What is the stability of additional organic carbon stored thanks to alternative mamagement? A multi-methods evaluation

Kpemoua Israel[1,2,3], Barré Pierre[2], Houot Sabine[1], Baudin François [4], Plessis Cédric [1], Chenu Claire[1]

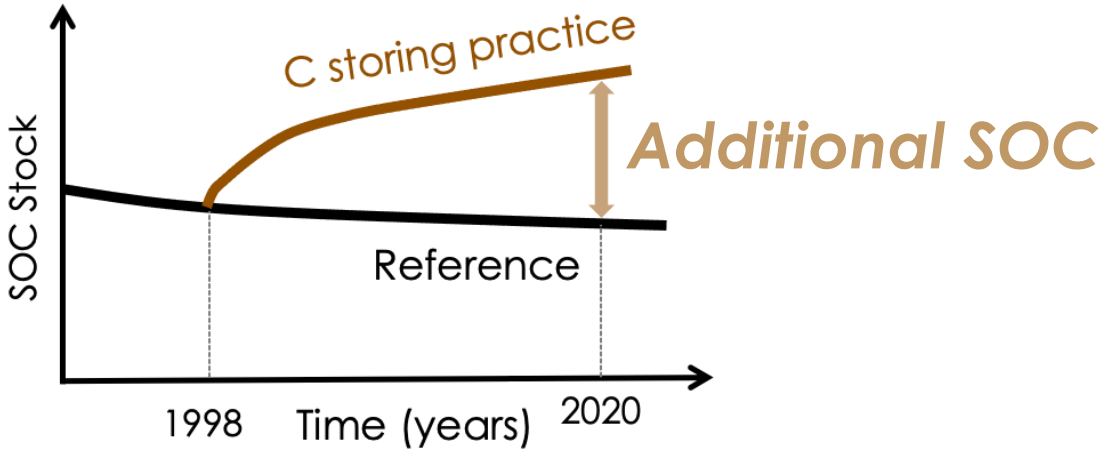
[1] UMR Ecosys, Université Paris-Saclay, INRAE, AgroParisTech, Palaiseau, France

[2] Laboratoire de Géologie, Ecole Normale Supérieure, PSL Research University, CNRS, Paris France

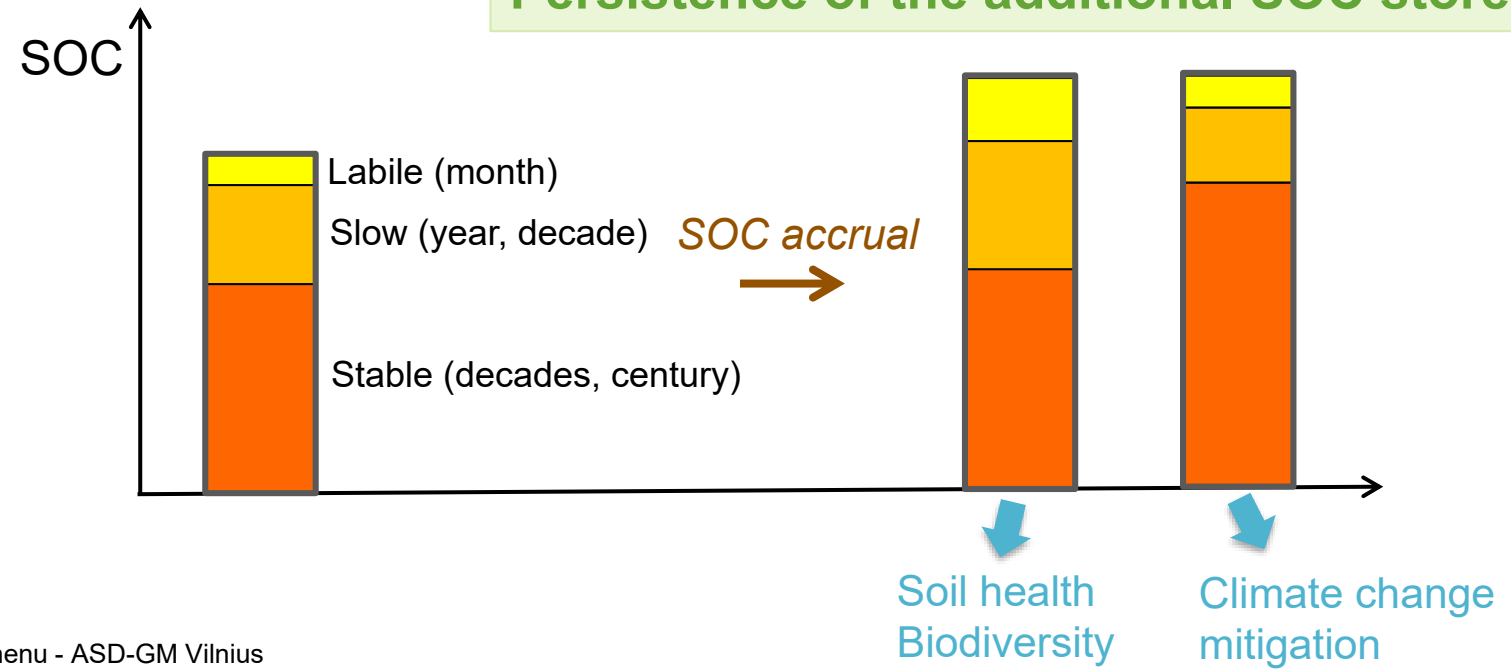
[3] Agence de la transition écologique, ADEMEAngers, France

[4] UMR ISTeP 7193, Sorbonne Université, CNRS, France

SOC accrual with management change



Persistence of the additional SOC stored?



Aim

- Assess the temporal stability of additional SOC stored with different management options

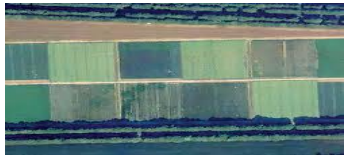
- Compare different methodological approaches

  - Long term incubation
  - Particle size and density fractionation
  - Rock-Eval© analysis & modelling

Long term experiments : Exogenous organic matter, alternative cropping systems

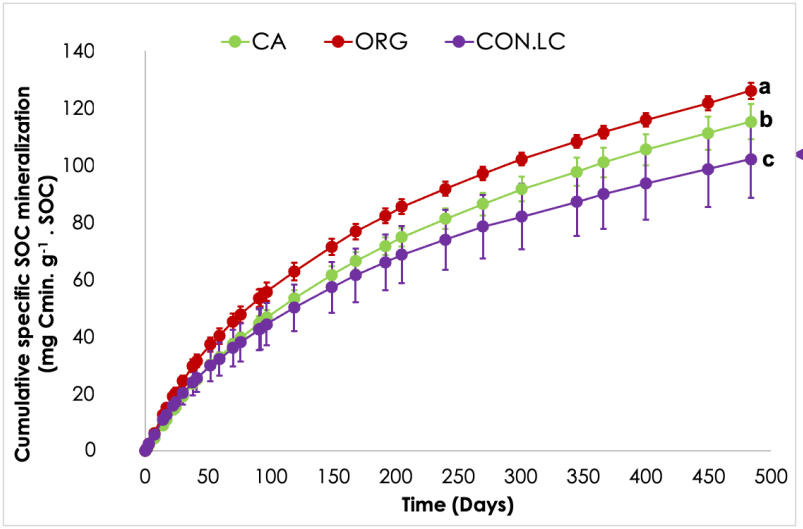
1998 | 627 mm | 11.3°C | Luvisol

After 20 years
0-30 cm

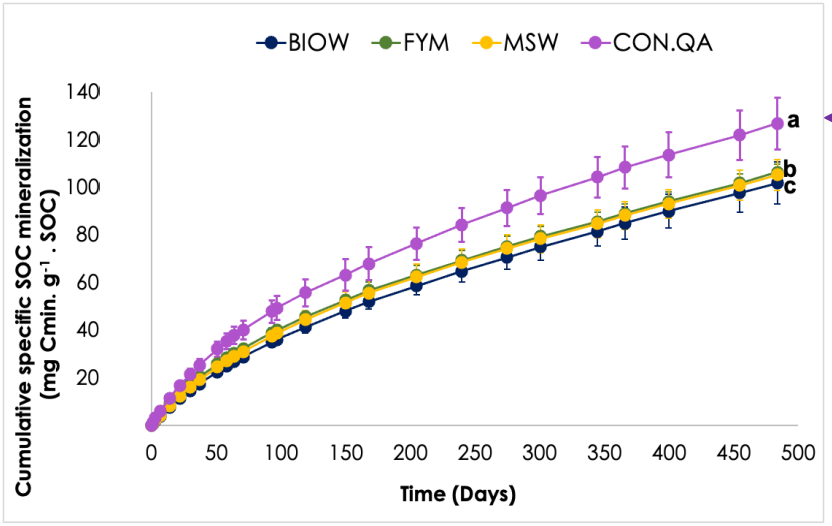
Site	Soil	Treatment		SOC stock (t C.ha^{-1})
La Cage 	Luvisol 17% Clay 58% Silt 25% Sand	Conventional	CON-LC	42.2 ± 2.1
		Organic agriculture	ORG	44.7 ± 1.8
		Conservation agriculture	CA	57.2 ± 4.5
Qualiagro 	Luvisol 15% Clay 78% Silt 7% Sand	Conventional	CON-QA	39.3 ± 2.5
		Residual municipal solid waste compost	MSW	54.1 ± 0.6
		Farmyard manure	FYM	55.1 ± 1.5
		Biowaste compost	BIOW	63.5 ± 2.7

SOC mineralisation in controlled conditions

Alternative cropping systems

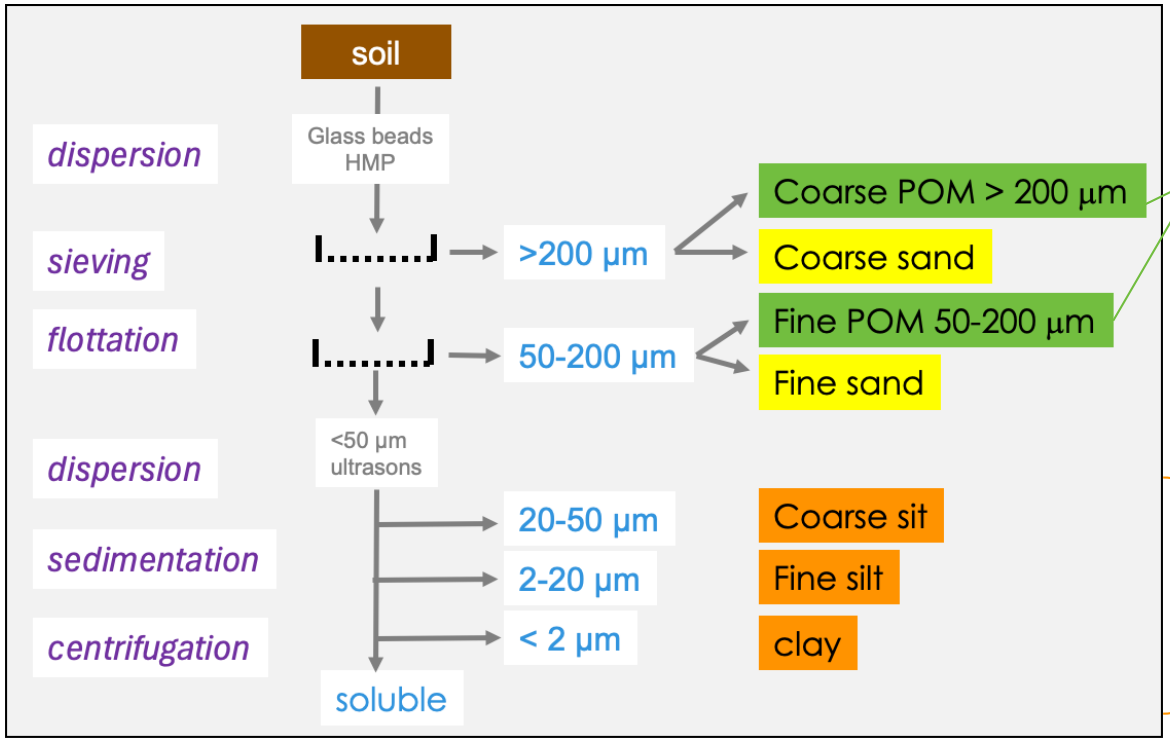


Exogenous OM additions



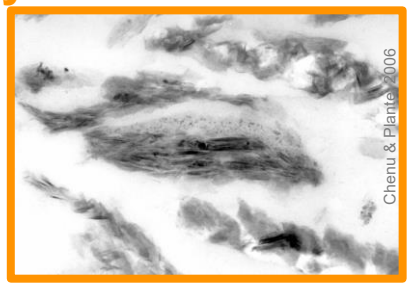
Constrasting abundance of <2y MRT in additional SOC / management options

Particle size and density fractionation



POM
MRT < 20 y

MAOM
MRT > 50 y

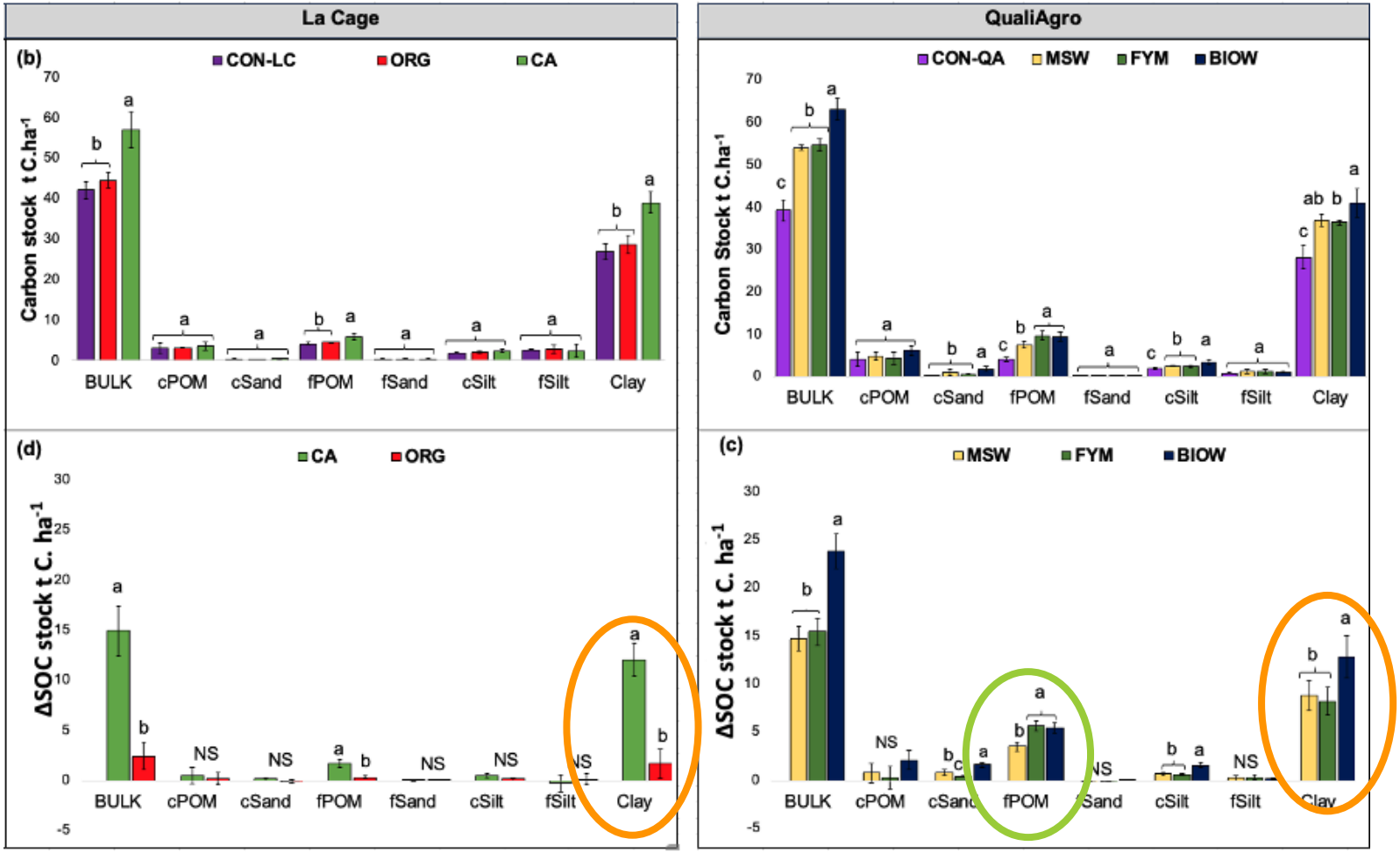


Balesdent et al. 1996,1998
AFNOR norm NF X 31-516

OC distribution in physical fractions

Alternative cropping systems

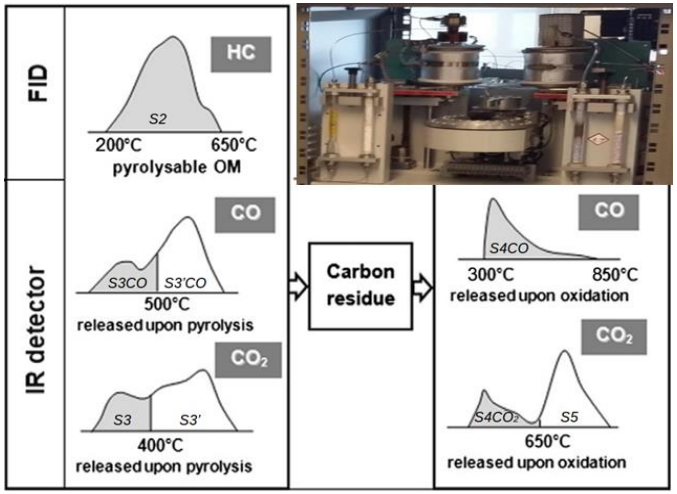
Exogenous OM additions



Rock-Eval© analysis & PartySOC model

Rock-Eval thermal analysis

Step 1: Cracking under inert condition with N2

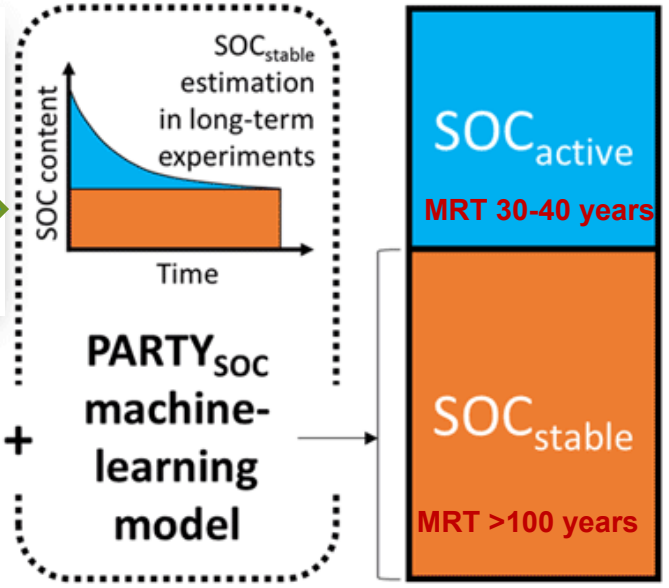


Step 2: Combustion in oxygen condition

18 RockEval® parameters

SOC thermal fractionation using Rock-Eval®

PARTYSOC machine Learning model

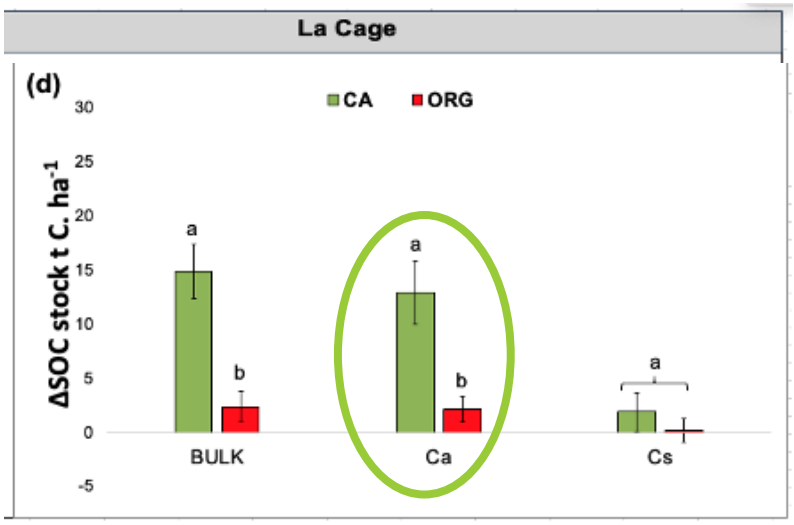


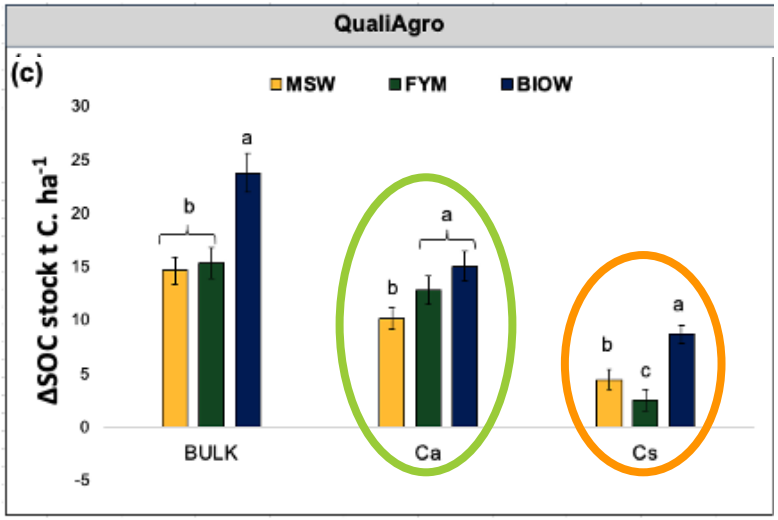
Cécillon et al., 2021
Kanari et a. 2022

SOC distribution across PartySOC active and stable compartments

Alternative cropping systems

Exogenous OM additions

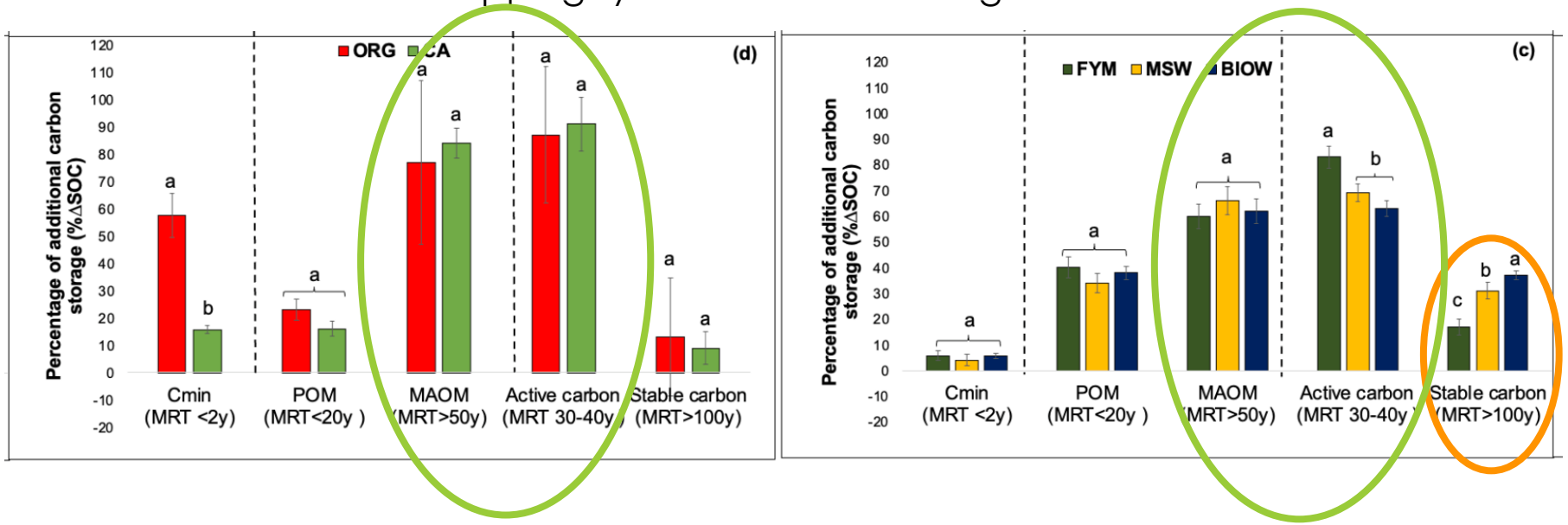




SOC and additional C distribution in fractions/kinetic compartments: wrap-up

Alternative cropping systems

Exogenous OM additions



Different management options : different MRTs of the additional SOC

Wrap-up

- Soil particle size/density fractions are kinetically heterogenous
  - Labile MAOM at La Cage (active C?)
  - Recalcitrant POM at Qualiagro (composts) (stable C?)
- Different management options => different pathways of SOC accrual (exogenous OM particles, rhizodeposits)
- Different methods, different residence times targetted - Stable C : *be explicit regarding MRT!*
- Need to maintain the C-storing practices over time!

Kpemoua et al. accepted, SOIL

Thank you for your attention