The contribution of soil organic matter to soil health. Soil Health for Climate

Claire Chenu

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Breakout Session

Soil health for climate

21 November 2023, 14:00-16:00

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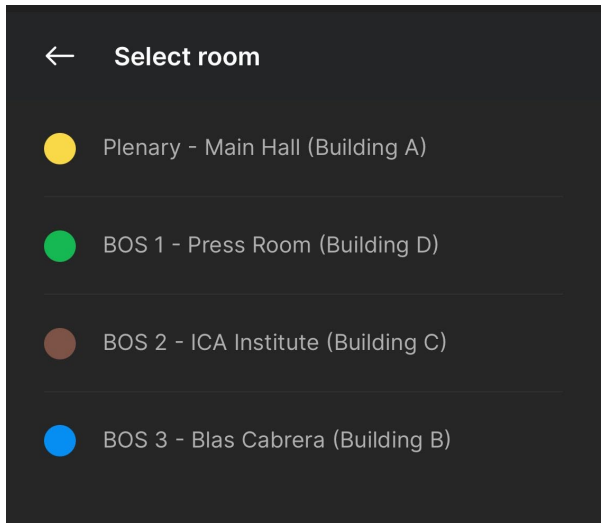
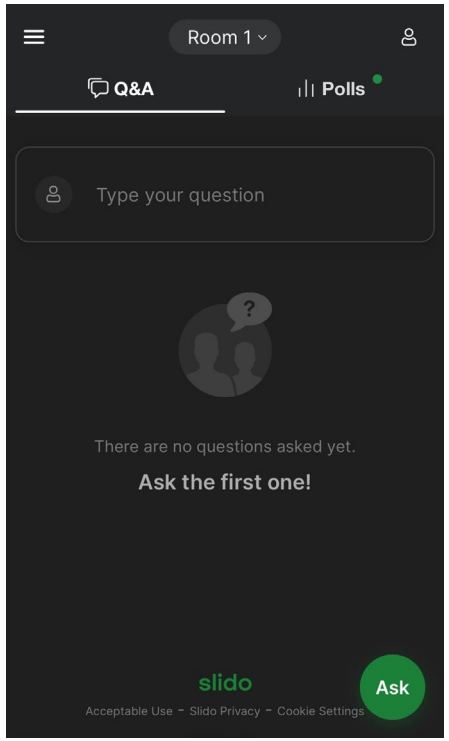
Housekeeping rules

- **WIFI**
  - Network : EMSW
  - Password : np9dpL9Y$8CS7v%

- **Questions**
  - Go to www.sli.do and enter event code **#ESMW2023** (or scan the QR code)
  - Select the ‘room’ of the session
  - Submit your questions





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Moderator

Anna Besse-Lototskaya

Co-coordinator of the EU-co-funded programme EJP SOIL

Wageningen University & Research

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Agenda

Presentations (moderator: Anna Besse-Lototskaya)

- Claire Chenu: *The contribution of soil organic matter to soil health*
- Marta Goberna: *Trade-offs between carbon sequestration, greenhouse gas emissions and nutrient losses*
- Martin H. Thorsøe: *How do existing carbon farming schemes account for synergies and trade-offs?*
- Input from the audience: *Slido*
- Saskia Visser: *Diversifying incomes through a comprehensive carbon farming/ nature credit framework*

Panel discussion (moderator: Claire Chenu)

- Tristano Bacchetti De Gregoris, Cristiano Ballabio, Christian Holzleitner, Saskia Visser: *How to develop carbon farming schemes that account for synergies and trade-offs*
- Summary of inputs

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Our speakers

Martin Thorsøe

Coordinator of the EU-co-funded project Road4schemes

Aarhus University

Marta Goberna

Coordinator

EU-co-funded project TRACE-Soils

Saskia Visser

Cluster manager

Resilient and climate neutral regions at Climate - KIC

Claire Chenu

Senior scientist and Coordinator of the EU co-funded programme EJP SOIL

INRAE (French National Research Institute for Agriculture, Food and Environment)

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The contribution of soil organic matter to soil health

Claire Chenu

INRAE, France

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GOBIERNO DE ESPAÑA MINISTERIO DE CIENCIA E INNOVACIÓN

CSIC

INIA Instituto Nacional de Investigación y Tecnología Agraria y Alimentaria

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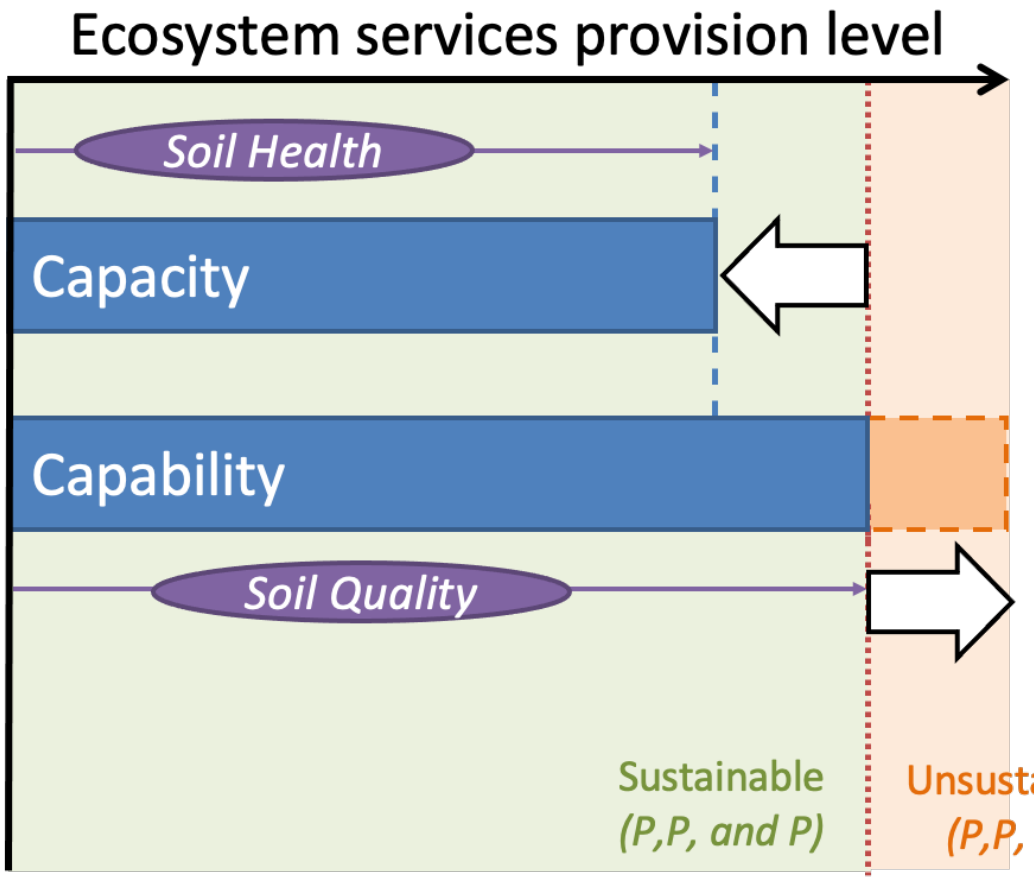
Soil health is the actual capacity of soils to provide ecosystem services



Doran et al. 1994
Veerman et al. 2020
Faber et al. 2021

Current soil status and ecosystem management limits provision of ecosystem services

Context properties (e.g., soil type and land use) define potential at sustainable use

Land use sustainability in terms of people, planet, profit (P,P,P)

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Faber et al. 2021
https://ejpsoil.eu/fileadmin/projects/ejpsoil/Policy_briefs/SIREN/SIREN_Policy_brief.pdf

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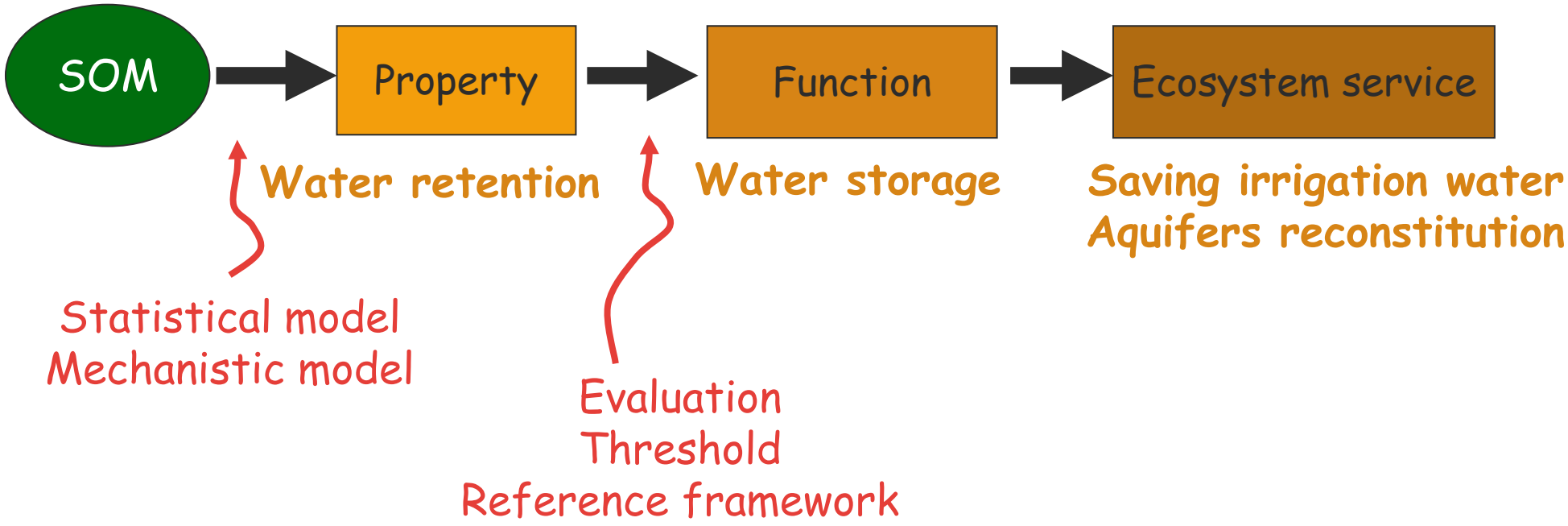
Quantitative relationships : from properties to functions and ecosystem services



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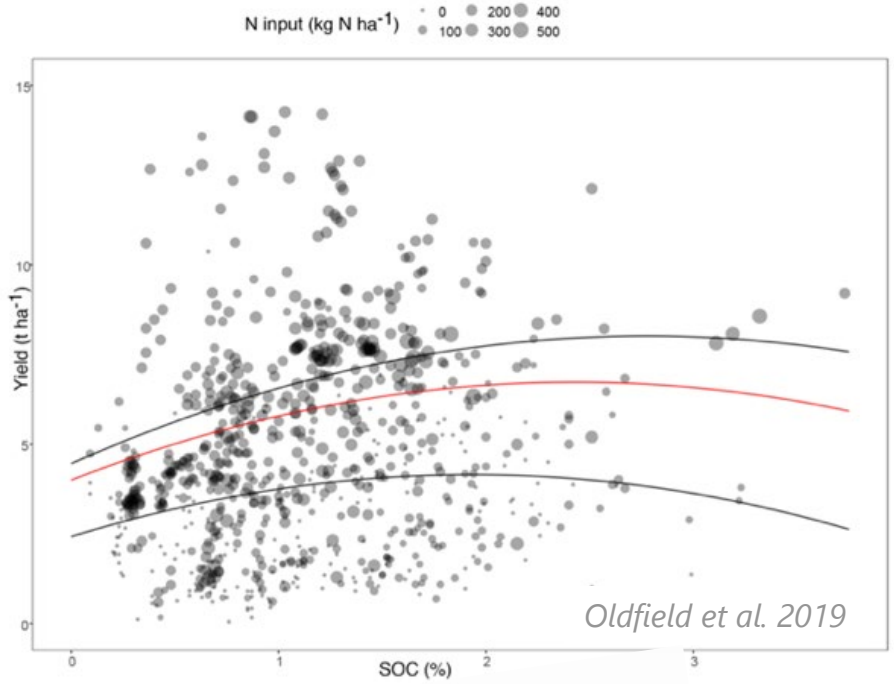
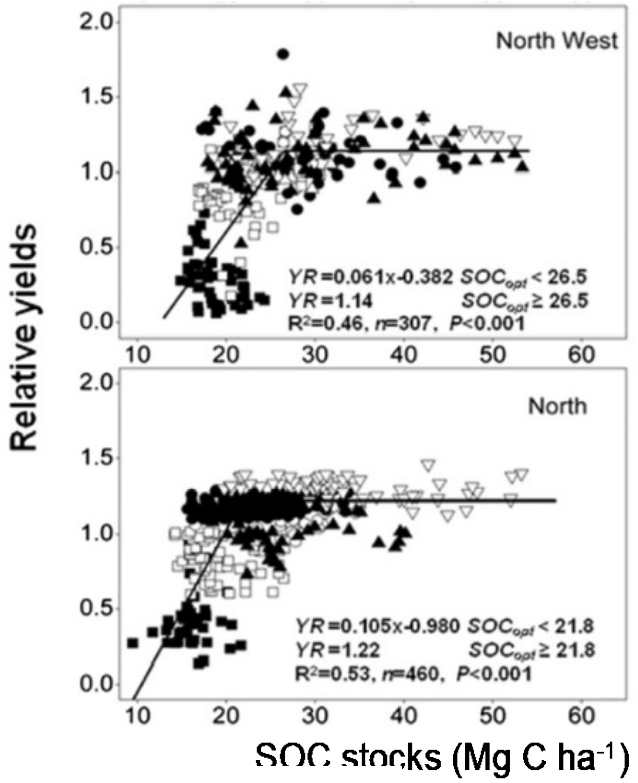
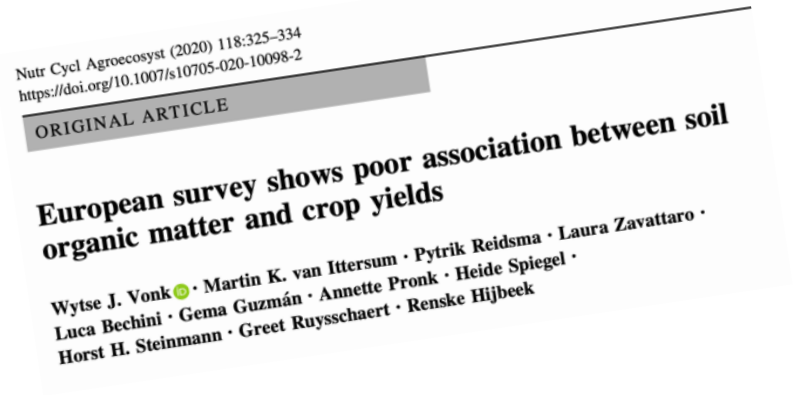
Supporting primary productivity: yields



Oldfield et al. 2019



Zhang et al. 2016

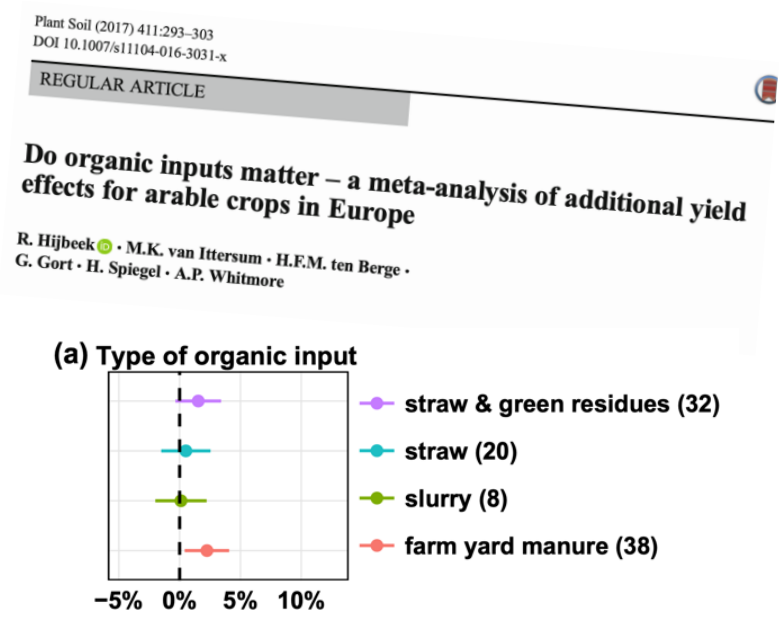


Nutr Cycl Agroecosyst (2020) 118:325–334
https://doi.org/10.1007/s10705-020-10098-2

ORIGINAL ARTICLE

European survey shows poor association between soil organic matter and crop yields

Wytse J. Vonk · Martin K. van Ittersum · Pytrik Reidsma · Laura Zavattaro · Luca Bechini · Gema Guzmán · Annette Pronk · Heide Spiegel · Horst H. Steinmann · Greet Ruysschaert · Renske Hijbeek ·



Plant Soil (2017) 411:293–303
DOI 10.1007/s11104-016-3031-x

REGULAR ARTICLE

Do organic inputs matter – a meta-analysis of additional yield effects for arable crops in Europe

R. Hijbeek · M.K. van Ittersum · H.F.M. ten Berge · G. Gort · H. Spiegel · A.P. Whitmore

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Soil organic matter effects and associated benefits

Property or process	Static (S) or dynamic (D) effect	Effect on soil properties	Benefit	predictive tool for property?	Soils most concerned
Chemical properties					
Increase in CEC	S	↗ NH_4^+, K, Ca, Mg, Fe retention	↗ plant mineral nutrition	PTF	Sandy soils
		↗ resistance to erosion	↘ erosion	model	
Porosity increase	S	↗ available water	↗ water available for plants	PTF	Sandy, stony and thin soils
		↗ water infiltration	↘ runoff and P and pesticide losses ↘ erosion ↗ water available for plants ↗ replenishment of water reserves (blue water)	PTF	Silty crusting soils, clayey soils
		↘ penetration resistance	↘ mechanical energy to work soils		Clayey soils
Mulch at the soil surface	S	↘ evaporation	↗ water available for plants ↗ replenishment of water reserves (blue water)		Sandy soils
		↘ runoff	↘ erosion	model	Silty crusting soils, slope soils
Darker color of soil	S	↗ rapid soil warming	earlier seedling emergence	model	
Biological properties and processes					
Mineralisation of N, P, S	D	↗ available nutrients	↗ plant mineral nutrition	model	All soils
		↗ nitrates in solution	↘ water quality	model	All soils
Mineralisation of C and N	D	↗ SOM stabilisation	↗ C storage	model	All soils
		↗ N_2O and methane emissions	↗ GHG emissions	model	Hydromorphic soils
Trophic resource for organisms. Increased abundance and diversity of soil biota	D	↗ abundance and biodiversity of soil biota	↗ soil resilience	-	All soils
		↗ symbiots and PGPR	↗ crop growth	-	
		↗ regulating pathogens and pests	↗ crop sanitary quality	-	All soils
		↗ biodegradation of organic contaminants	↗ water quality, food quality	-	All soils

$$CEC = 0.037\ clay_{g/kg} + 0.273\ Corg_{g/kg}$$
$$CEC = 1.24 + 0.058\ clay_{g/kg} + 0.466\ Corg_{g/kg}$$
$$CEC = 0.062\ clay_{g/kg} + 0.295\ Corg_{g/kg} + \Delta OC\ charge(pH8.1\text{-soil pH})$$

Bigorre et al. 2000
Krogh et al. 2000
Van Erp et al. 2001

Chenu et al. in Pellerin & Bamière, 2017. INRAE 4p1000 expert assessment

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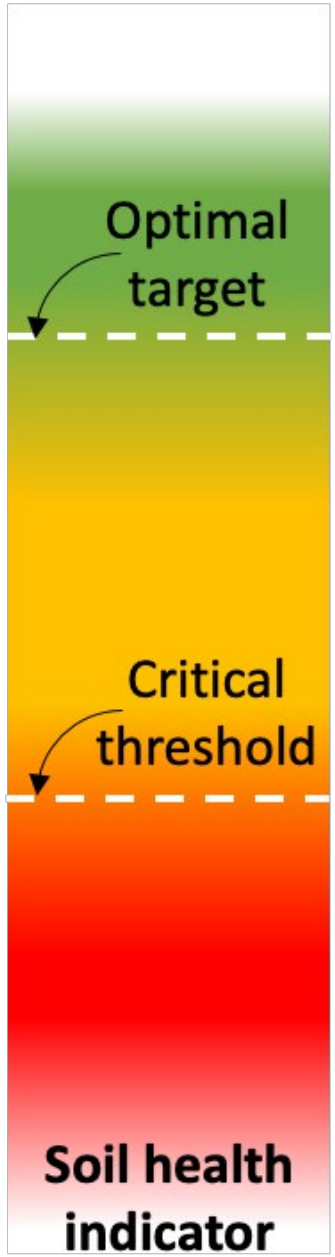
Setting SOM critical values



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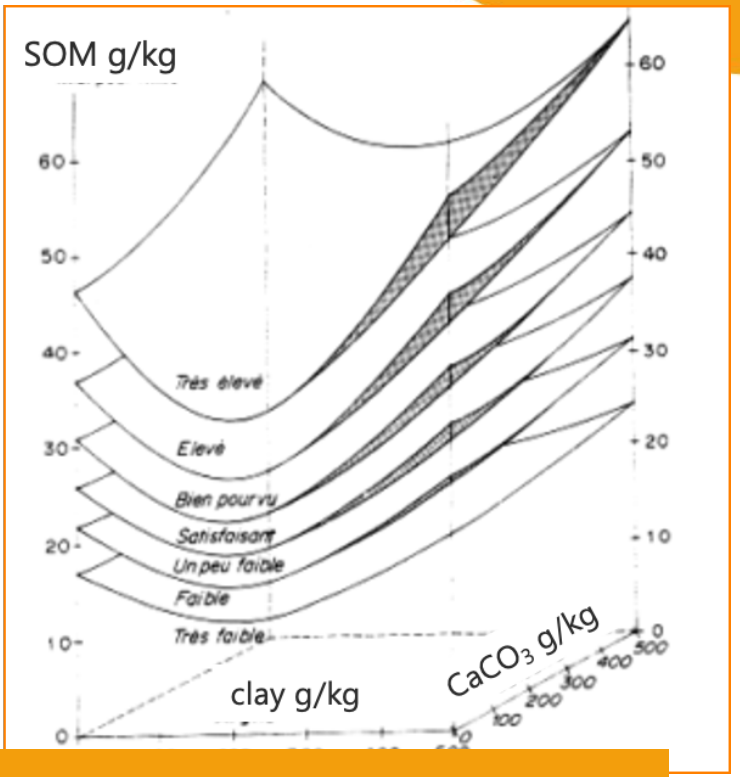
1- Fixed critical values

Table 2.5 **Matrix of mean SOC minimum and maximum thresholds for cropland soils (% soil mass)**

Soil texture class	Climatic water balance (mm) summer					
	Less than -100		-100 to 0		More than 0	
	Min.	Max.	Min.	Max.	Min.	Max.
Sand	0.5	1.23	0.9	1.73	1.2	2.23
Silt	1.5	2.53	1.0	2.07	0.8	1.59
Loam and clay	0.6	1.47	0.9	1.92	1.9	3.23

Source: Compiled from Wessolek et al. (2008).

Wessolek et al. 2008 in Baritz et al. EEA report 2023



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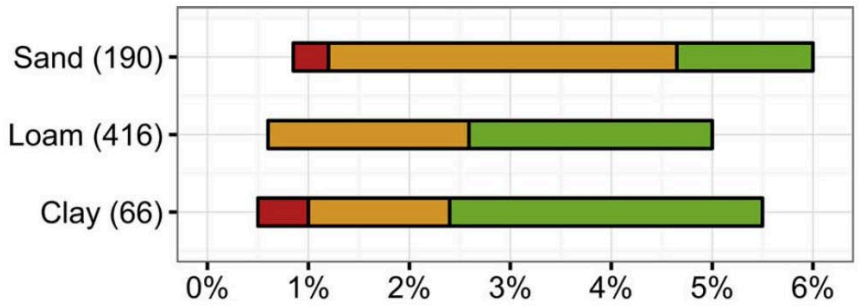

Hijbeek et al. 2017

Perceived deficiency of SOM

- Neutral, high and very high
- Very low to very high (all)
- Neutral, low and very low

1642 arable fa

- Simple
- Can be linked to functions
- Requires context specific references
- Available knowledge?

Matson et al. submitted

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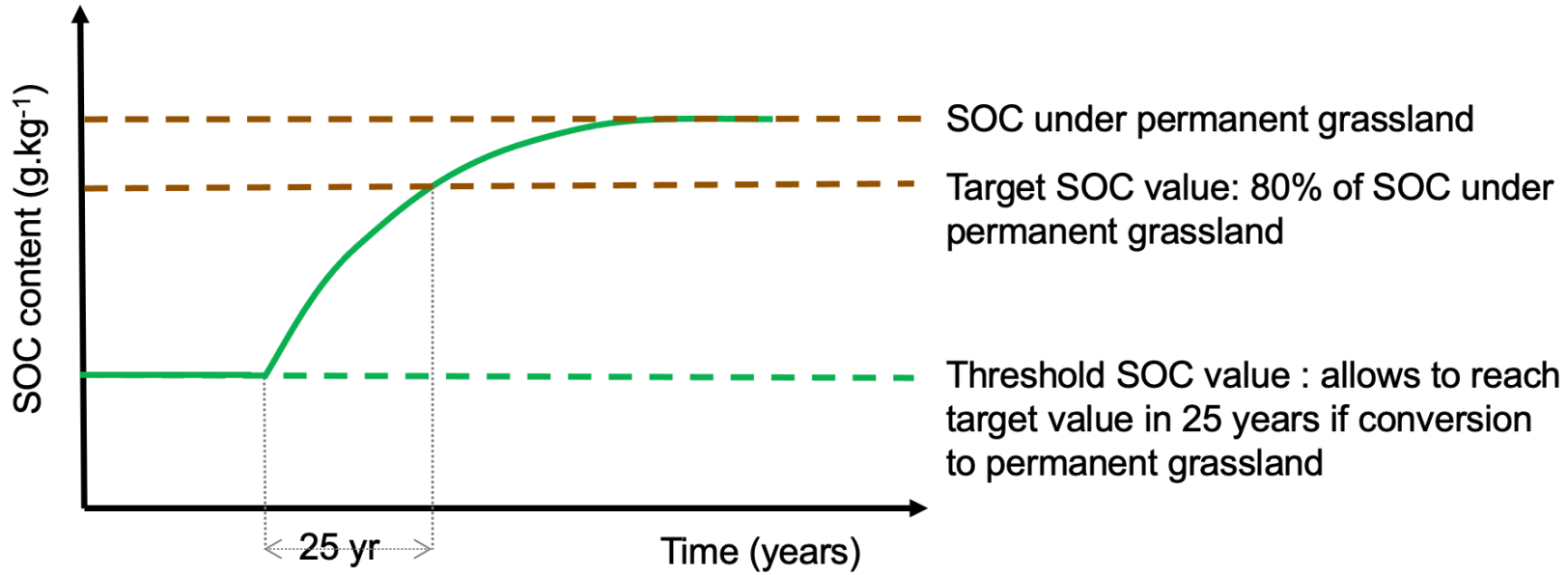
2- Critical values relative to “natural” land uses



Adapted from *Sparling et al. 2003*

- Simple
- Not linked to functions
- Needs to be context specific
- “Natural” references available?

Matson et al. submitted

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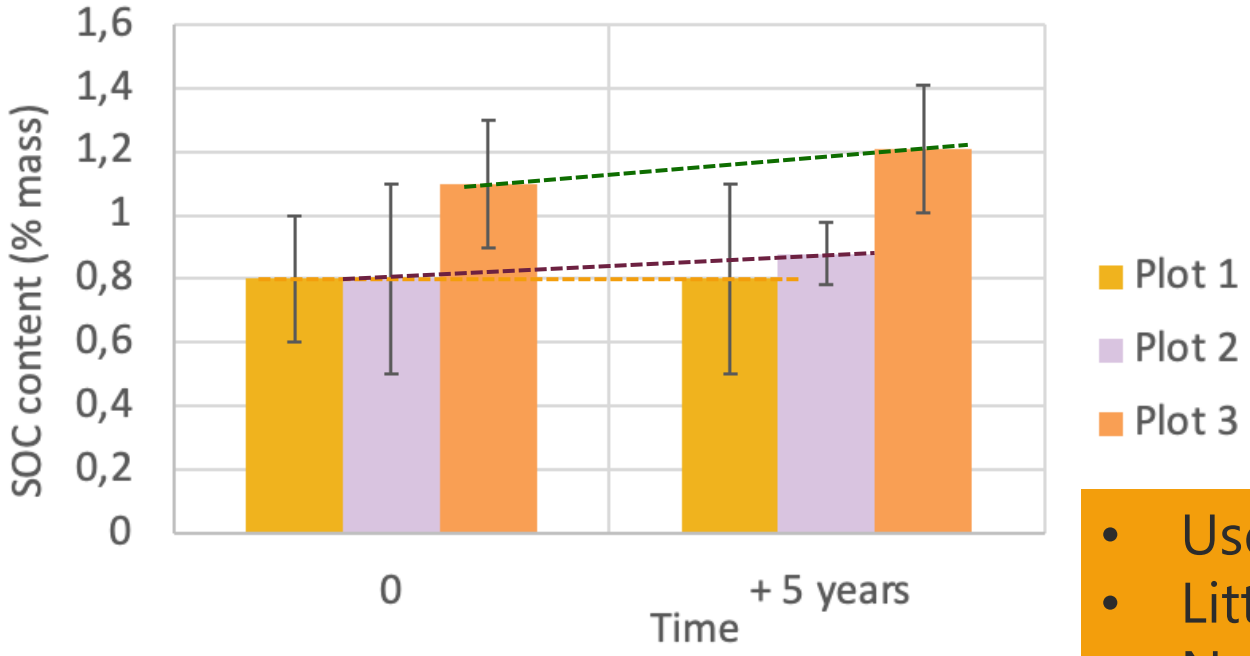
3- Critical values based on relative changes



- Uses current values
- Little knowledge & stratification required
- Not linked to soil functions
- Which desired/measurable % improvement
- What about pioneers ?

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Matson et al. submitted

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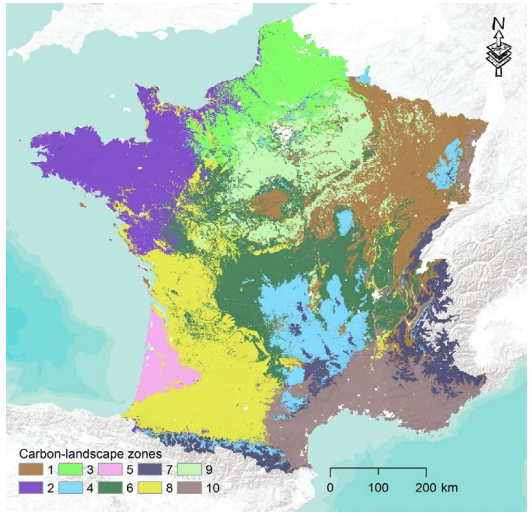
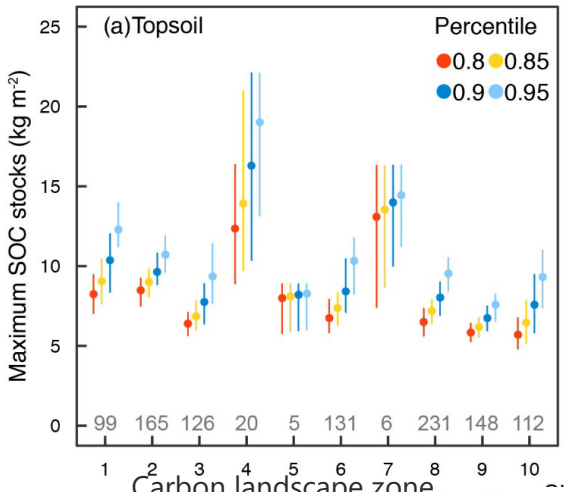
4- Critical values based on existing distribution of the indicator values

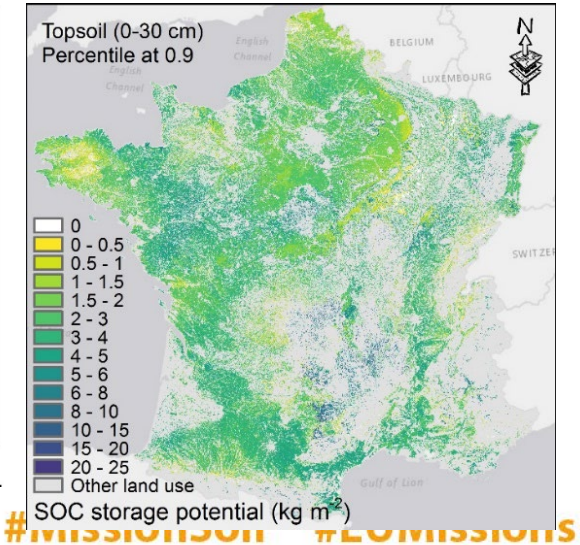
	SOC stocks for 0-20 cm layer (Mg C. ha^{-1})	
	Target value	Threshold value
Soil order	Median C content long term pasture	Lower quartile
Recent	72	54
Granular	88	78
Melanic	98	74
Allophanic	132	103

Sparling et al. 2003



Chen et al. 2019 Stoten





- Not linked to functions
- Requires extensive data
- How to set critical values?

Matson et al. submitted

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Conclusion: The contribution of soil organic matter to soil health

- Central role of soil organic matter.
- Soil health: several ecosystem services. Tradeoffs.
- Need for quantitative information to sustain decision- support tools. Context-specific. Synthesis.
- Different approaches are available to set SOM critical values.

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EJP SOIL work on critical values for indicators: A. Bispo, C. Calzolari, I. Cousin, J. Faber, M. Fantappie, R. Hessel, S. Mocalli, A. Matson, F. van Egmond et al.

Thank you!

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