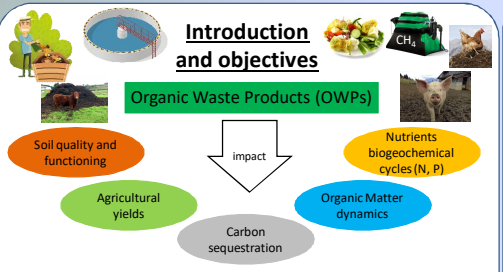
Influences of repeated application of organic waste products on soil organic carbon content and stability assessed using Rock-Eval 6® thermal analysis

Amicie Delahaie (UMR 8538, *ENS PSL*), Pierre Barré (UMR 8538, *ENS PSL*), Lauric Cécillon (UMR 8538, *ENS PSL* ; ECODIV EA 1293-URA, *Univ-Rouen/INRAE*), François Baudin (UMR ISTeP 7193, *Sorbonne Université*), Camille Resseguier (UMR 1402 Ecosys, *INRAE/AgroParistech/Université Paris-Saclay*), Thierry Morvan (UMR 1069 SAS, *INRAE*), Denis Montenach (UE 0871 UEAV, *INRAE*), Florence Savignac (UMR ISTeP 7193, *Sorbonne Université*), Aurélia Michaud (UMR 1402 Ecosys, *INRAE/AgroParistech/Université Paris-Saclay*), Florent Levavasseur (UMR 1402 Ecosys, *INRAE/AgroParistech/Université Paris-Saclay*) and Sabine Houot (UMR 1402 Ecosys, *INRAE/AgroParistech/Université Paris-Saclay*)

Introduction and objectives

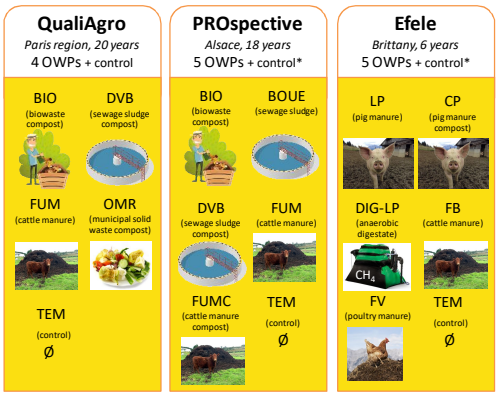


How do OWPs influence the carbon content ?
How do OWPs influence the carbon stability ?
Does the impact depend on the considered OWP ?

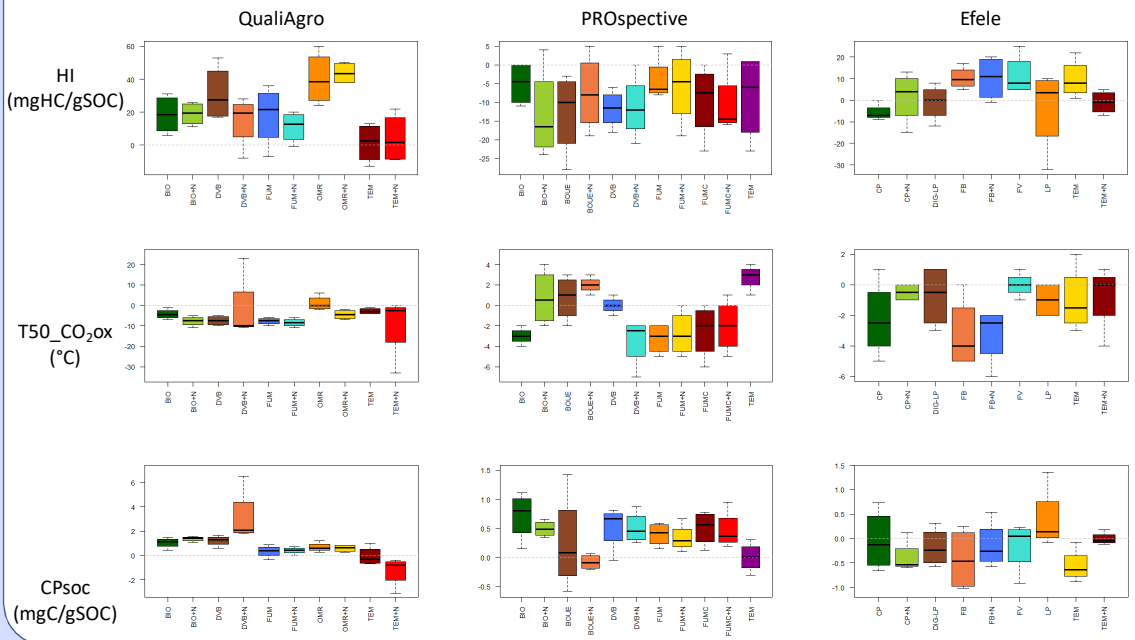
→ We explore the carbon thermal (T50_CO_2ox) and chemical (HI) stability by Rock-Eval 6® thermal analyses, along with its biogeochemical stability (CPsoc), depending on the OWPs.

Material and methods

- **14 different OWPs** (with and without additional nitrogen, indicated by +N), all replicated 4 times;
- Samples taken up at the onset of the experiment and in 2018 : allow to plot the **differential effect of OWPs to get rid of soil heterogeneity**;
- Surface (0-30 cm) soil samples amended with the different OWPs analyzed using **Rock-Eval 6® (RE6) thermal analyses**, resulting in a set of **248 analyses of different samples;**
- **2 RE6 parameters** related to SOC biogeochemical stability in previous studies (*e.g.* Barré et al., 2016):
  - HI (hydrogen index: amount of hydrogen-rich effluents formed during the pyrolysis phase of RE6; mgCH/gSOC);
  - T50 CO_2 oxidation (temperature at which 50% of the residual organic C was oxidized to CO_2 during the RE6 oxidation phase, in °C).
- CPsoc: amount of centennially stable SOC from RE6 parameters using the model developed in Cécillon et al. (2018).



Results



- The higher the HI, the more labile the SOC.
- The lower the T50_CO_2ox, the more labile the SOC.
- CPsoc = quantity of stable C in SOC.

Discussion

- QualiAgro: both HI and T50_CO_2ox show a decrease in respectively chemical and thermal stability, that is a more labile SOC, along with an increase of the quantity of stable carbon.
Although this sounds contradictory, it only means that we strongly increased the carbon content of the soil, as well as the stable carbon content, while decreasing the ratio of stable versus labile carbon.
As shown in Obriot et al. 2016, BIO and DVB are the most efficient to increase the content in stable carbon.

- PROspective: HI shows the C has become more chemically stable. The thermal stability is unclear as the sewage sludge and the N-enriched green waste amendment seem to increase it while the other OWPs decrease the stability.
The CPsoc increased with all OWPs, but the increase is smaller than in QualiAgro, probably due to the smaller amount of OWPs provided.

- Efele: both thermal and chemical stability seem to have decreased. Nevertheless, the effect is not totally clear, and must be monitored on longer times to strengthen the observations.
The stable carbon content decreased, which is particularly surprising and should also be monitored over the coming years.

Conclusion

- No clear effect of OWPs addition can be established for the youngest site (Efele, 6 years).

- OWPs amendments had a clear effect on SOC quality at the oldest sites. They **decreased SOC thermal stability** (T50 CO_2 oxidation) and **chemical stability** (Rock-Eval 6® HI).

- OWPs amendments tended to **increase the CPsoc** at the oldest sites. The effect is stronger in QualiAgro, probably due to the higher amount of OWPs added.

- OWPs addition seems to increase SOC content, at least in the long run, but **the majority of this additional SOC is labile and may be quickly lost** if OWPs additions are stopped.

References

Barré P., Plante A.F., Cécillon L., Lutfalla S., Baudin F., Bernard S., Christensen B.T., Eglin T., Fernandez J.M., Houot S., Kätterer T., Le Guillou C., Macdonald A., van Oort F. & Chenu C. (2016) The energetic and chemical signatures of persistent soil organic matter. *Biogeochemistry*, 130: 1-12.
Cécillon L., Baudin F., Chenu C., Houot S., Jolivet R., Kätterer T., Lutfalla S., Macdonald A.J., van Oort F., Plante A.F., Savignac F., Soucémarianadin L.N. & Barré P. (2018) A model based on Rock-Eval thermal analysis to quantify the size of the centennially persistent organic carbon pool in temperate soils. *Biogeosciences*, 15: 2835-2849.
Obriot F., Stauffer M., Goubard Y., Revallier A., Vieublé-Gonod L. & Houot S. (2016) Multi-criteria indices to evaluate the effects of repeated organic amendment applications on soil and crop quality. *Agriculture, Ecosystems & Environment*, 232: 165-178.