Crops and cropping systems that contribute to carbon storage in soil

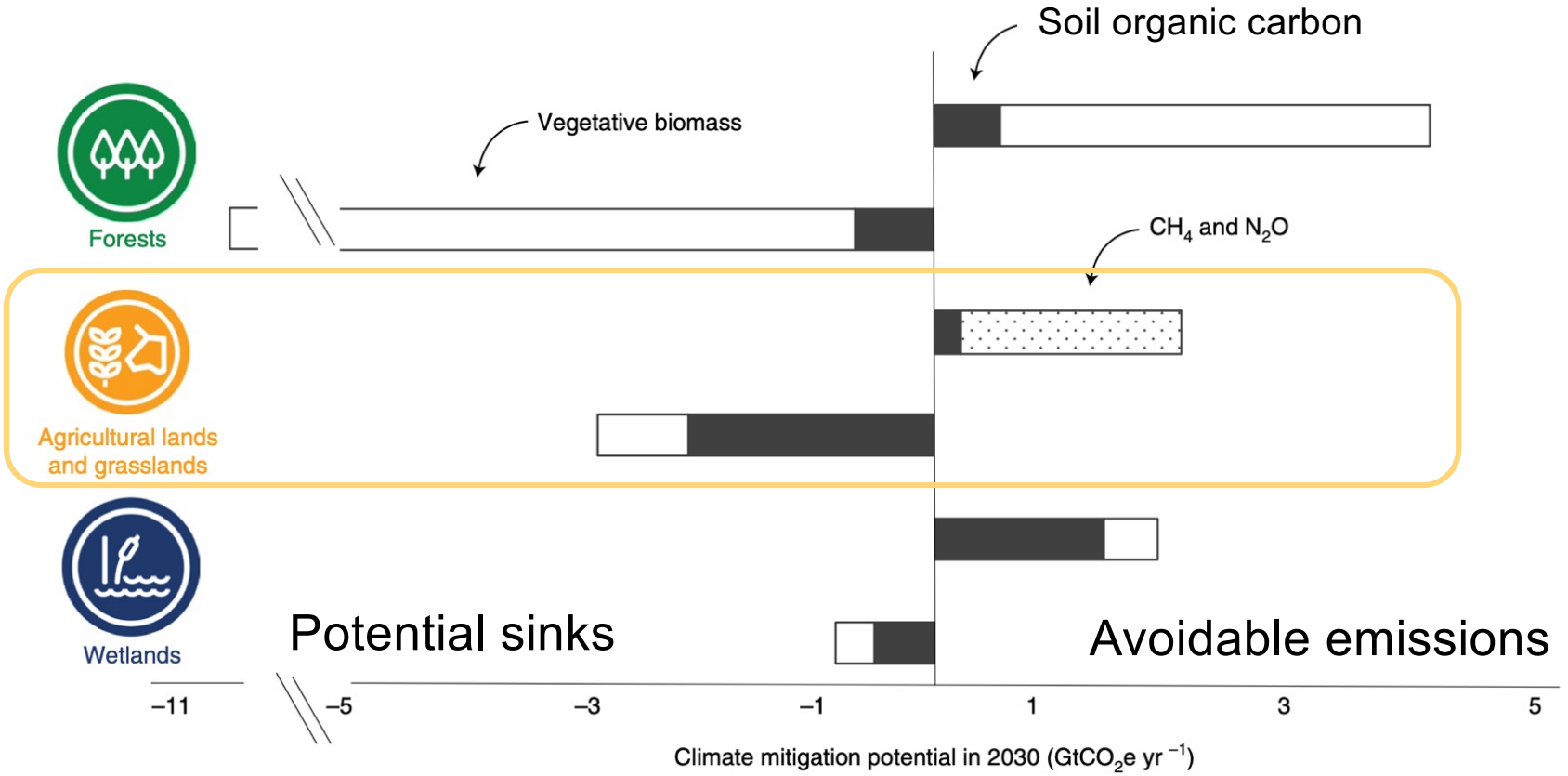
Claire Chenu
INRAE – AgroParisTech
claire.chenu@inrae.fr

Zero Greenhouse Gas Emission in High Productive Agriculture

International conference 3 – 5 May

Novo Nordisk Foundation, Tuborg Havnevej 19, DK-2600 Hellerup

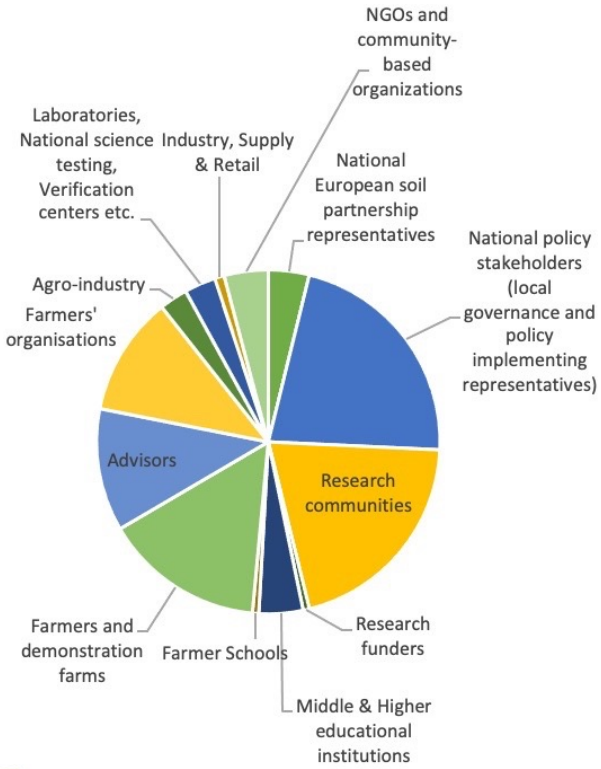
A globally large C sequestration potential in soils

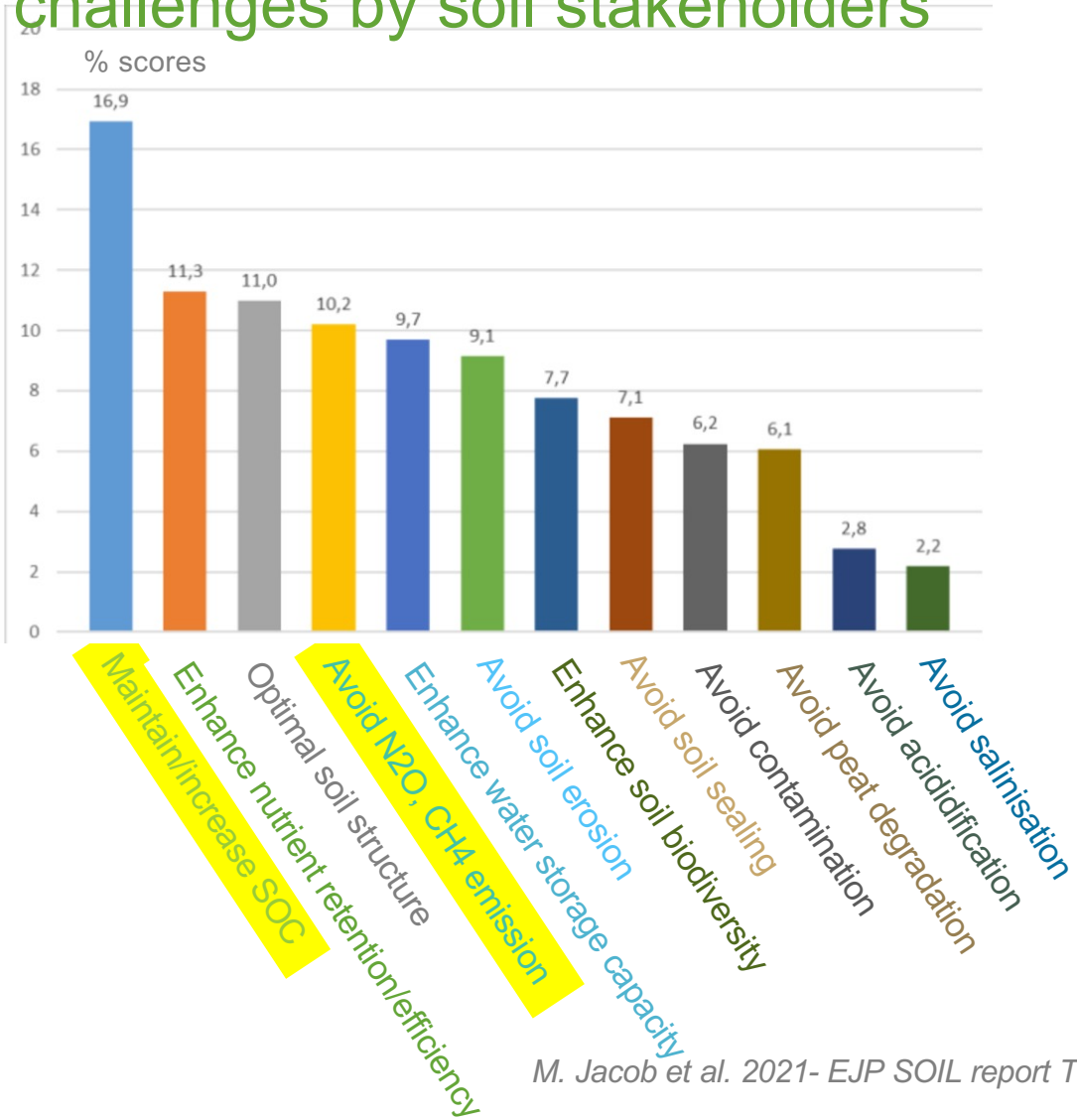


Bossio et al. 2020, Nature Sustain

Perception of agricultural soil challenges by soil stakeholders

National Hubs (>350 stakeholders)





EJP SOIL
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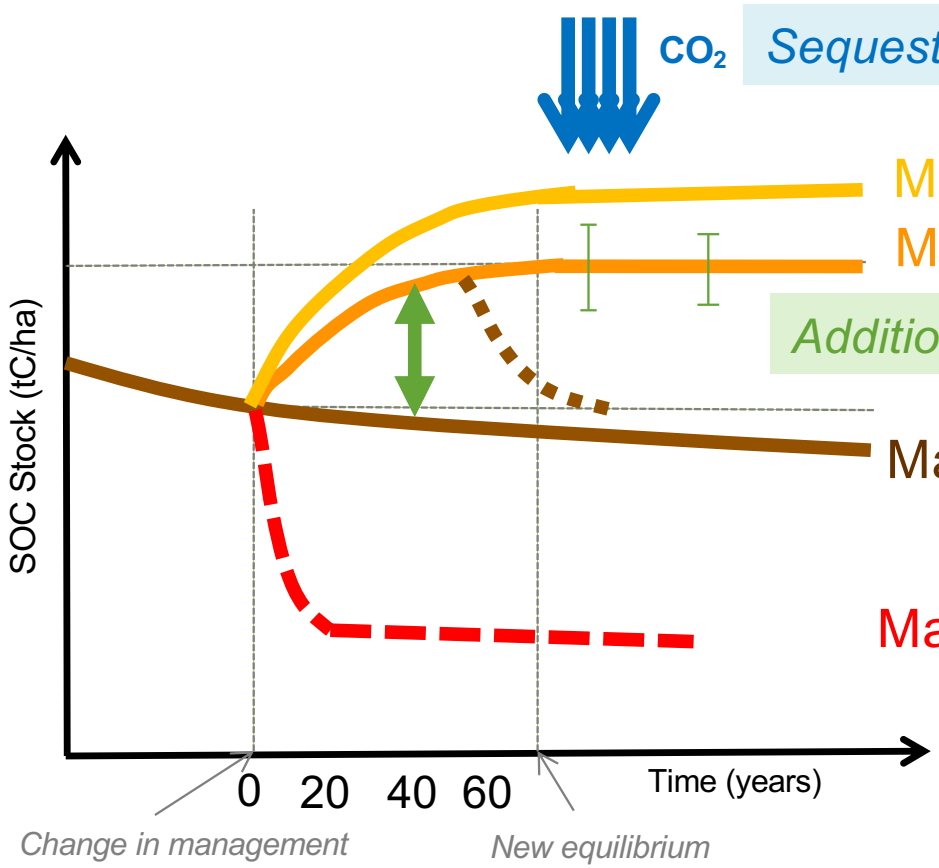
M. Jacob et al. 2021- EJP SOIL report T2.1

SOC storage for climate change mitigation: framing it



Sequestration. Avoid leakage

Managt C

Managt B

Storage is slow, limited, management dependent

Additional SOC storage relative to baseline to be quantified

Managt A

SOC storage is reversible

Managt D

Priority: protect existing SOC stocks

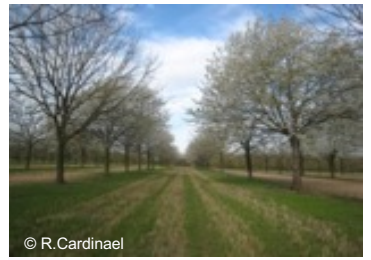
Organic amendments: a leakage issue

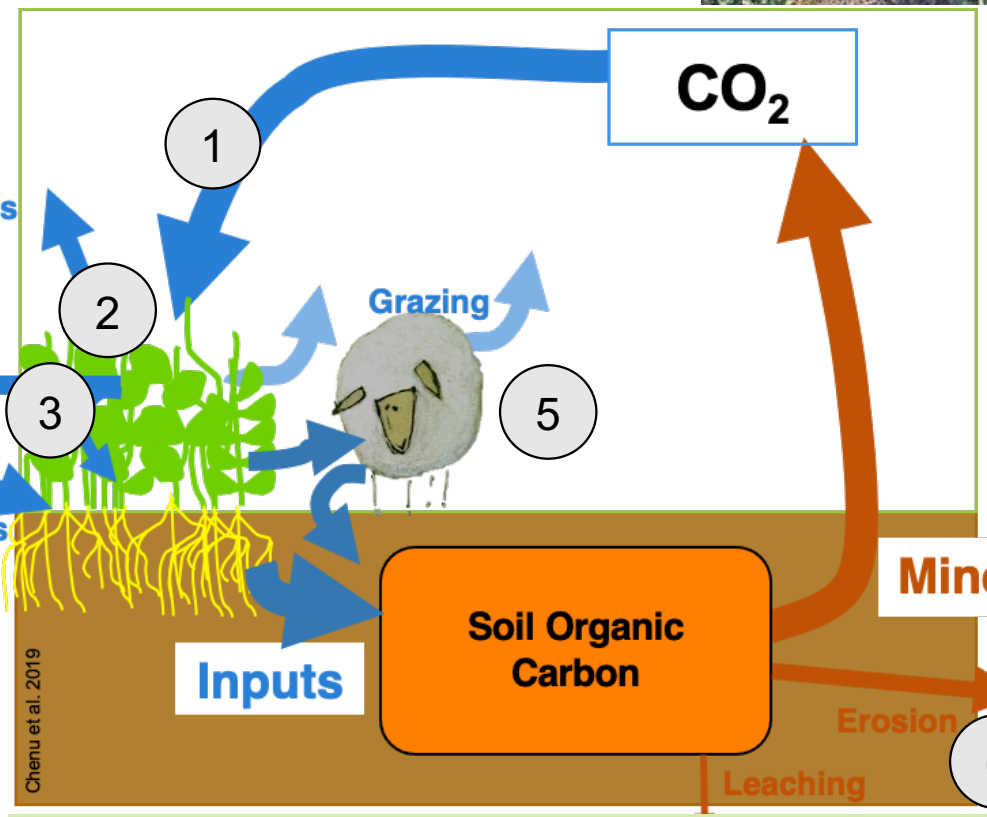
How? Management options are identified!











Chenu & al. 2019

To increase SOC stocks it is more efficient to increase organic inputs to soil than to reduce C outputs

1- Introduction

2- Storing additional carbon in soil: how much? where?

3- Storing additional carbon, beyond SOC

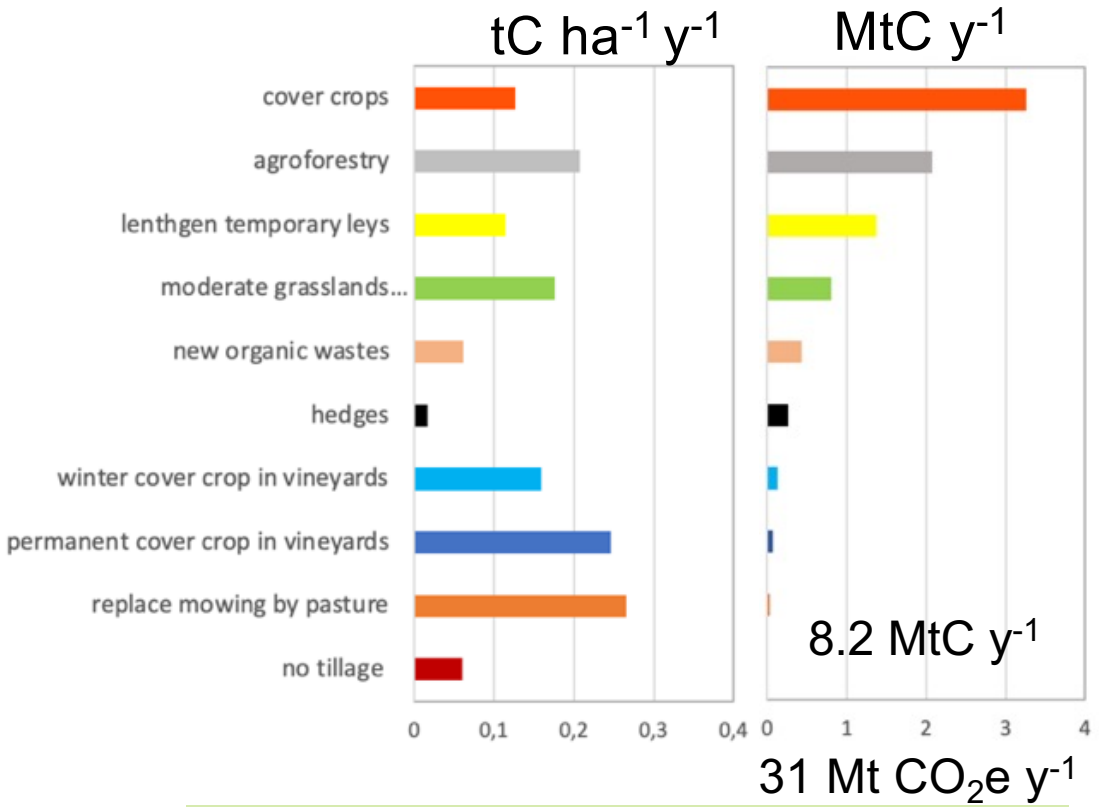
4- Innovative crops and cropping systems for C storage

5- The way forward

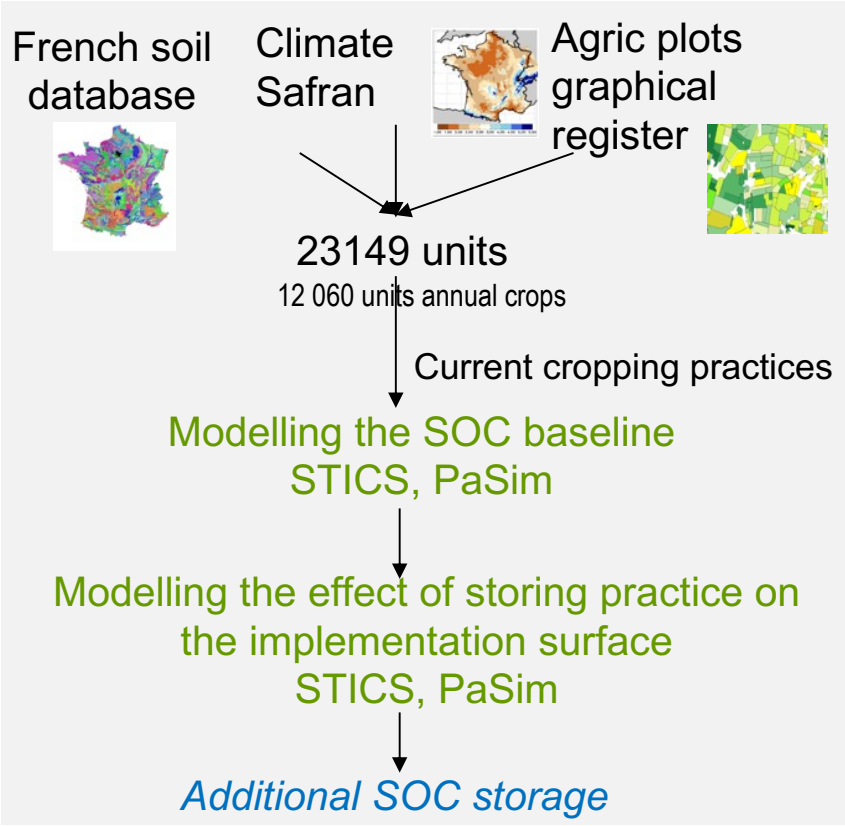
2- Storing additional carbon in soil: how much? where?

How much? SOC storage technical potential

Additional SOC storage mainland France (after 30 years)



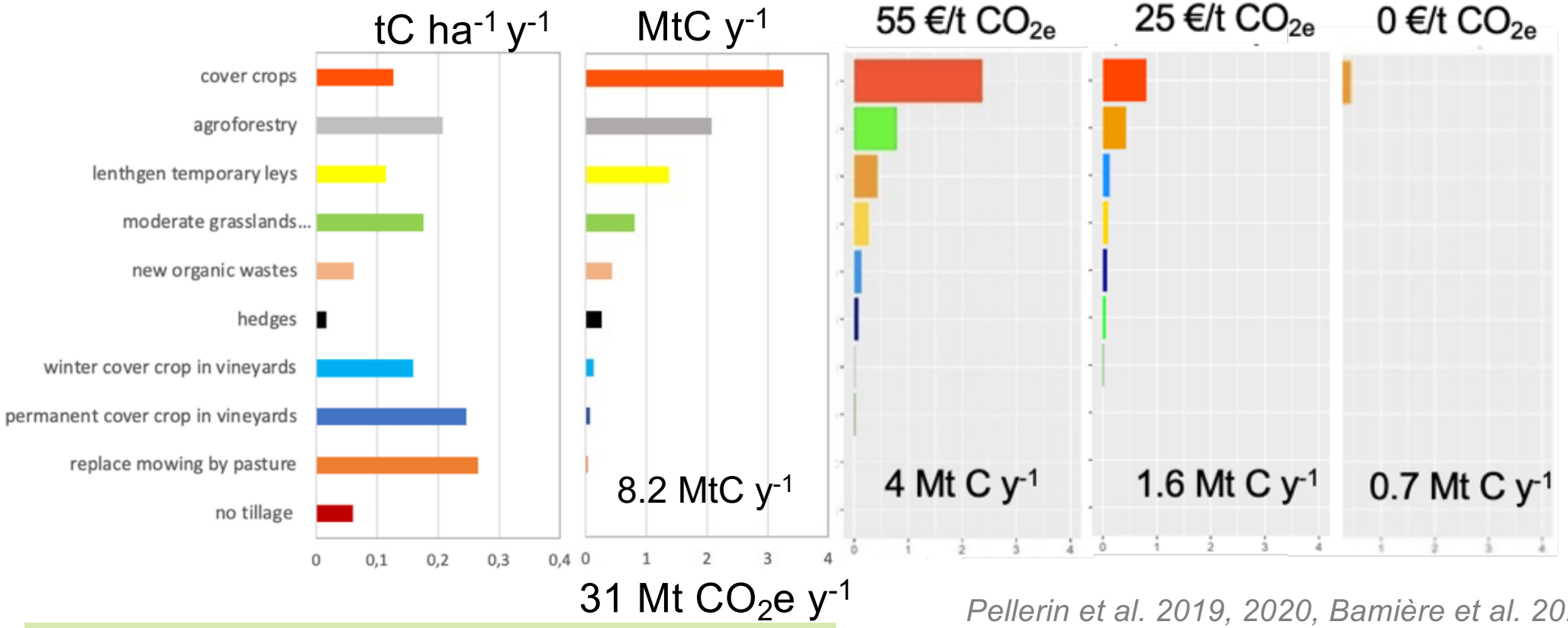
≈ 6% National annual GHG emissions
≈ 41% French annual agric emissions



Pellerin et al. 2019, 2020, Bamière et al. 2021
INRAE 4p1000 assessment
https://www.inrae.fr/en/news/storing-4-1000-carbon-soils-potential-france

How much? SOC storage economic potential

Additional SOC storage mainland France (after 30 years)



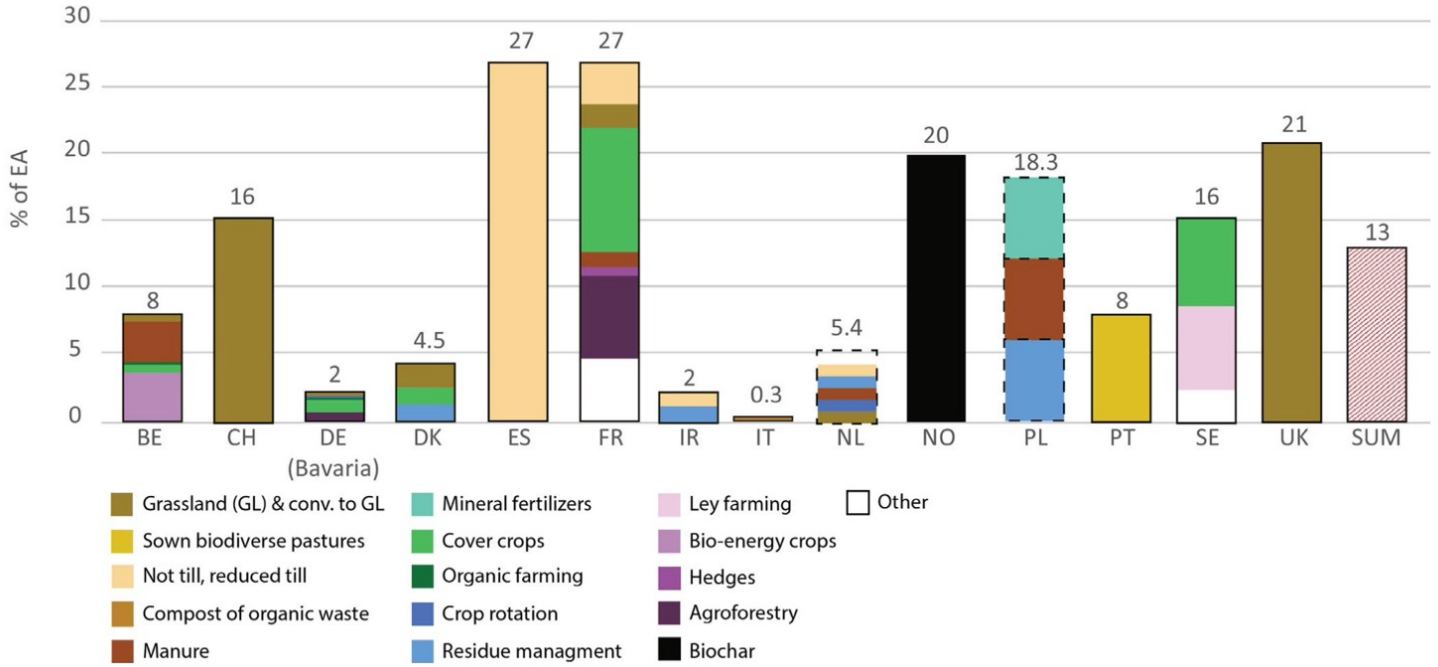
Additional SOC storage in agricultural SOC is significant, but has a cost: incentives needed

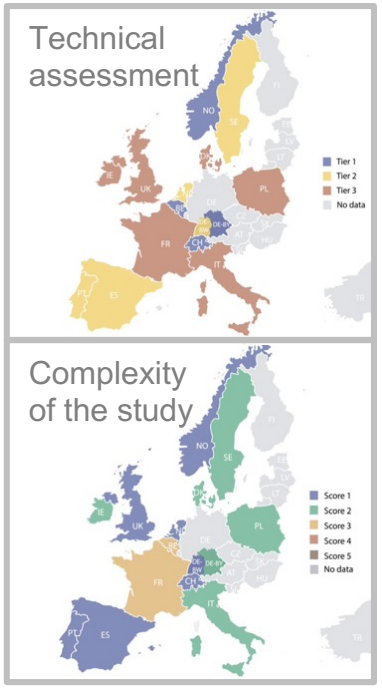
Pellerin et al. 2019, 2020, Bamière et al. 2021
INRAE 4p1000 assessment
https://www.inrae.fr/en/news/storing-4-1000-carbon-soils-potential-france

How much? SOC storage technical potential

Stocktake of existing studies at the national scale:

Potential for reducing annual National agricultural GHG emissions (%) by additional SOC storage





Rogrigues et al. 2021- GCB - EJP SOIL report D2.3

Widely contrasted management options considered and methods used

Estimating the technical carbon sequestration potential of 23 European countries in a common effort: the CARBOSEQ project

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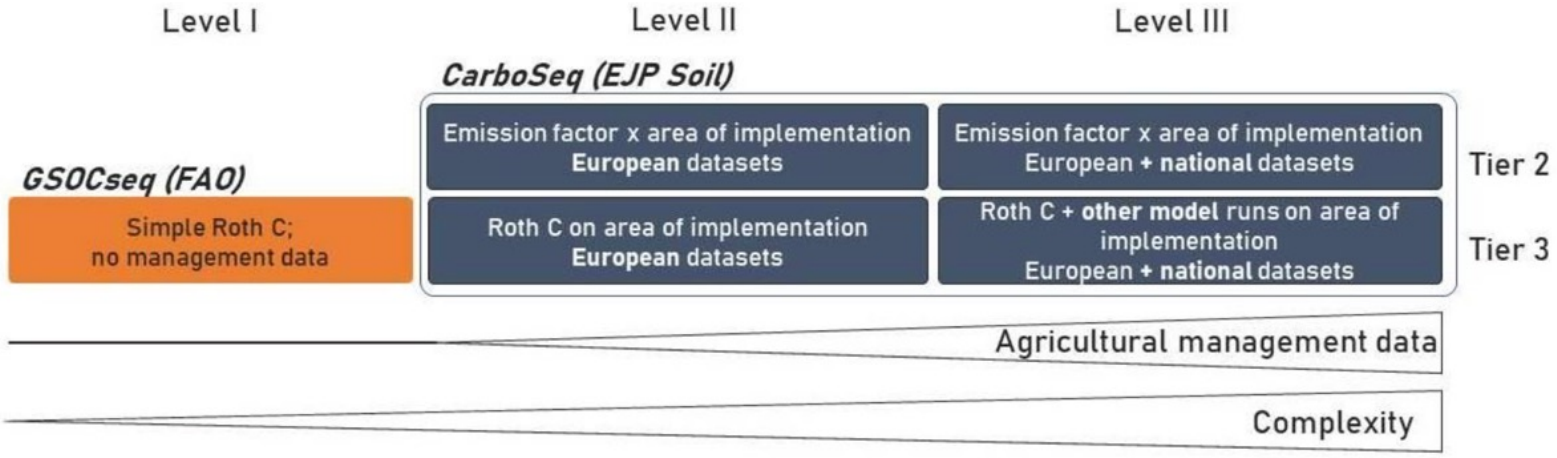
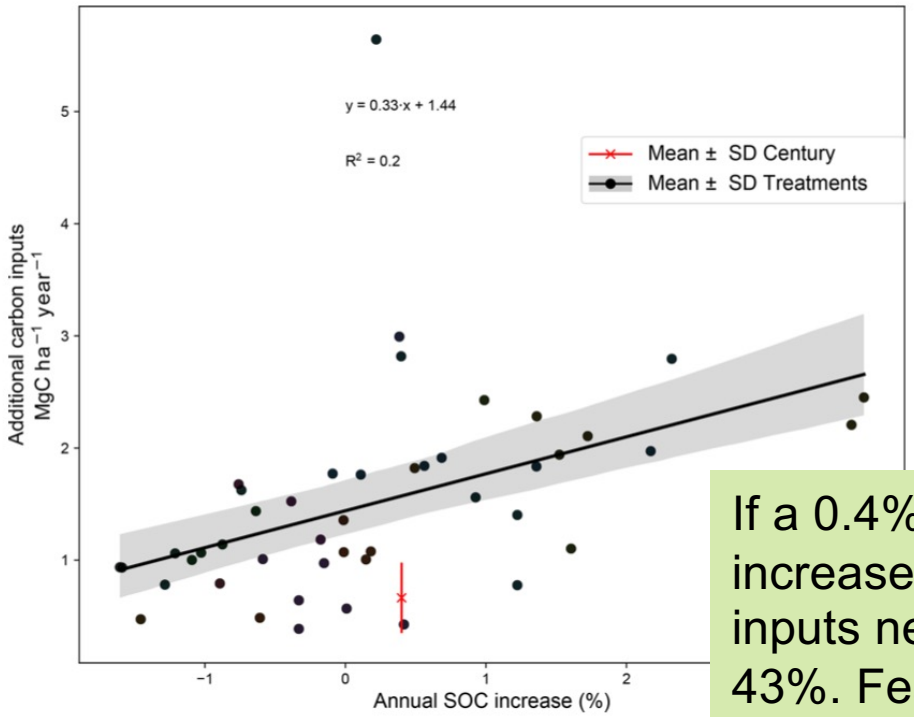
Cover crops
High carbon crops in the rotations
Intercropping
Crop residues
No tillage
Reduced tillage
Irrigation
Hedgerows
Agroforestry (Alley croppling)
Biochar application
Land-use change to grassland



A. Don et al. CarboSeq Proposal, 2020
www.ejpsoil.eu

How much OC inputs needed for a given SOC increase?

- Inverse modelling (Century)
- 14 long term experiments

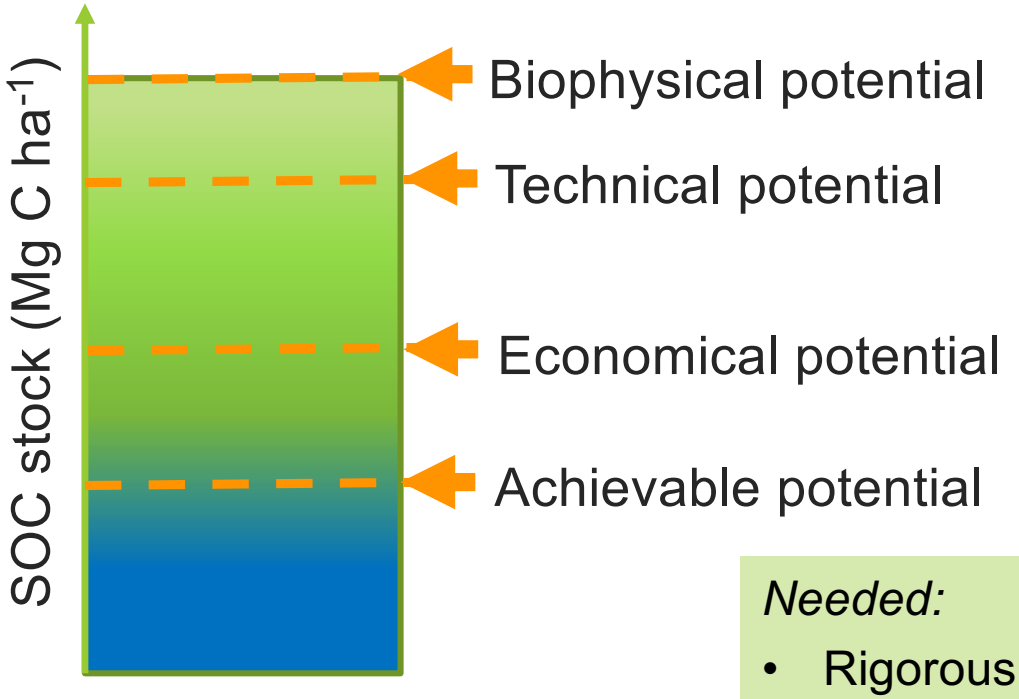


If a 0.4% SOC annual increase is targeted inputs need to increase by 43%. Feasible?

Correlation between additional carbon inputs (Mg C ha^{-1} per year) and annual SOC stock increase (%) in the carbon input treatments and mean ± standard deviation of the additional carbon inputs to reach the 0.4 % target in Century.

Bruni et al. 2021, Biogeosciences

Carbon storage potentials need to be estimated



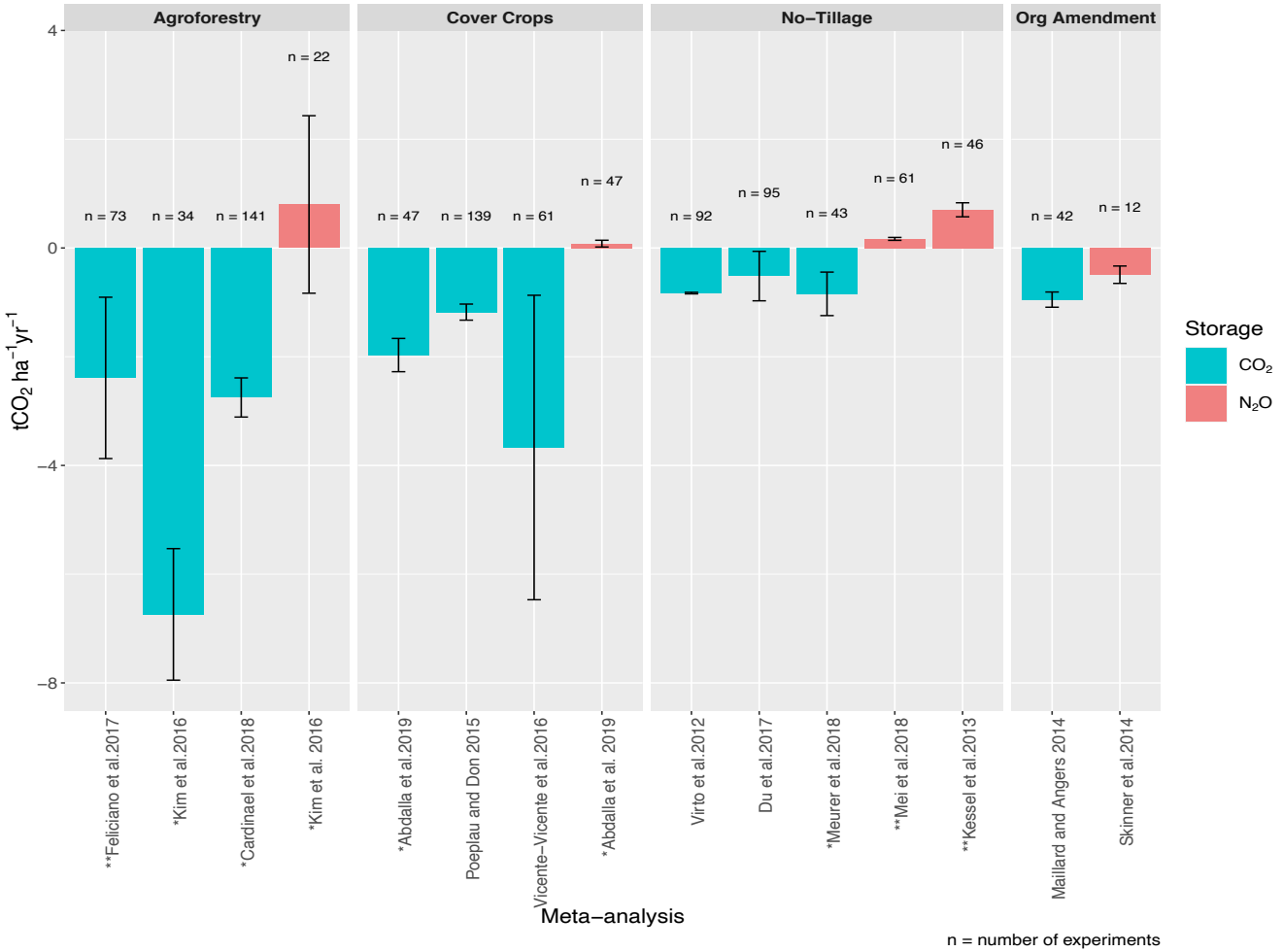
Needed:

- Rigorous terminology
- Activity data
- Robust calibrated models
- Estimates of achievable SOC storage (adoption)

3- Storing additional carbon, beyond SOC

Tradeoffs of SOC storage

Additional SOC storage & N_2O emisions when implementing management options



Guenet et al. 2020, GCB

Tradeoffs of SOC storage: identification, prediction, management (ongoing projects)

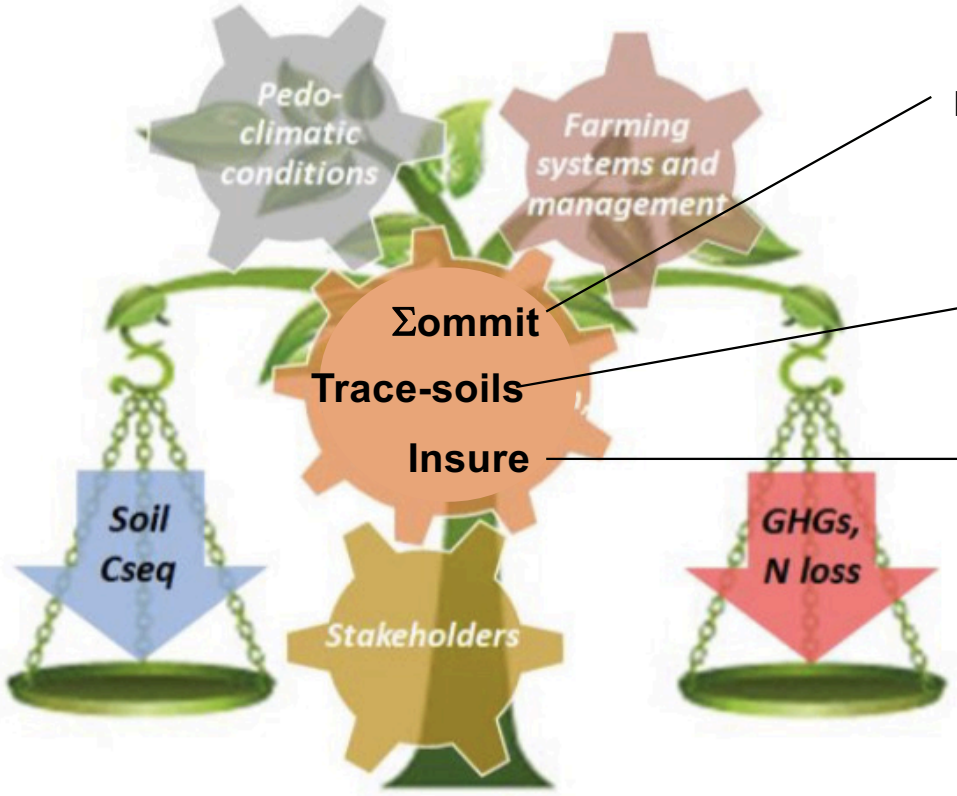


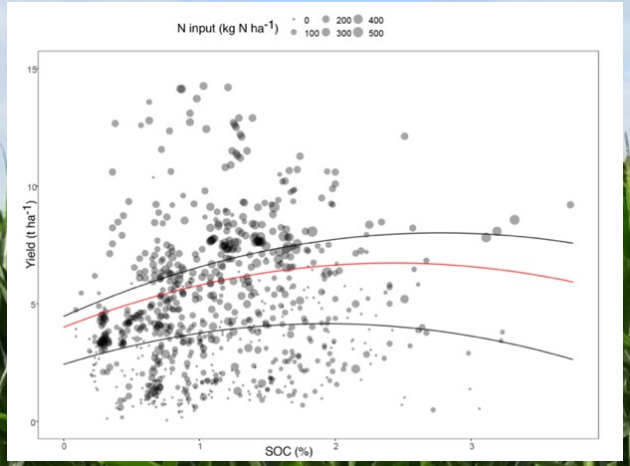
Figure @ A. Lagomarsino

mineral soils, increasing OM inputs to soil

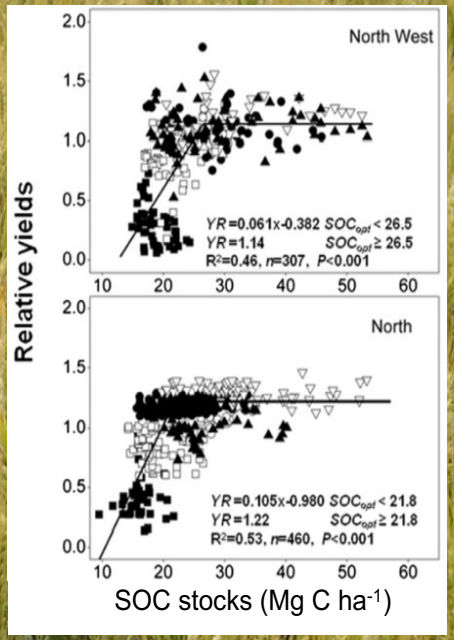
mineral soils, conservation agriculture

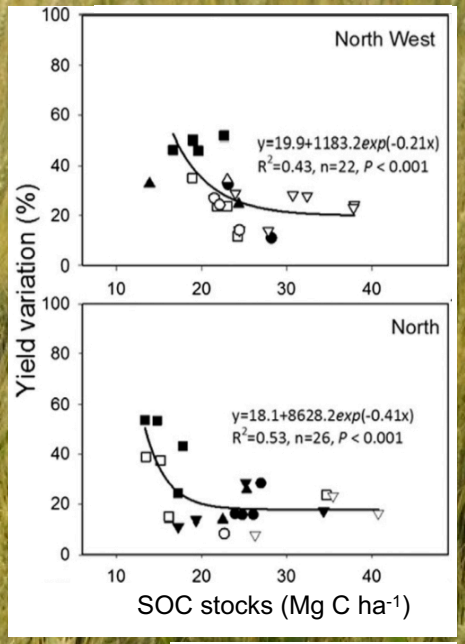
organic soils, rewetting peatlands

Benefits of soil organic matter: 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

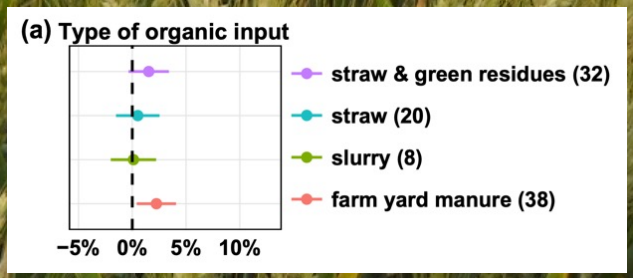
Wytse J. Vonk · Martin K. van Ittersum · Pytrik Reidsma · Laura Zavattaro · Luca Bechini · Gema Guzmán · Annette Pronk · Heide Spiegel · Horst H. Steinmann · Greet Ruysschaert · Renske Hijbeek

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

REGULAR ARTICLE

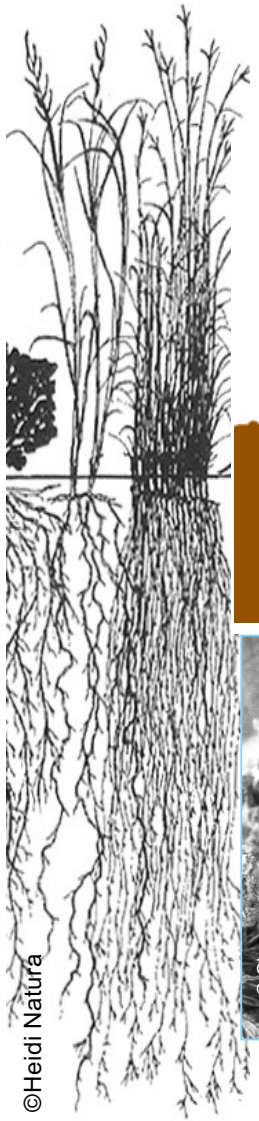
Do organic inputs matter – a meta-analysis of additional yield effects for arable crops in Europe

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

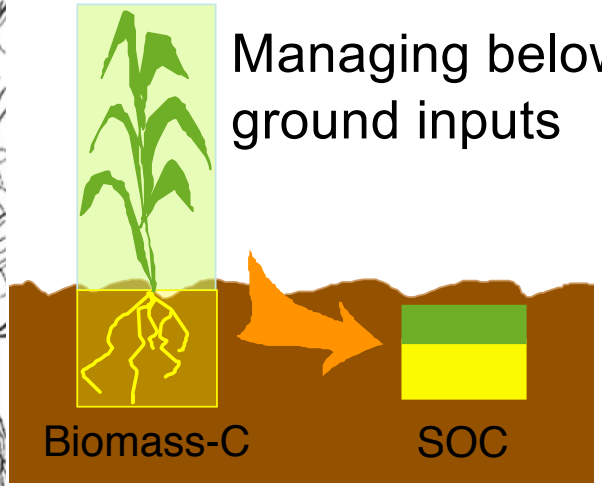


Better predict the benefits

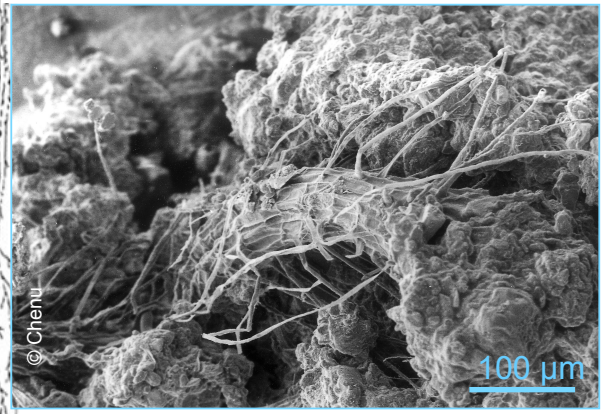
4- Innovative crops and cropping systems for C storage



Innovative options

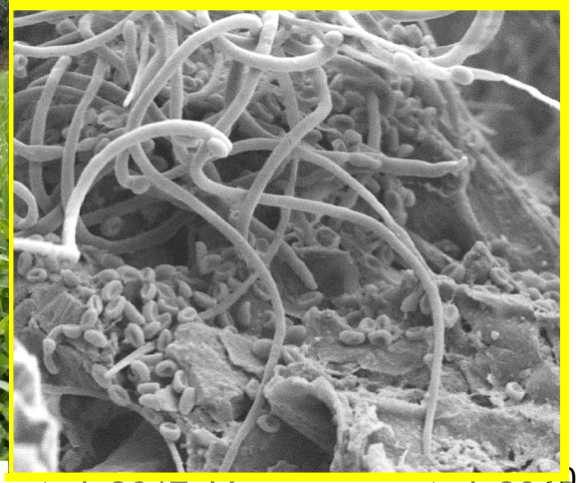


Managing below-ground inputs



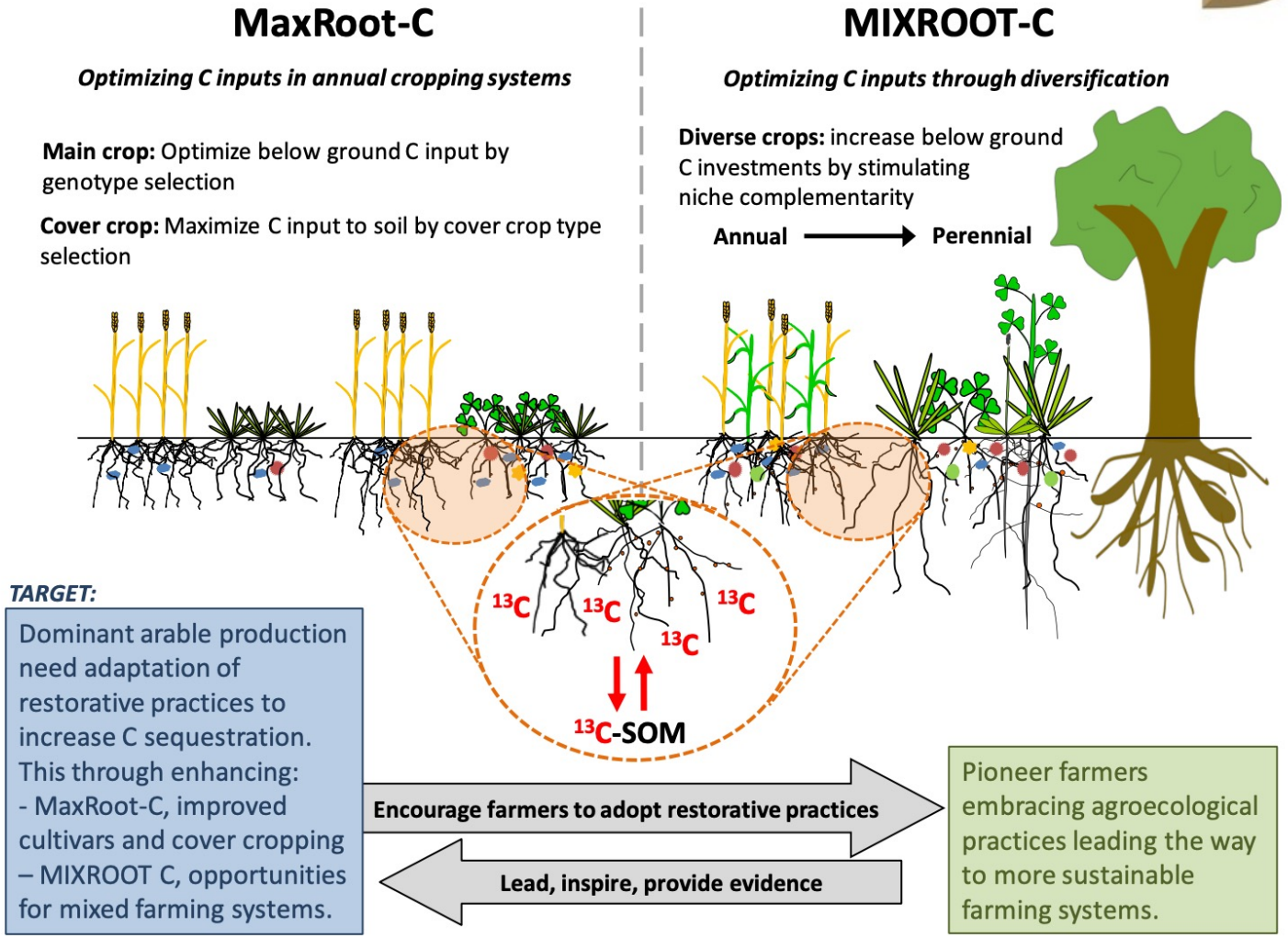
Rasse et al. 2005
Katterer et al. 2011

Increasing/managing biodiversity



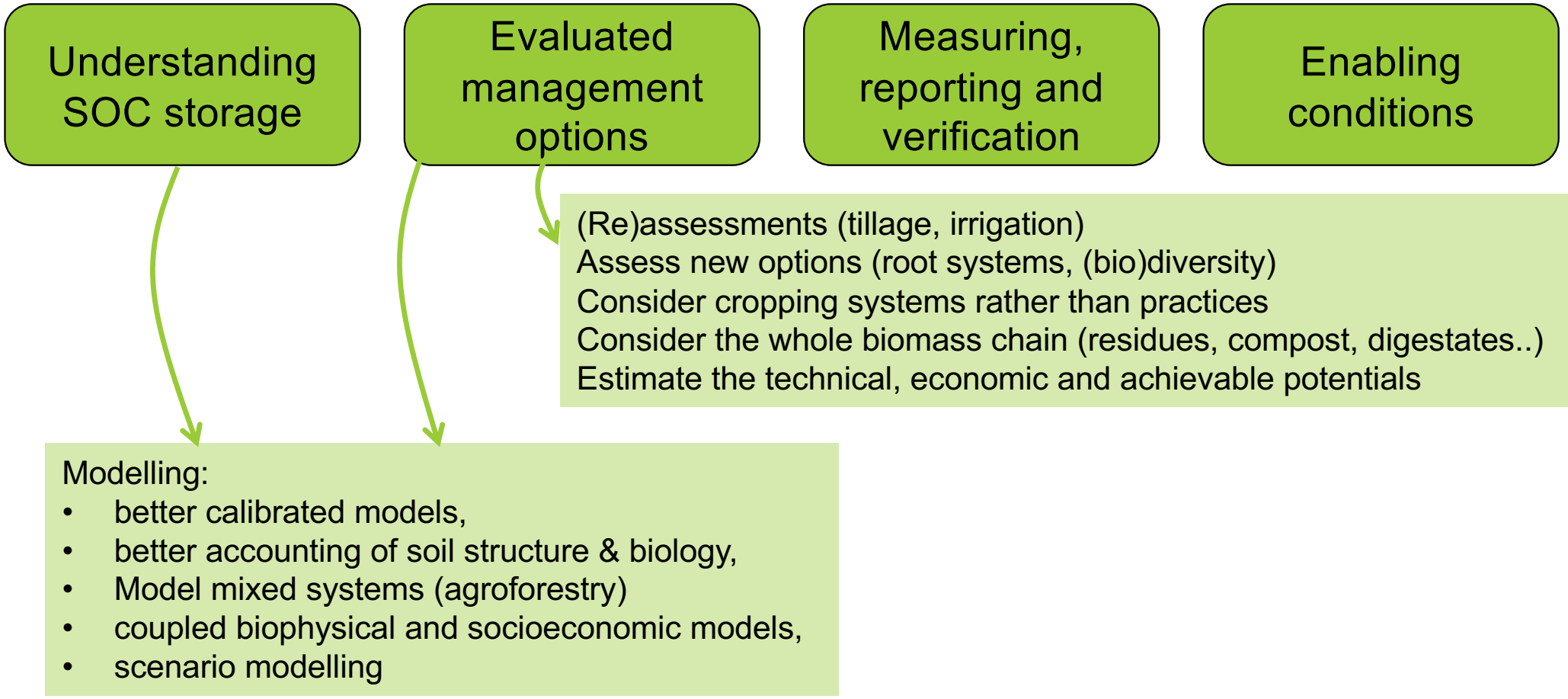
Lange et al. 2015, Blouin et al. 203; Lubbers et al. 2017; Vergruggen et al. 2013

MixRoot and MaxRoot projects



5- The way forward

Knowledge needs: crops and cropping systems to store carbon in soils



Crops and cropping systems that contribute to carbon storage in soil

- Crops and cropping systems can preserve and increase soil organic carbon stocks
- Significant contribution to GHG mitigation, but limited. Not a magic solution
- Key is increasing organic inputs to soil (cover crops, temporary leys, agroforestry, hedges…): efficient for SOC storage and brings many other benefits
- Integrative view needed: not only carbon! Leakage, trade-offs, ecosystem services
- Priority is protecting/restoring soil quality via soil carbon

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SOILS FOR FOOD SECURITY AND CLIMATE
Thank you for your attention
EJP SOIL has received funding from the European Union's Horizon 2020 research and innovation programme: Grant agreement No 862695

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