Evaluation of the effect of reduced tillage systems on earthworms community, soil properties and ecosystem services, an integrative approach in a farms network

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1. Background

❖ Reduced tillage systems (including reduced soil disturbance, use of cover crops and crop rotation, and improved organic matter management) are expected to be good alternatives to conventional system which have led to a decrease of soil biodiversity and multi-functionality.

❖ Many studies worldwide have analyzed the impact of tillage systems on different soil functions, but an integrated view of the impact of these systems is still lacking

➔ **SoilMan** project (https://ecobiosoil.univ-rennes1.fr), performed in France, Germany, Sweden, Romania and Spain proposes an interdisciplinary collaboration in order to evaluate the agro-environmental, economical and sociological sustainability of agroecological practices such as reduced tillage systems, crop rotation including pasture and organic farming.

2. Objectives of SoilMan project

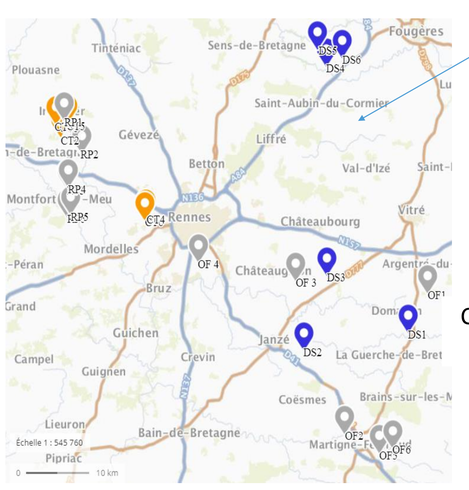
i) to study how reduced-tillage systems impact on ecosystem services
- soil biodiversity regulation: earthworms, nematodes, microorganisms
- soil structure maintenance: aggregate stability, soil erosion
- water regulation : run-off, transfer of pesticides
- food production

ii) to develop a tool for assessing these multiple ecosystem services: Soil Quality Index

iii) to identify, via a socio-economic study on farmer networks, the drivers of adoption of reduced-tillage systems

3. Field, treatment and parameter description

Sites (12 fields: 6 conventional tillage, 6: direct seeding) are located closed to Rennes (48°06'53"N, 1°40'46"W) (Brittany, France).



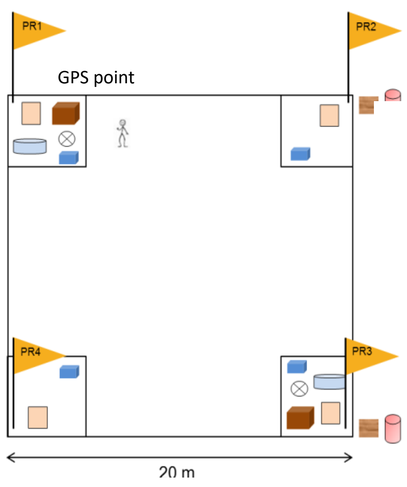
Soils are loamy or sandy-loamy soils
OM: 1.5-2% ; pH: 6-

Conventional tillage system (CT) (moulboard plough 25 cm)

Direct seeding system (DS)

Crop: all fields are under winter wheat

Sampling design - Studied parameters



Earthworm (*hand sorting + AITC; 1/16 m²; ISO 23611)*
→ abundance (nb/m²),
→ functional structure (epigeic, anecic, endogeic)
→ specific structure (richness, diversity)

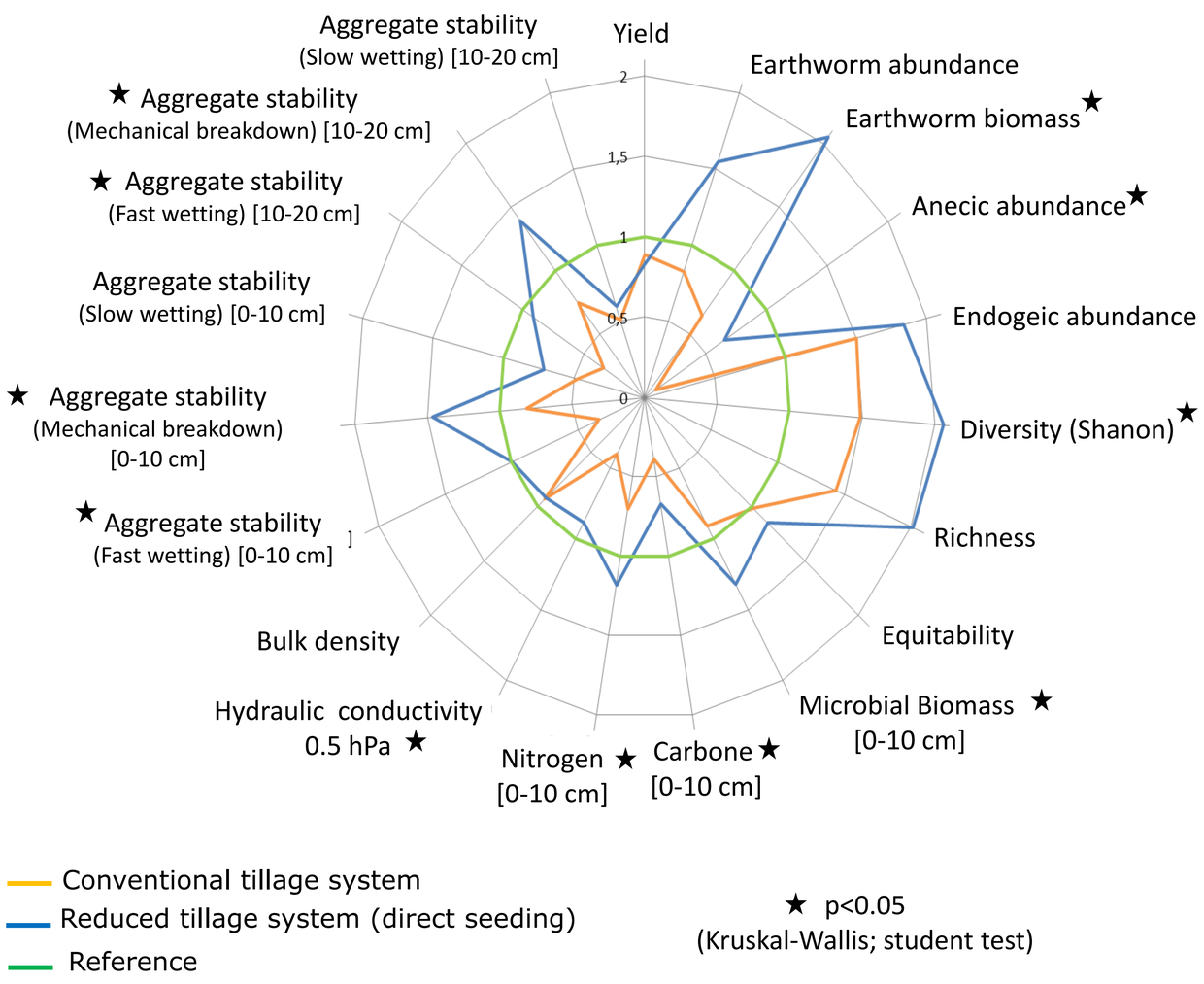
Microbial biomass (mg/kg dry soil) (*fumigation-extraction method; Vance et al.,* 1987)
Total Carbon (% dry matter), *ISO 10694,*
Total Nitrogen (% dry matter), *ISO13878*

Bulk density (g/cm³) *ISO 11272*

Aggregate stability (mwd) *(Le Bissonnais method, 1996)*
→ fast wetting reflecting effect of heavy rain
→ slow wetting reflecting effect of smoothy rain
→ mechanical breakdown

Infiltration rate (*Beerkan; Haverkamp et al., 1996*)
Hydraulic conductivity (*Decagon; Coutadeur et al., 2002)*

4. Effect of treatment on ecosystem services



Compared to conventional ploughing system, direct seeding system (without soil inversion, complex rotation, organic fertilisation) positively affect **Ecosystem Services** through different **indicators**:

❖ **Soil Biodiversity conservation**

- Increase of **earthworm communities** (biomass and diversity) with an significant effect on anecic community, and in la lesser extent on endogeic community ($p>0.05$)
- Increase of **microbial biomass** especially in the first 10 cm [0-10 cm]; a vertical stratification is also observed (higher at 0-10 cm vs 10-20 cm depth)

❖ **Nutrient cycling**

- Increase of **carbon** and **nitrogen** soil content in the first 10cm [0-10cm], and in a lesser extend ($p>0.05$) at deeper depth [10-20cm]

❖ **Soil structure maintenance**

- Increase of **aggregate stability** at both depths [0-10; 10-20cm] for the fast wetting and breakdown tests, linked to microbial biomass, carbon content, and length of hypha (for fast wetting).

❖ **Water regulation**

- Despite an increase of **hydraulic conductivity** at the first 10 cm [0-10 cm] for -0.5hPa, no real effect was noticed for the water infiltration.

❖ **Yield**, there is no difference between conventional and reduced tillage system, demonstrating the capacity to maintain the yield.

5. Conclusions and outlook

Direct seeding system by improving several soil functions and by the way several ecosystem services such as soil biodiversity conservation, nutrient cycling and soil structure maintenance, provide resilience capacity of this agroecological system and resistance against soil erosion. Moreover, by maintaining yield, it reinforces the idea that this agroecological system based on 3 major pillars (no till, length and divers crop rotation, fertilisation) is a real opportunity for developing sustainable practices.

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