in this range constitutes immobile water, but still available for plant extraction. Even though the organic and conventional intensive tillage systems are structurally similar (in pore size distribution), their contribution to available plant water differs.

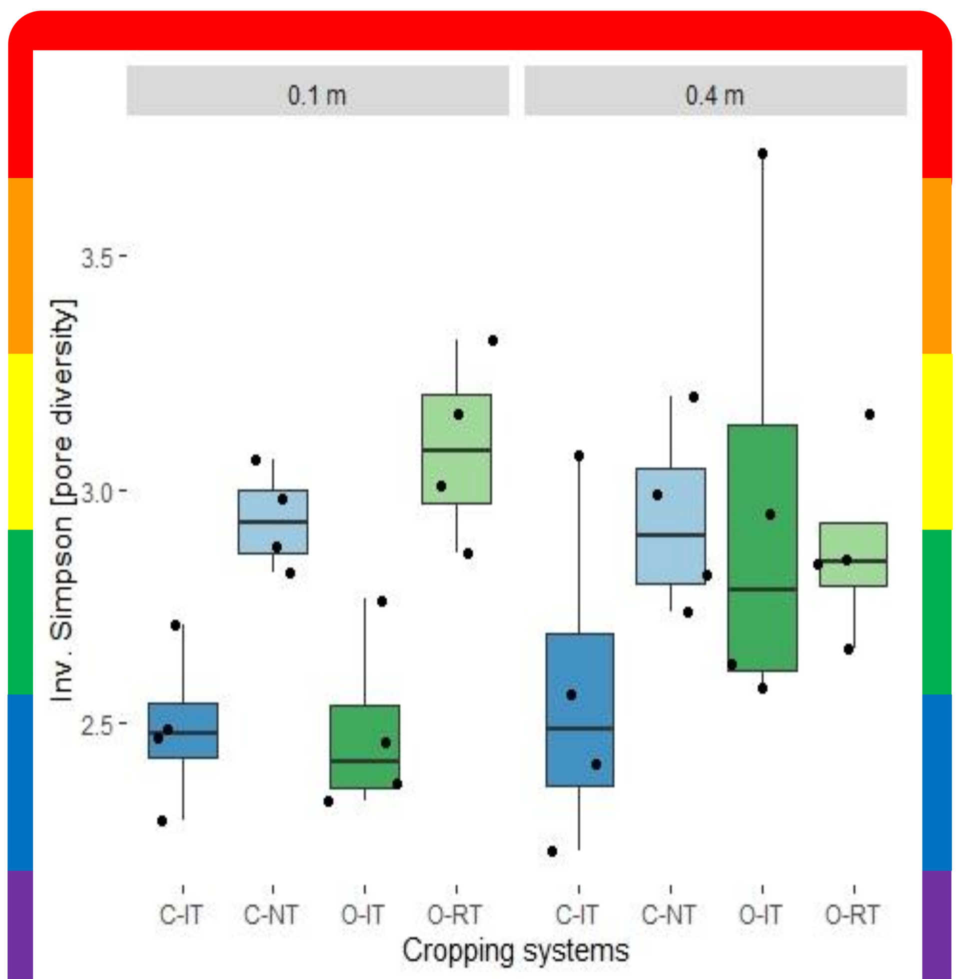


Fig 4. Inverse Simpson diversity index of soil pore sizes per plot. Higher diversity index means that the soil is more structured, with varied pore sizes. Conservation tillage (no till and reduced tillage) and organic plots show better pore diversity at 10cm. Interestingly, at 40cm, bellow the intensive tillage layer, the organic system has higher pore diversity.

Conclusions:

1. Conventional intensive tillage cropping systems features seems to facilitate plant growth, demanding less plant energy for water uptake and root growth, for example.
2. However, after 8 years under each of the management practices, conservation agriculture and organic systems displayed features that could increase systems resilience under predicted drought conditions.

good food, healthy environment

Agroscope

ETH zürich grassland sciences

STIFTUNG MERCATOR SCHWEIZ

World Food System Center

Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Swiss Confederation

Federal Department of Economic Affairs, Education and Research EAER
Agroscope