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The effect of tillage, SOM inputs and P-K fertilization on soil structural stability in three long-term field trials in the loess belt of Belgium

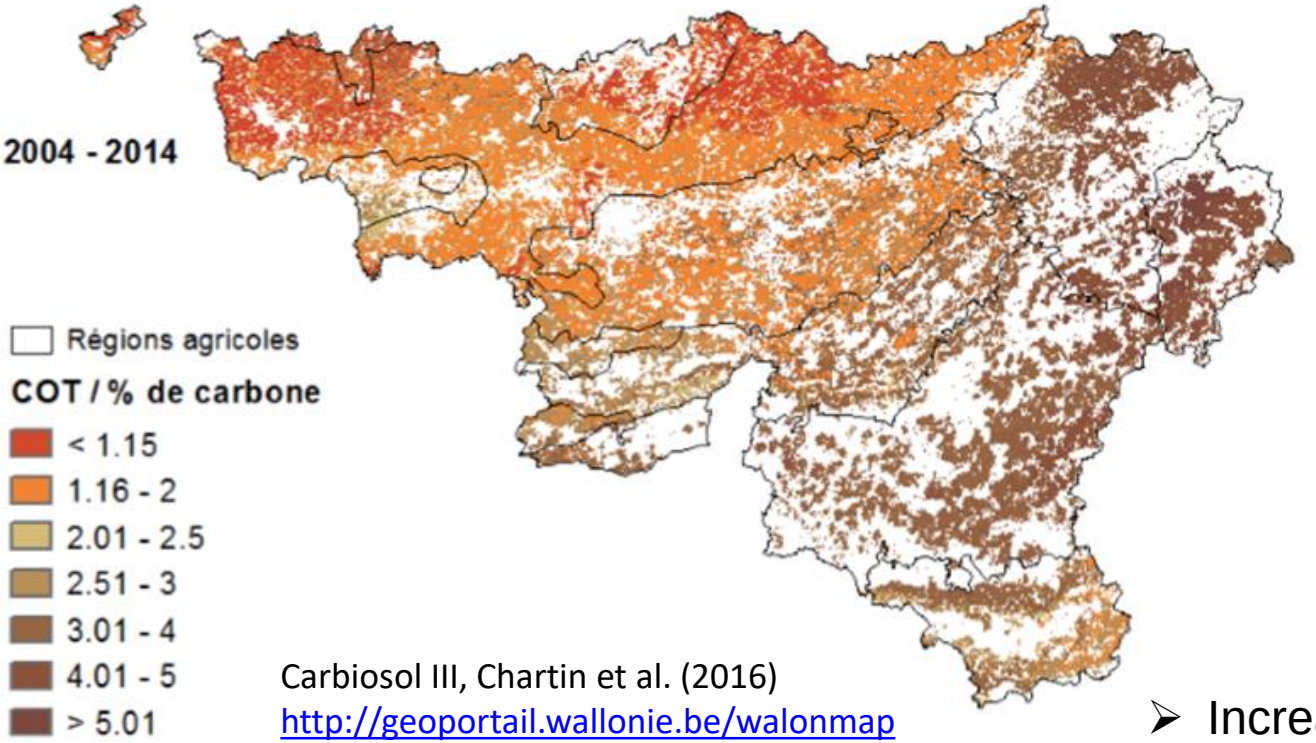
Brieuc Hardy & Frédéric Vanwindekens,
Sols, Eaux et Productions Intégrées, département Systèmes & Prospectives, CRA-W

Wallonie recherche CRA-W

Wallonie

Context

Many cropland soils of the belgian loess belt have a SOC content below the threshold value of structural instability



Carbiosol III, Chartin et al. (2016)
http://geoportail.wallonie.be/walonmap

From 1960 to 2005:

- Cropland soils of the silt loam region - 14 tC/ha!
- 22 % of cropland area < 1.15 % SOC against 9 % en 1960!

- ➢ Increase in plowing depth
- ➢ Decrease of winter crops & temporary grassland in rotation

Context

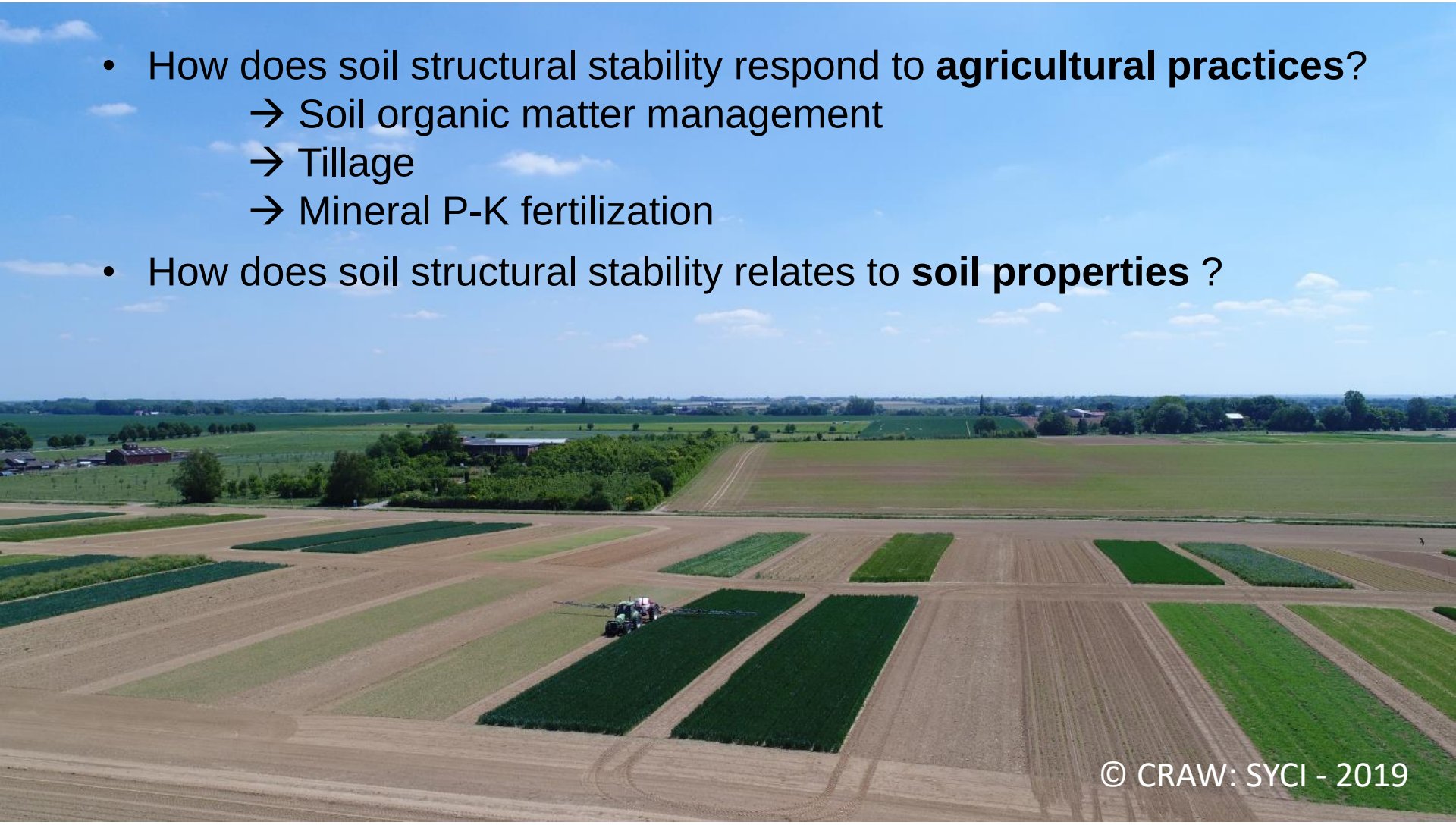
Many cropland soils of the belgian loess belt have a poor structure due to their high silt and low SOM contents

→ Poor resistance to **compaction**

→ Poor resistance to **raindrop impact** and **water erosion**

Objectives

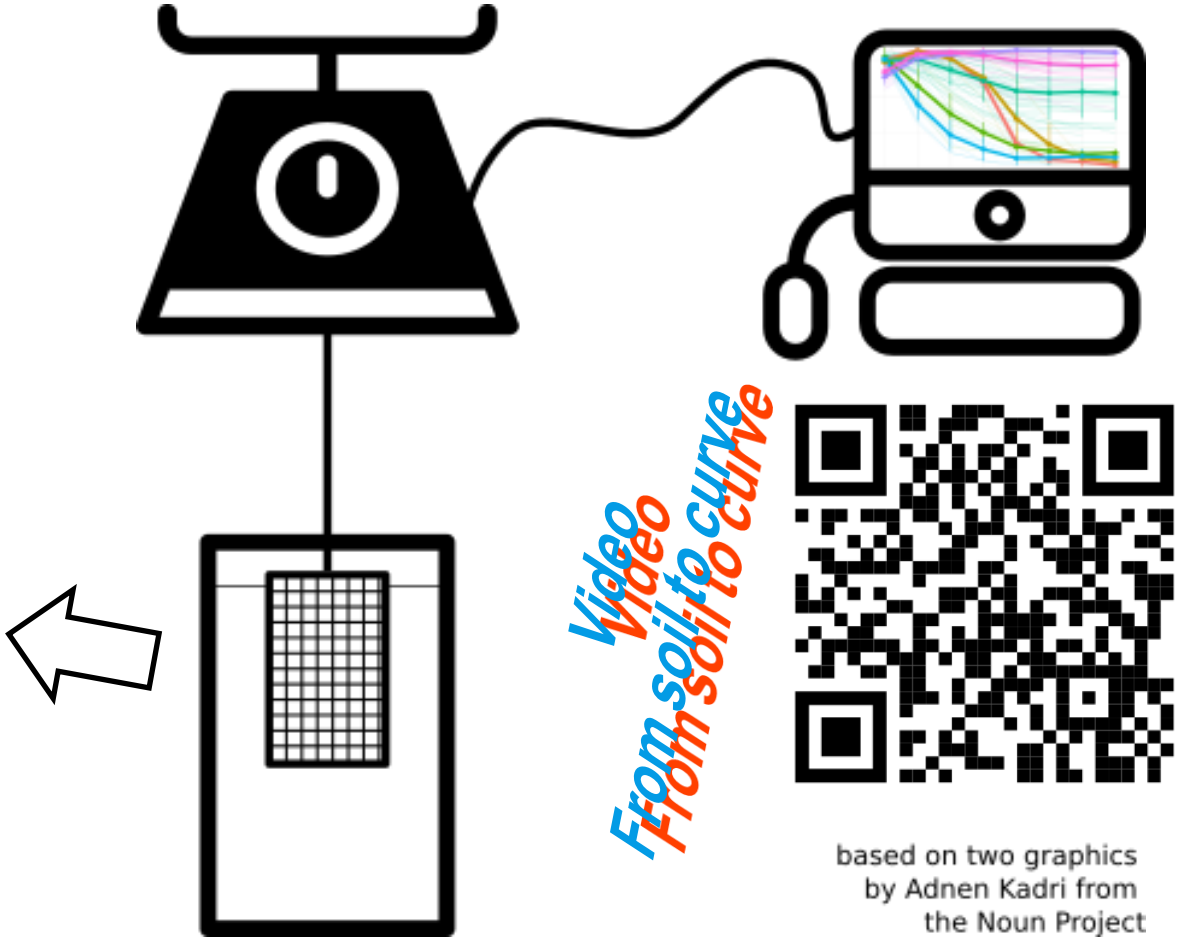
- How does soil structural stability respond to **agricultural practices**?
  - → Soil organic matter management
  - → Tillage
  - → Mineral P-K fertilization
- How does soil structural stability relates to **soil properties** ?



The QuantiSlake test

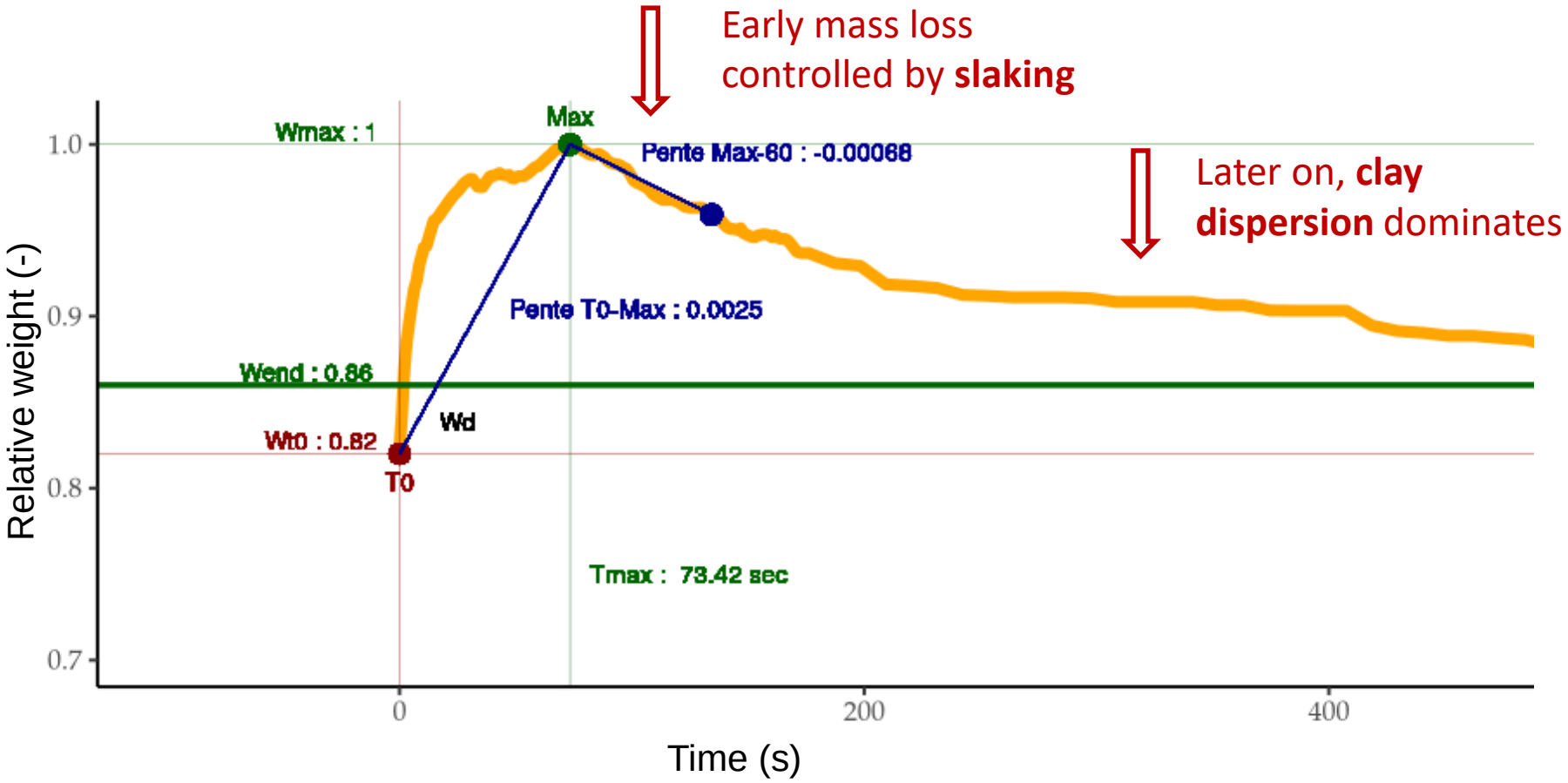
How does it work?

Picture – F. Vanwindekens, 2021 - CC-BY



The QuantiSlake test

Indicators from curves



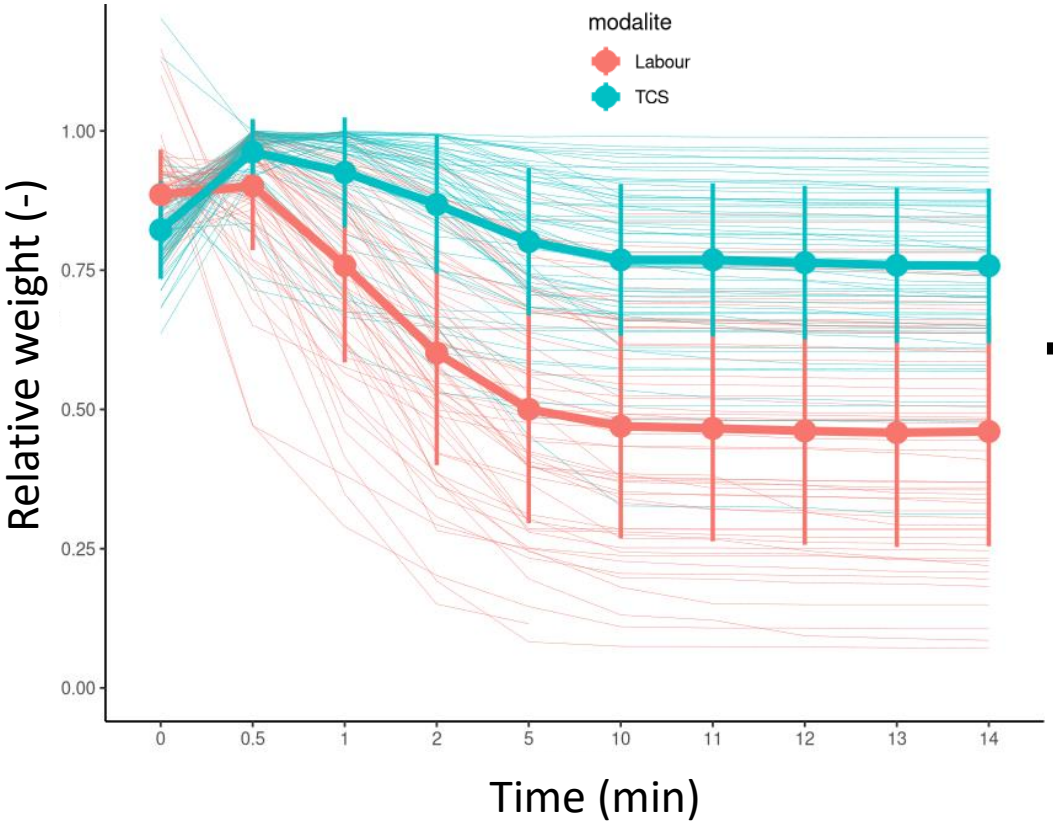
Application to soils subjected to contrasting soil management practices

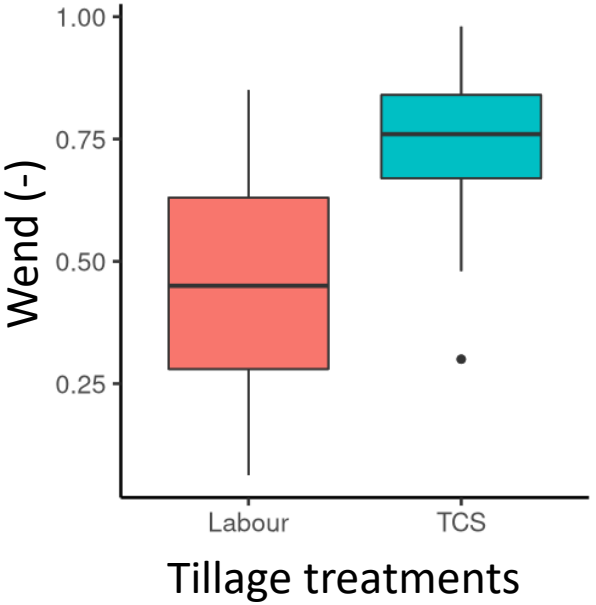
Soil Sampling at three long-term field trials in CRA-W

- **Tillage trial (4)** :
  - Ploughing
  - Reduced tillage
- **Organic matter trial (6)** :
  - Composted cattle manure
  - Green manure & res. rest.
  - Exportation of all residues
- **P-K trial (3)**:
  - K0xP1
  - K1xP1
  - K2xP1
- **For each field…**
  - 5 slake tests
  - SOC, clay, pH, bulk density

Results

Reduced tillage improves soil structural stability regardless of QST indicator

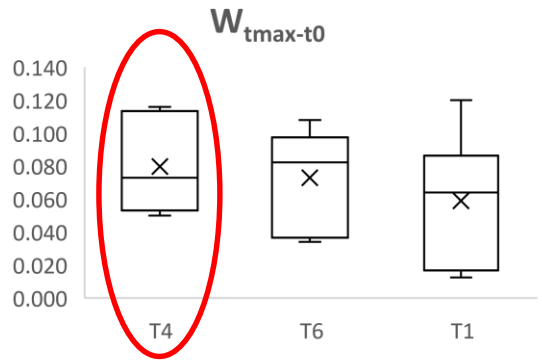


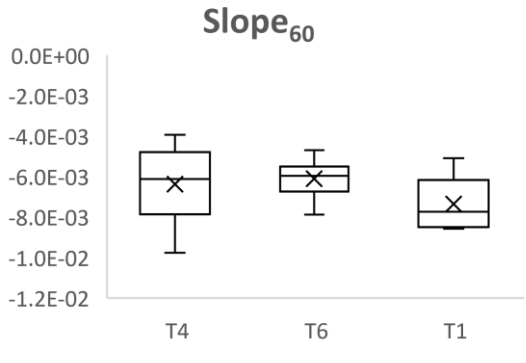


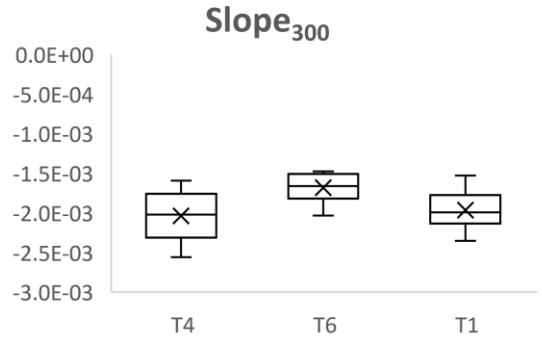
Results

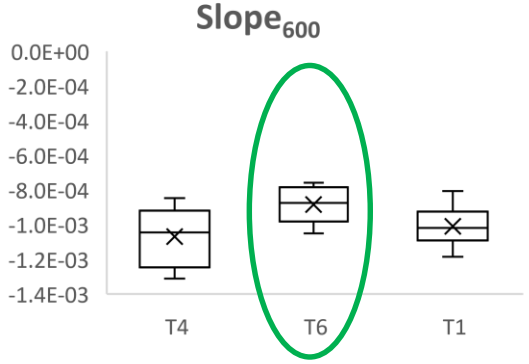
For similar OM inputs, farmyard manure and green manure have contrasting effects on slaking and clay dispersivity

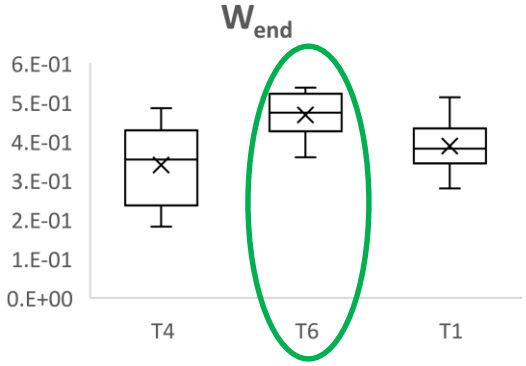
Composted cattle manure (T4) is more efficient against slaking → **macroaggregation**







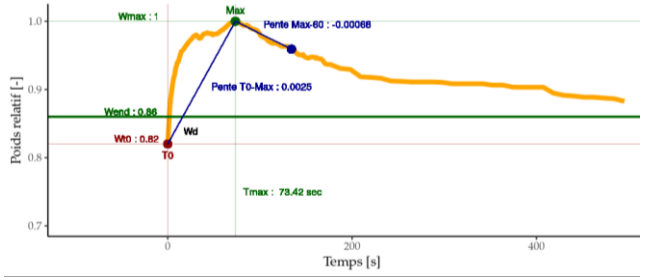




Green manure & crop residues (T6) are more efficient against clay dispersion → **microaggregation**

Results

Relationship with soil properties



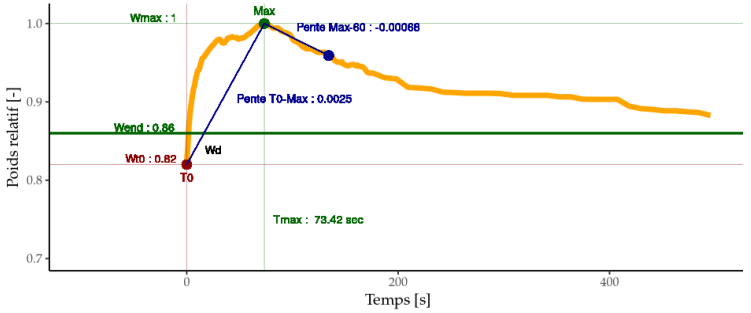
	OC	Clay	OC:Clay	pH	ρb
Wmax-Wt0	0.558	-0.818	0.917	0.103	-0.551
Tmax	0.539	-0.651	0.812	0.025	-0.437
Slope 30	0.468	-0.628	0.703	-0.116	-0.08
Slope 60	0.476	-0.561	0.681	-0.161	-0.145
Slope 300	0.348	-0.569	0.636	-0.012	-0.386
Slope 600	0.295	-0.574	0.607	0.016	-0.426
Wend	0.226	-0.528	0.539	0.001	-0.347

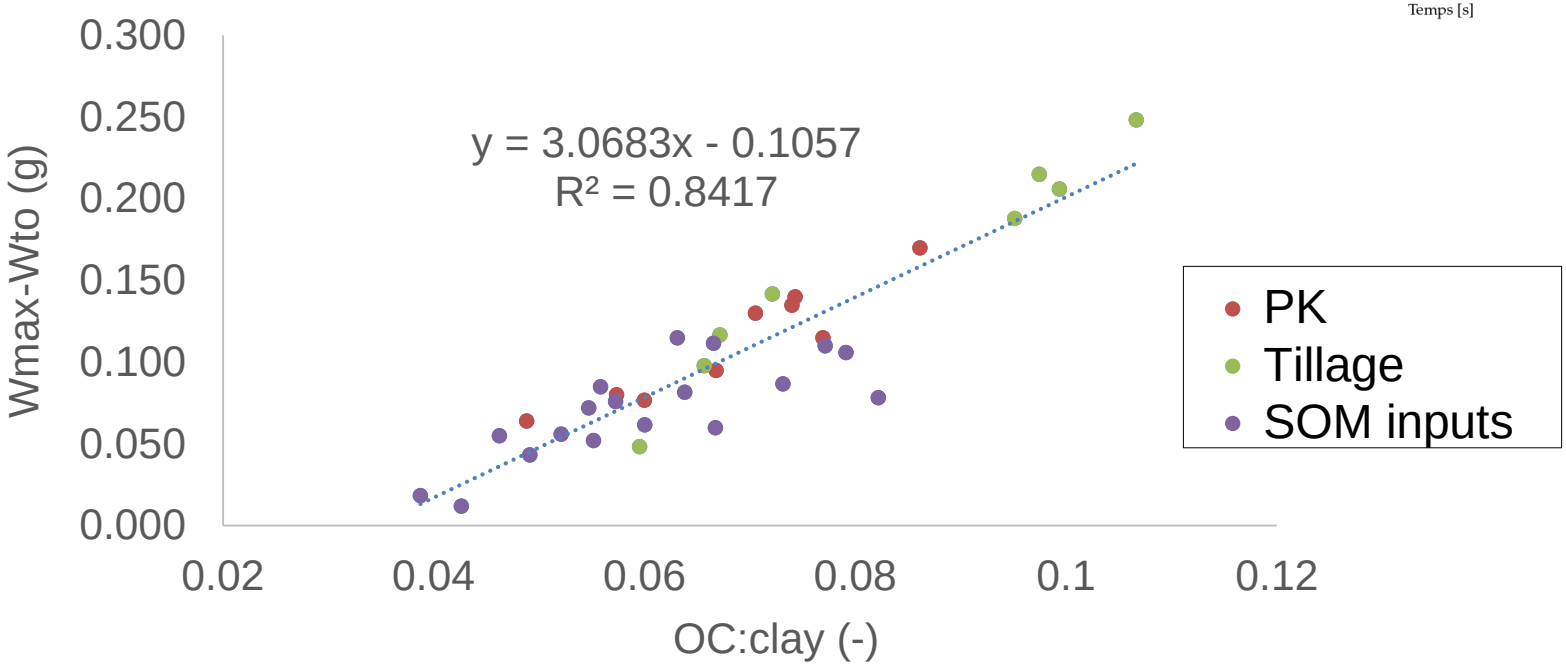
- **Clay** is negatively correlated to every indicator of the QuantiSlake, which underlines the role of dispersible clay in soil disagregation in wet conditions

- The **OC:Clay** ratio is positively correlated to every indicator of the curves, which confirms its potential to manage soil structural stability and SOM status of agricultural soil (Dexter et al., 2008; Johannes et al., 2017).

Results

Several indicators from the curves are strongly correlated to the OC:clay ratio





- Particularly, the early increase in soil mass after introduction in water (**Wmax-Wt0**) is **strongly correlated to the OC:Clay ratio** and might therefore represent a useful indicator for the direct estimation of soil structural stability

Conclusions & Perspectives

Strengths

- Rapid, simple, requires little equipment & lab consumables
- Works on structured soil samples of large size (100 cm^3)
- Dynamic analysis, high density of information
- Information on both slaking and clay dispersibility
- Strong correlation with the OC:Clay ratio which is a recognized proxy for soil structural stability (Dexter, 2008)

Limitations

- Doesn't investigate the resistance of soil to raindrop impact
- No information on particle size after disaggregation

To be continued…

- R package and an application to manage data (indicators calculations & statistics) and plot results
- Curve interpretation & modelling, disaggregation mechanisms and response to farming practices and soil properties

Thank you for listening!

References

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

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Contact

Unité Sols, Eaux & Productions Intégrées

rue du bordia 4, 5030 Gembloux
Belgique

Video
From soil to curve

Frédéric Vanwindekens
f.vanwindekens@cra.wallonie.be
081/874184

Brieuc Hardy
b.hardy@cra.wallonie.be
081/874340