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Participatory modeling of soil carbon dynamics following the adoption of agroecological systems in Quebec, Canada.

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Context

- Decrease of soil organic matter (SOM) in East Canada
- Farmers participating to the Living Lab – Québec noticed that even with best managment practices, their SOM is declining.
- This observation was notably made by four farmers of the Pot-au-Beurre watershed.

Objectives

- To improve our understanding of the current dynamic of SOM and to assess the potential impact of agroecological cropping systems on SOM in the context of a changing climate.

Materials and methods

Workflow

Workshop 1 — Establishing objectives and initial crop rotations and cropping systems

Simulation 1 — Simulation of the initial systems with STICS

Workshop 2 — Presentation of simulated SOM dynamic with initial systems and codesign of agroecological systems including, for example, cover crops.

Simulation 2 — Simulations of the agroecological systems under historical and climate change conditions.

Workshop 3 — Presentation of simulated SOM dynamics with initial and agroecological systems under historical and climate change scenarios, adjustment to simulations.

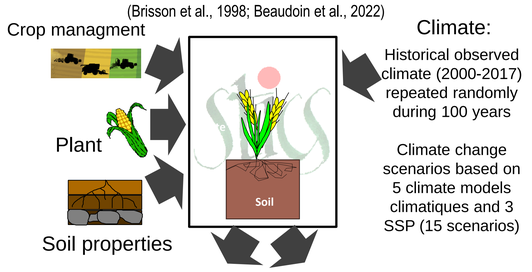
Examples of observed dynamics of SOM

3 constrasted soil of a farm, cultivated with the same croping system

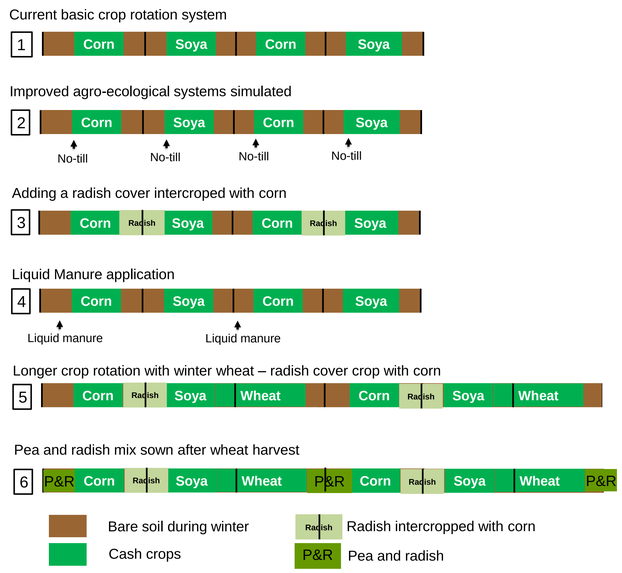
Soil	Clay (%)	Loam (%)	SOM (%)	Observed SOM dynamic
Loam clay named St-Ours	20 %	50 %	4,4 %	↗
Sandy loam named Fleury	4 %	10 %	2 %	→
Sandy loam humiferous named Fleury	15 %	16 %	9,2 %	↘

The STICS crop model

(Brisson et al., 1998; Beaudoin et al., 2022)

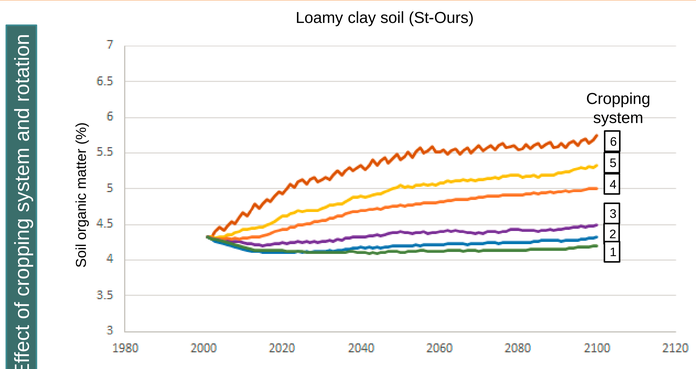


Examples of initial and improved cropping and rotation systems



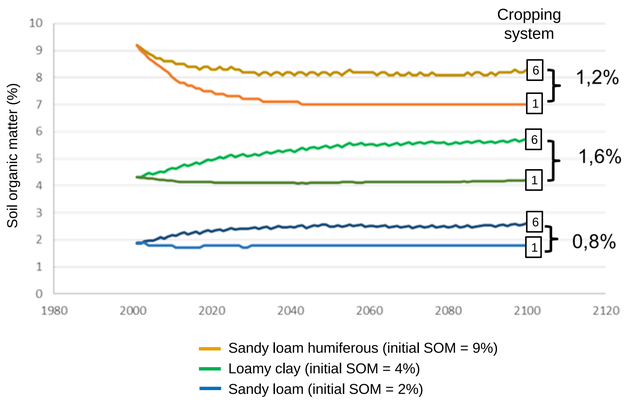
Results

Effect of cropping system and rotation



- Direct seedling, organic fertilization and cover crop can increase SOM in the loamy clay soil (Cropping system #2, #3 and #4)
- Combining these practices in agroecological cropping systems leads to greater SOM increase (#5 and #6).

Effect of soil type



- The soil characteristics (notably soil texture) and initial SOM content greatly influence the dynamics.

Effects of climate change

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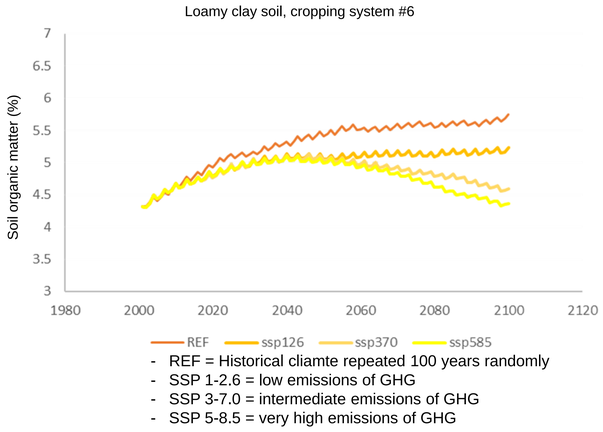

- REF = Historical cliamte repeated 100 years randomly
- SSP 1-2.6 = low emissions of GHG
- SSP 3-7.0 = intermediate emissions of GHG
- SSP 5-8.5 = very high emissions of GHG

- Climate change will, according to these results, enhance a greater pressure on SOM content, depending on their intensity.

Outcomes

- Farmers who partipated to these simulations learned about the dynamic currently occuring, the factors affecting these dynamics and the threat that climate change represent for SOM in a context where carbon sequestration in soils is crucial to mitigate climate evolution.

References

Beaudoin N., et al. eds. 2022. STICS soil-crop model. Conceptual framework, equations and uses, Versailles, Éditions Quæ. / Brisson N., et al. (1998) STICS: A generic model for the simulation of crops and their water and nitrogen balances. I. Theory and parameterization applied to wheat and corn. Agronomie 18:311-346.