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Soil organic matter thermal pools as influenced by depth, tillage, and soil texture : A Rock-Eval® analysis study on the cropland soils of the Swiss Plateau

Soil Carbon in the Ecological Transition 2024

INRAE

Deluz et al. under revision (*Geoderma*)

from the master thesis of :

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Context

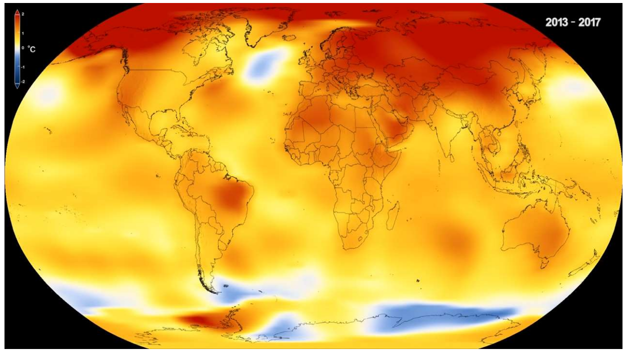
Soil quality in critical condition

https://www.mediaterre.org/20170820012304.html

https://www.terre-net.fr/2179-149712.html

https://www.terre-net.fr/2179-149712.html

Global warming



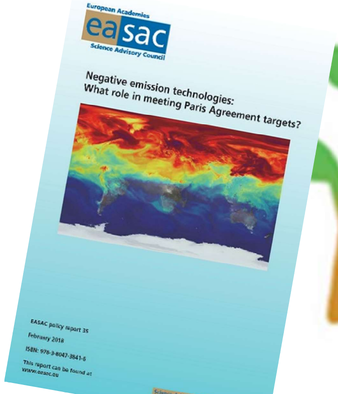
https://www.youtube.com/watch?time_continue=36&v=Z4bSxb5THm4

← **Carbon** →

Photosynthesis

⚠ **<u>Lack</u> of organic carbon**

<u>Excess</u> CO_2 ⚠



European Academies
easac
Science Advisory Council

Negative emission technologies:
What role in meeting Paris Agreement targets?

EASAC policy report 35
February 2018
ISBN: 978-3-8047-3841-6
This report can be found at
www.easac.eu

Science Advice for the Benefit of Europe

Courvoisier et al. 2018

4 POUR 1000

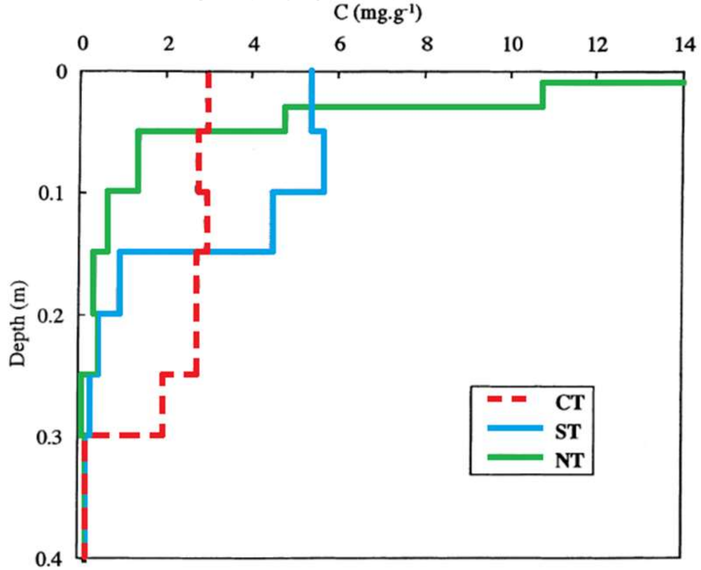
https://www.4p1000.org/fr

Solution with **c**onservation **a**griculture (CA)?

http://www.fao.org/zhc/detail-events/en/c/238478/

Effect of CA on soil organic matter

Profile relocation



Based on figure by Balesdent et al. (2000) recolored

Soil quality

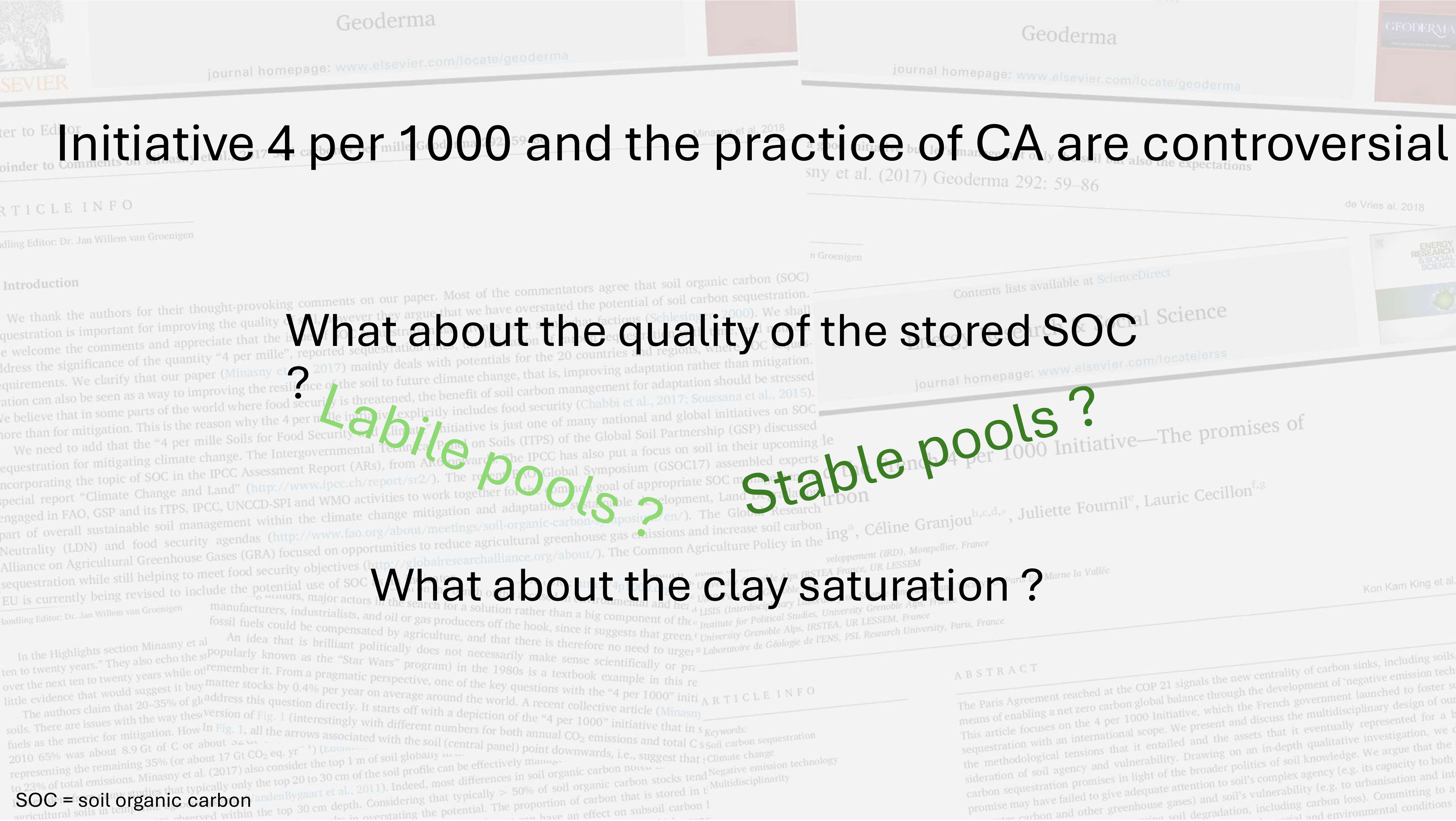
✓

well established

Carbone sequestration

~

still debated



Initiative 4 per 1000 and the practice of CA are controversial

Minasny et al. 2018

de Vries al. 2018

Kon Kam King et al.

What about the quality of the stored SOC ?

Labile pools ?

Stable pools ?

What about the clay saturation ?

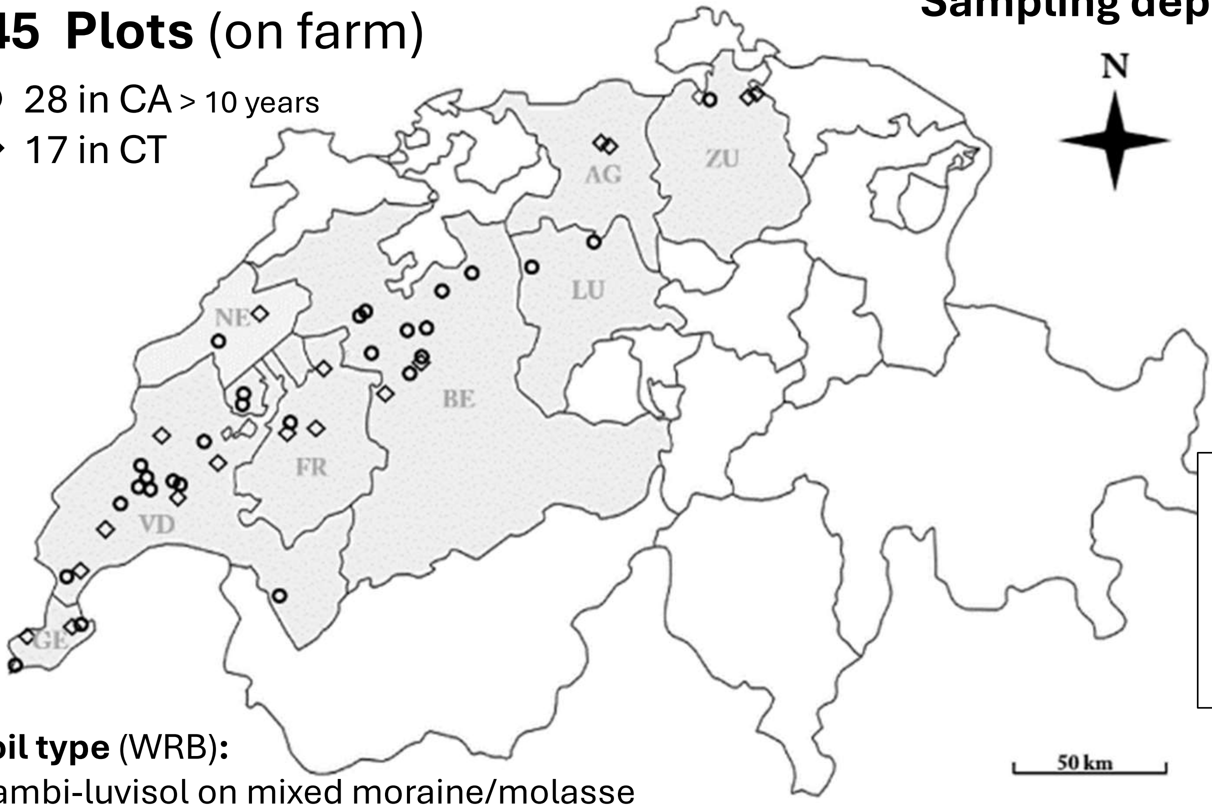
SOC = soil organic carbon

Main objectives of the study:

1) Compare the quality of organic carbon under CA and CT

2) Study the equilibrium of OM pools according to the degree of clay saturation

M&M : data collected



45 Plots (on farm)

- ○ 28 in CA > 10 years
- ◇ 17 in CT

Sampling depths [cm]

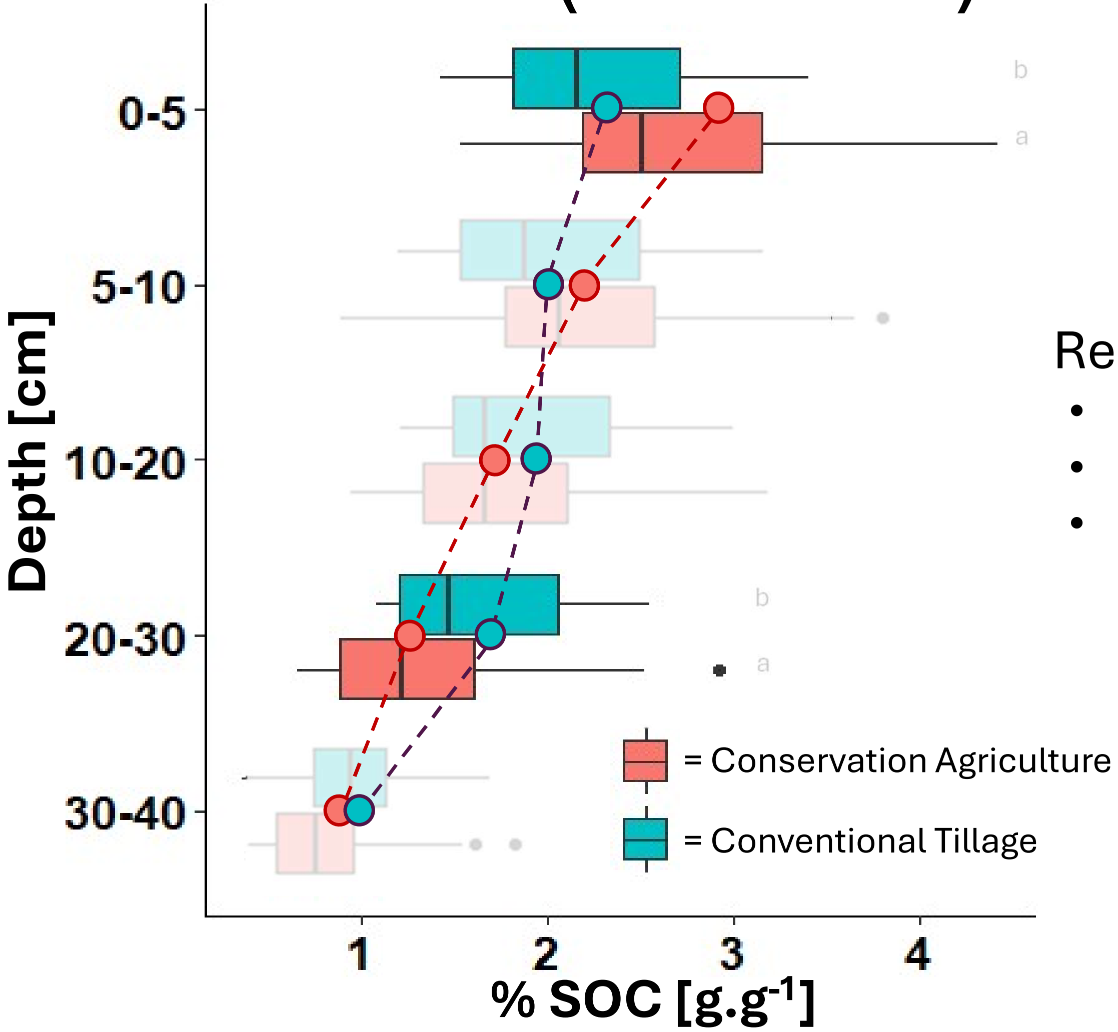
0-5
5-10
10-20
20-30
30-40

Soil type (WRB)**:**
Cambi-luvisol on mixed moraine/molasse

Analysis:

- Clay content (10-40%)
- SOC content (0.5-4.5%)
- **SOM quality (RockEval®)**

Results : SOC (CA *vs* CT)



Relocation of OM in the soil profile

- More SOC for CA at 0-5cm depth range
- More SOC for CT at 20-30cm depth range
- No difference for other depth range

⚠ Not a paired experiment

M&M: Rock-Eval® analysis

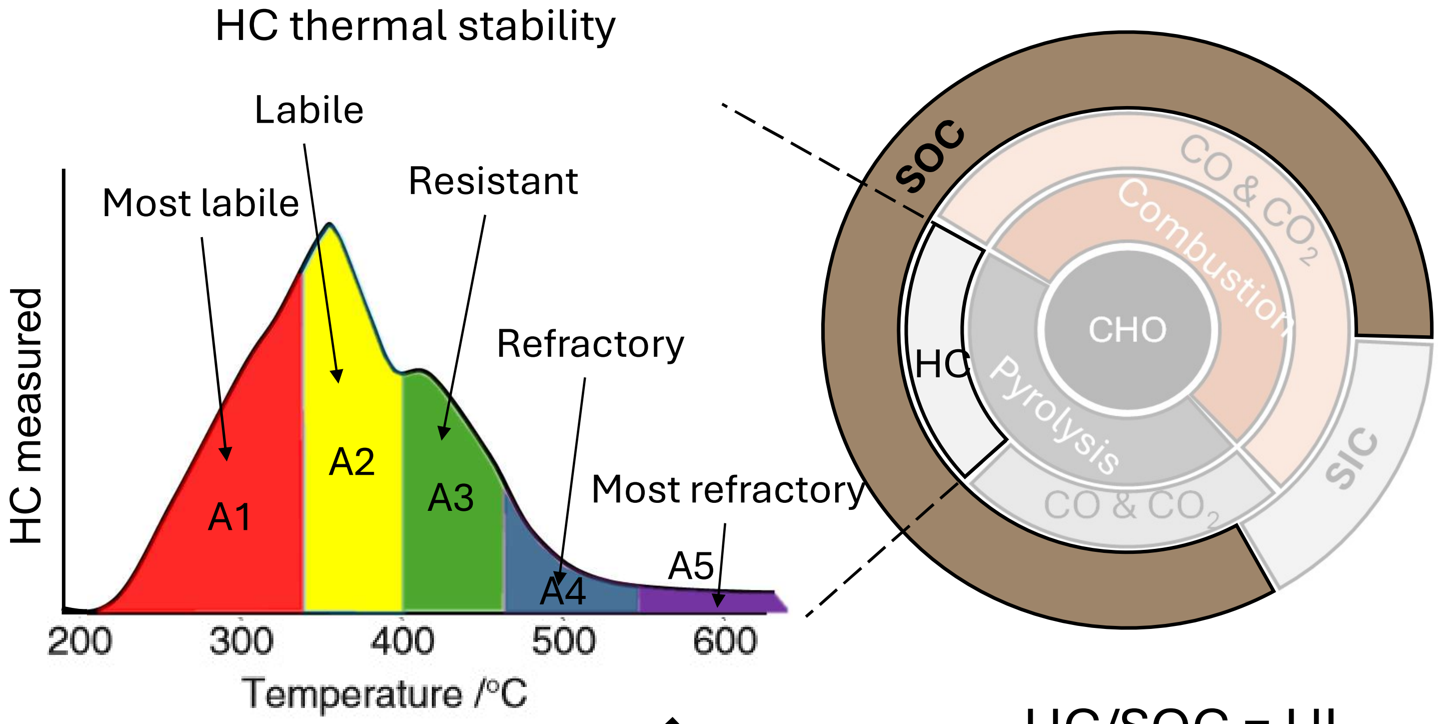


Diagram based on the diagram of Sebag et al. 2006 with the information of Sebag et al. 2016

HC/SOC = HI

HIAx

x = 1, 2, 3, 4 or 5

HC = hydrocarbon compound

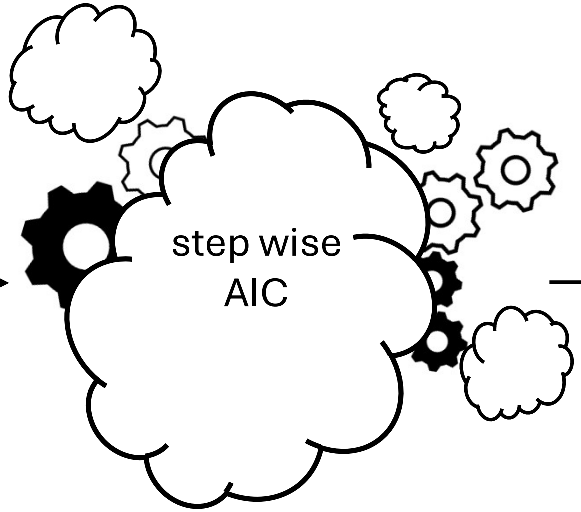
Data analysis : variable selection

Dependent variables

HIAx

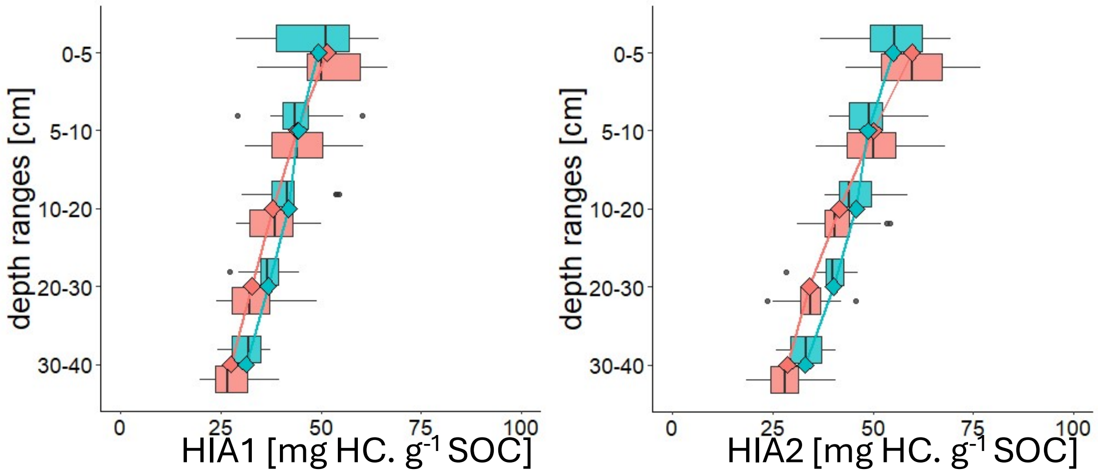
Independent variables

texture fractions (clay, silt, sand)
SOC
SOC:clay ratio
soil tillage
Depth
pH
Rock-Eval® analytical serie °n
Altitude
cumulated rainfall (mm) during the 2 weeks before sampling
….

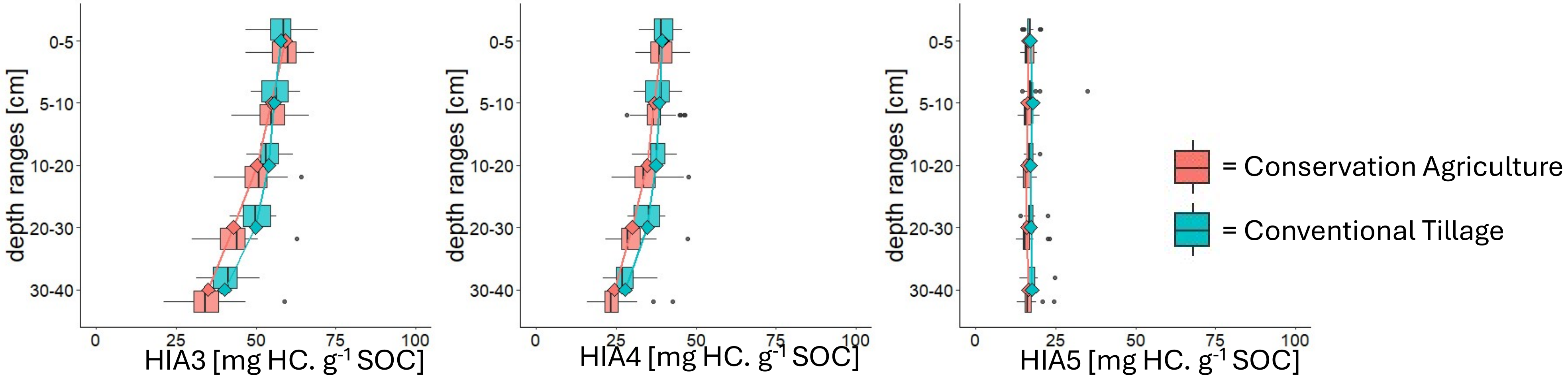


- **SOC:clay ratio**
- **Depth**

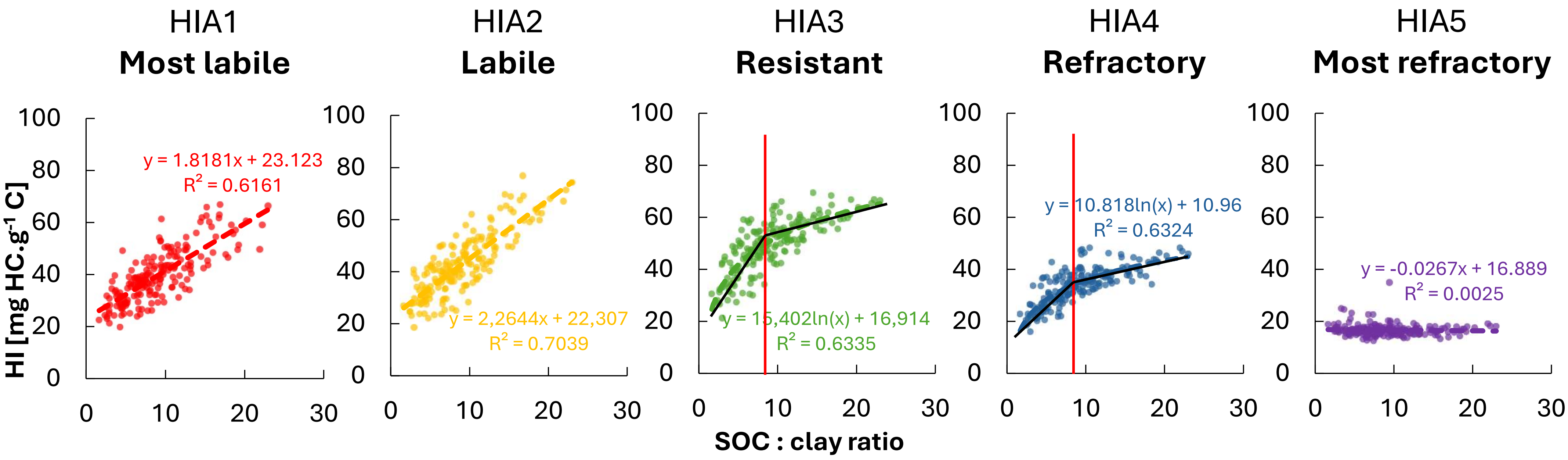
Result: SOM thermal pools (CA vs CT)



- Almost no major difference between CA and CT for OM thermal pools
- The remaining differences are driven by the SOC, not practices
- Practices play only an indirect role via the relocation of OM in the profile



Result: Proportion of different HC pools


HIA1
Most labile

HIA2
Labile

HIA3
Resistant

HIA4
Refractory

HIA5
Most refractory

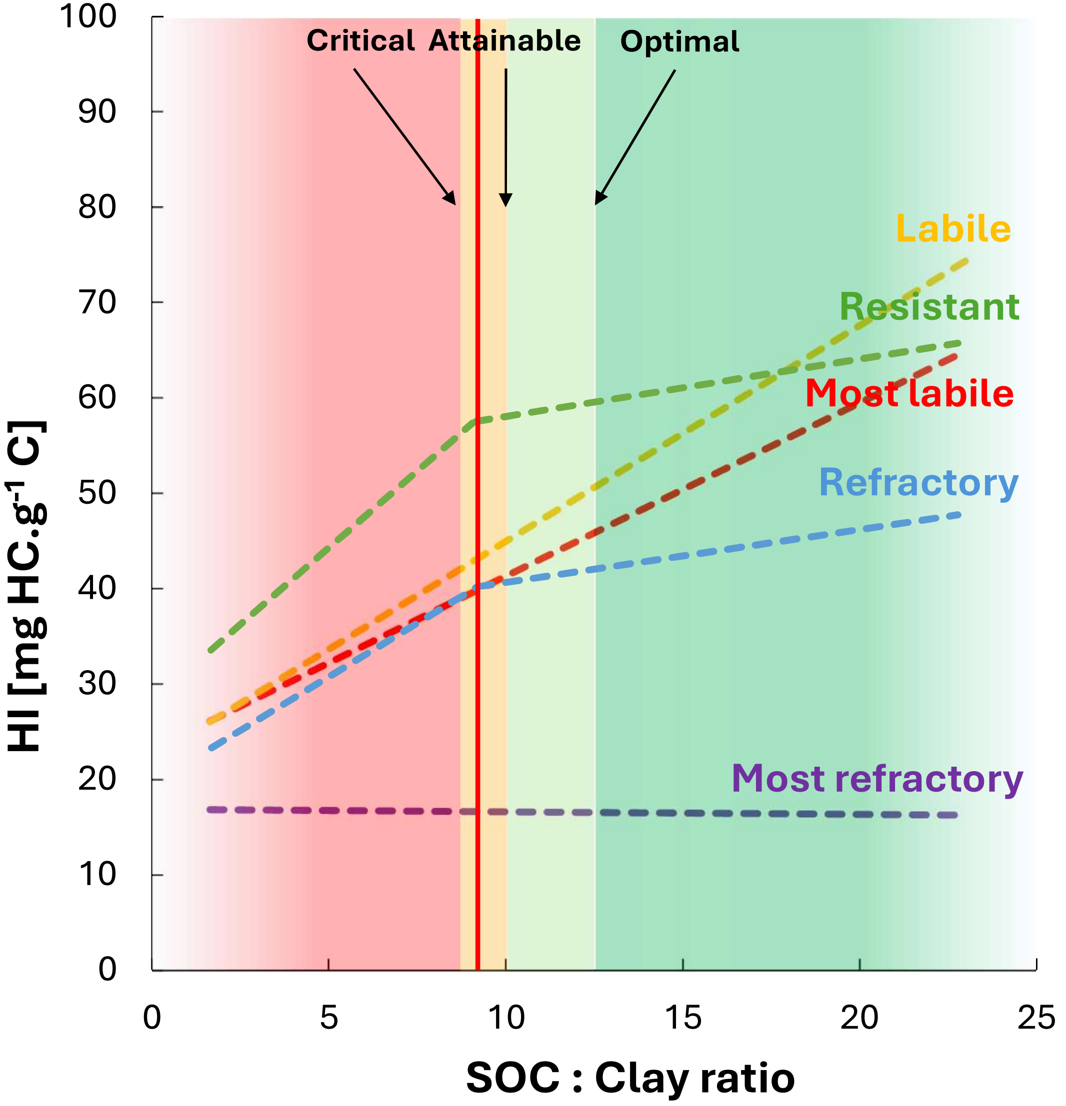
Linear relationship

Logarithmic relationship
(or brocken-stick)

No relationship

Structure high vulnerability: low proportion of resistant and refractory thermal pools

Structure Vulnerability Index (Johannes et al. 2017)



Structure low vulnerability: big proportion of labile and most labile thermal pools

Conclusion

- No direct differences on OM thermal pools between CA & CT
  - →CA & CT are categories too large : need to study practices in more detail

- No clay saturation by OM from quantitative point of view… BUT :
- For OM thermal pools equilibrium : yes !
- Saturation limit point of the SOC:clay ratio correspond to the threshold of the soil structure vulnerability index

Importance to considering both, stable AND labile pools for soil quality

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Thank you for your attention

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Bibliographie

Courvoisier, T.J. (2018). Negative emission technologies: what role in meeting Paris Agreement targets? (Halle (Saale): EASAC Secretariat, Deutsche Akademie der Naturforscher Leopoldina).

Dexter, A.R., Richard, G., Arrouays, D., Czyż, E.A., Jolivet, C., and Duval, O. (2008). Complexed organic matter controls soil physical properties. Geoderma *144*, 620–627.

Johannes, A., Matter, A., Schulin, R., Weisskopf, P., Baveye, P.C., and Boivin, P. (2017). Optimal organic carbon values for soil structure quality of arable soils. Does clay content matter? Geoderma *302*, 14–21.

Minasny, B., Malone, B.P., McBratney, A.B., Angers, D.A., Arrouays, D., Chambers, A., Chaplot, V., Chen, Z.-S., Cheng, K., Das, B.S., et al. (2017). Soil carbon 4 per mille. Geoderma *292*, 59–86.

Naveed, M., Herath, L., Moldrup, P., Arthur, E., Nicolaisen, M., Norgaard, T., Ferre, T.P.A., and de Jonge, L.W. (2016). Spatial variability of microbial richness and diversity and relationships with soil organic carbon, texture and structure across an agricultural field. Appl. Soil Ecol. *103*, 44–55.

Sebag, D., Verrecchia, E.P., Cécillon, L., Adatte, T., Albrecht, R., Aubert, M., Bureau, F., Cailleau, G., Copard, Y., Decaens, T., et al. (2016). Dynamics of soil organic matter based on new Rock-Eval indices. Geoderma *284*, 185–203.