

Soil carbon: key to address vulnerabilities of agriculture to climate change and food security issues

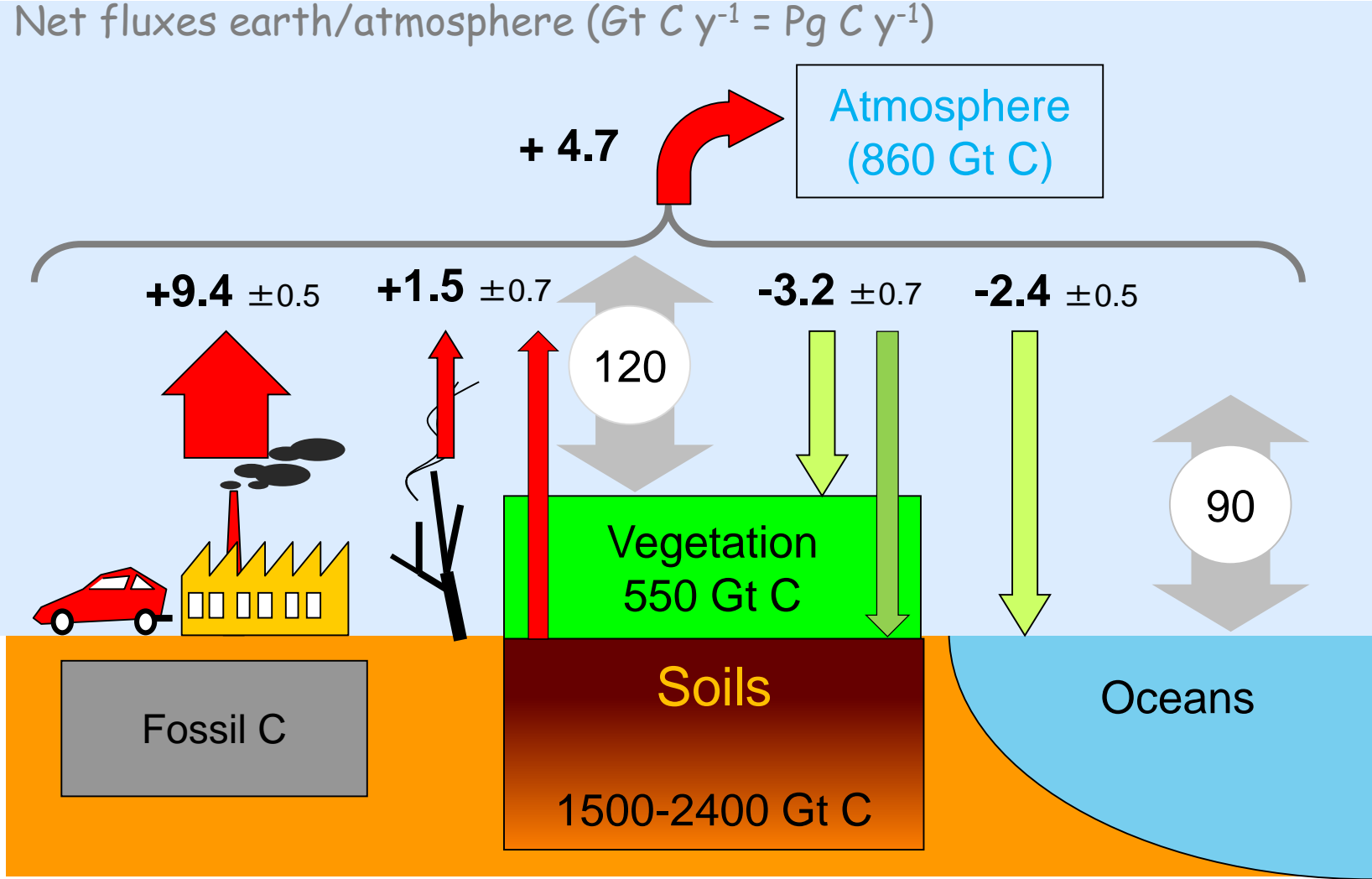
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Why soil carbon?

Soil carbon pool is big

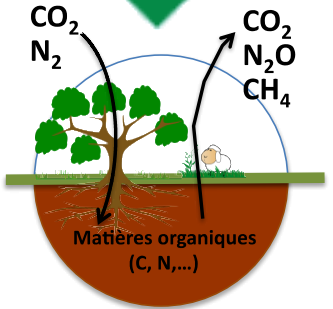


Graph adapted from Balesdent 1996
 Values means 2008-2017 : Le Quéré et al. 2018

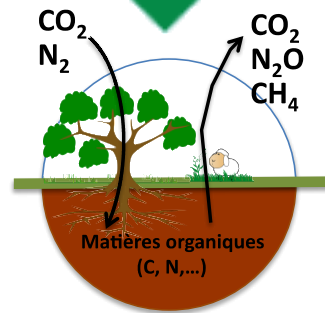
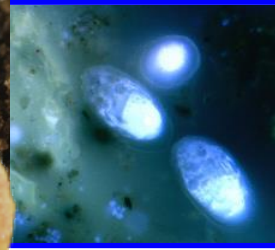
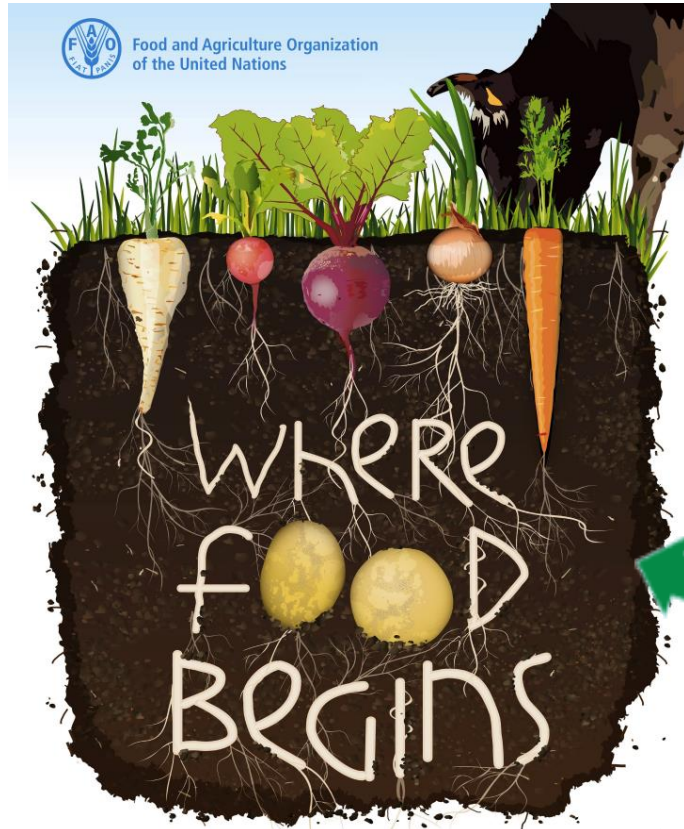
Soils provide ecosystem services



2015 International Year of Soils



Soil organic matter provide ecosystem services



©C.Chenu

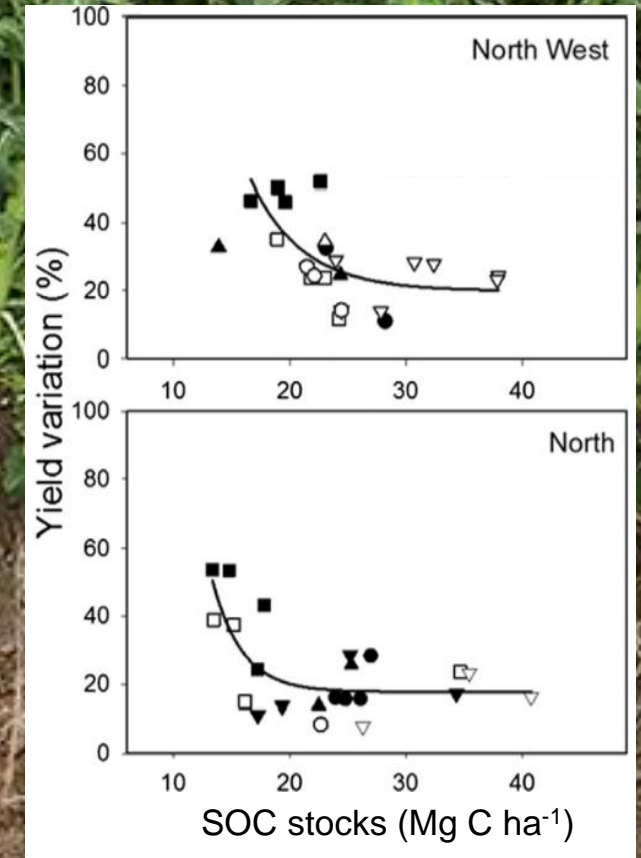
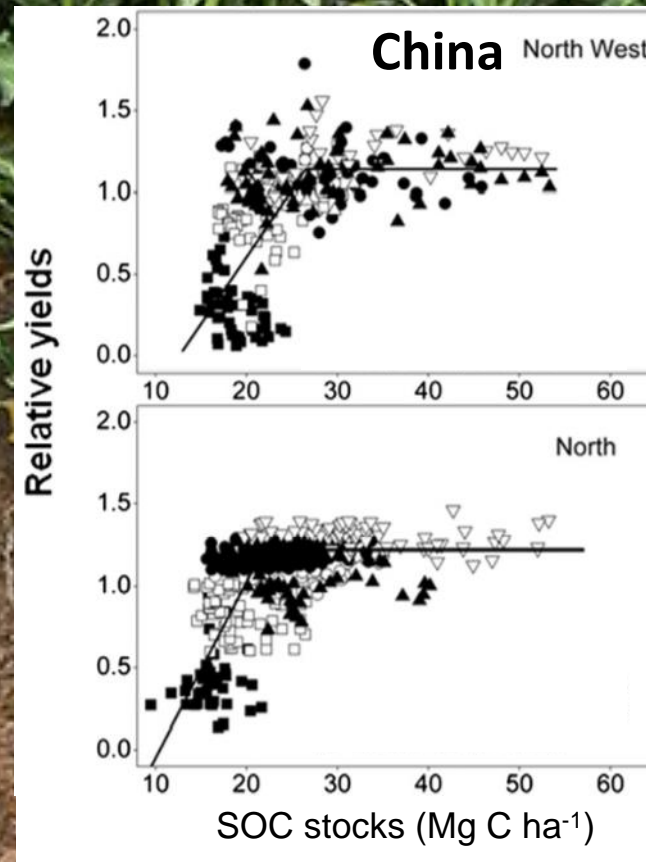
Soil organic matter provide ecosystem services

good soil structure
water infiltration and retention
aeration
provision of nutrients
beneficial organisms

Soil fertility - Soil health

Food security

Adaptation to climate change



Soil carbon

Soil biodiversity



Soil fertility
Water retention
Erosion control



climate ch adaptation
GHG mitigation





2.4 "improve **soil** quality"



12.4 "chemicals and wastes ... reduce their release to air, water and **soil** "



3.9 "reduce ...deaths and illnesses from air, water and **soil** pollution and contamination"



15.3 "restore degraded land and **soil**"



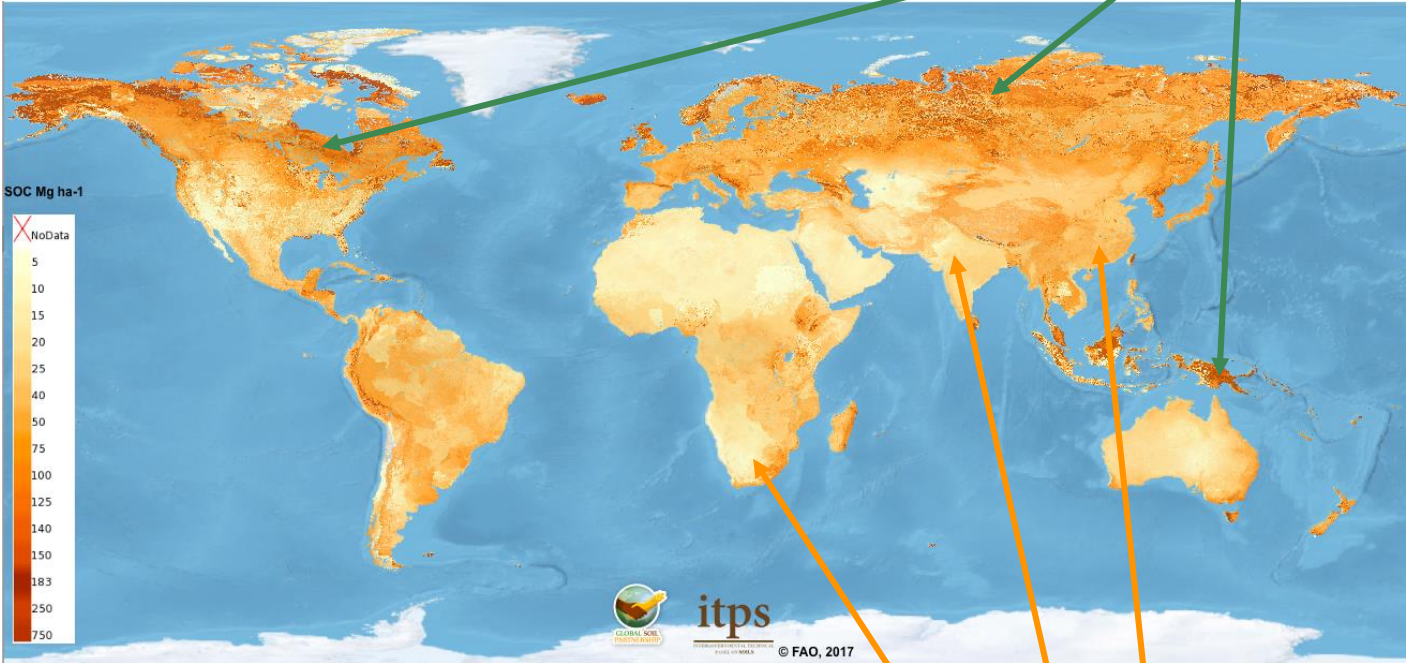
Objectives



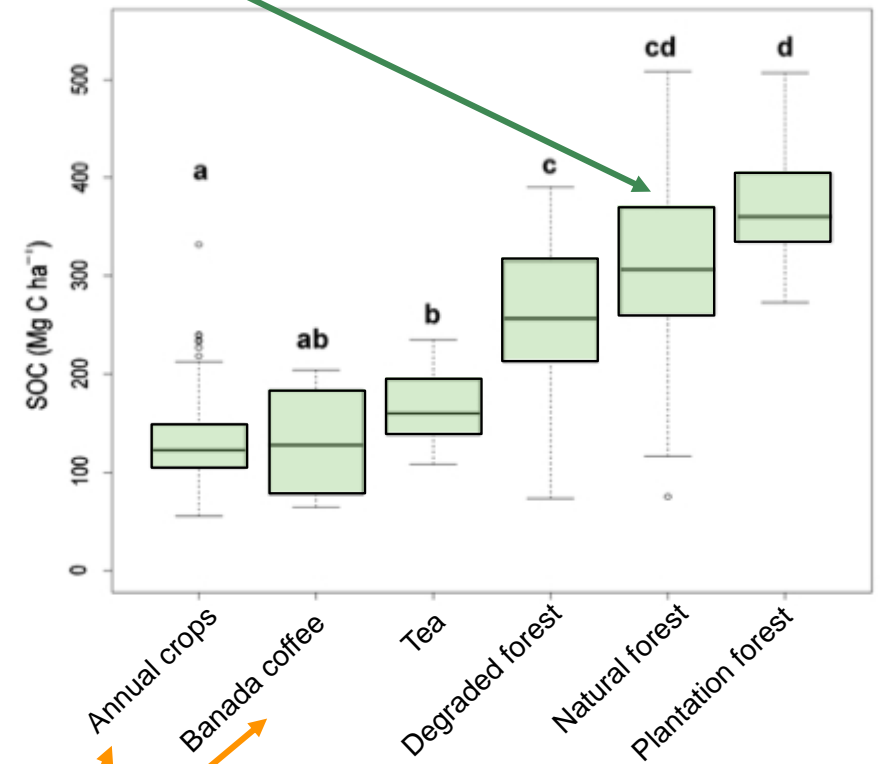
Protect existing SOC stocks

FAO, GSP, dec 2017

Global soil carbon map



Rwanda, Wasige et al. 2014

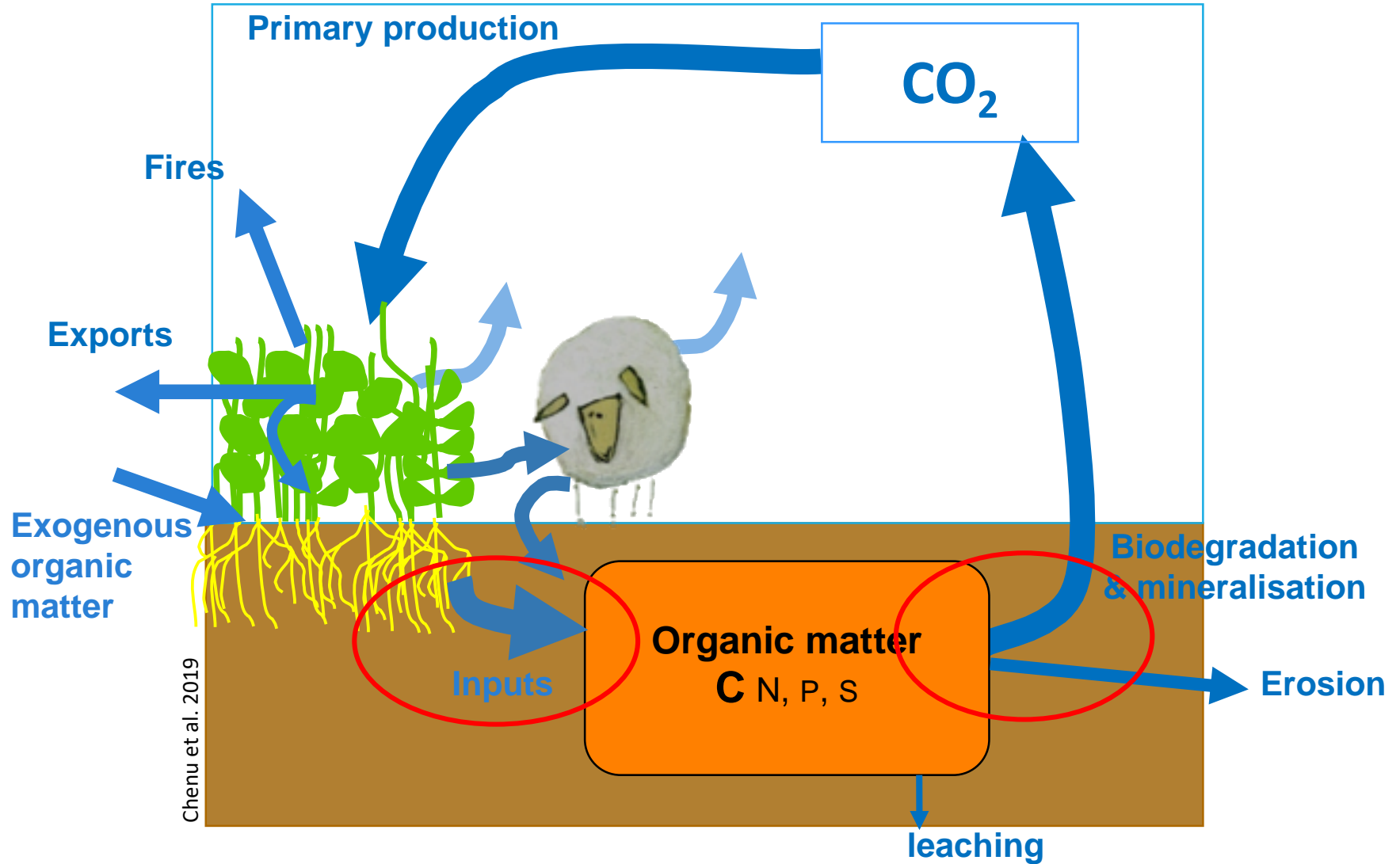


Increase SOC stocks

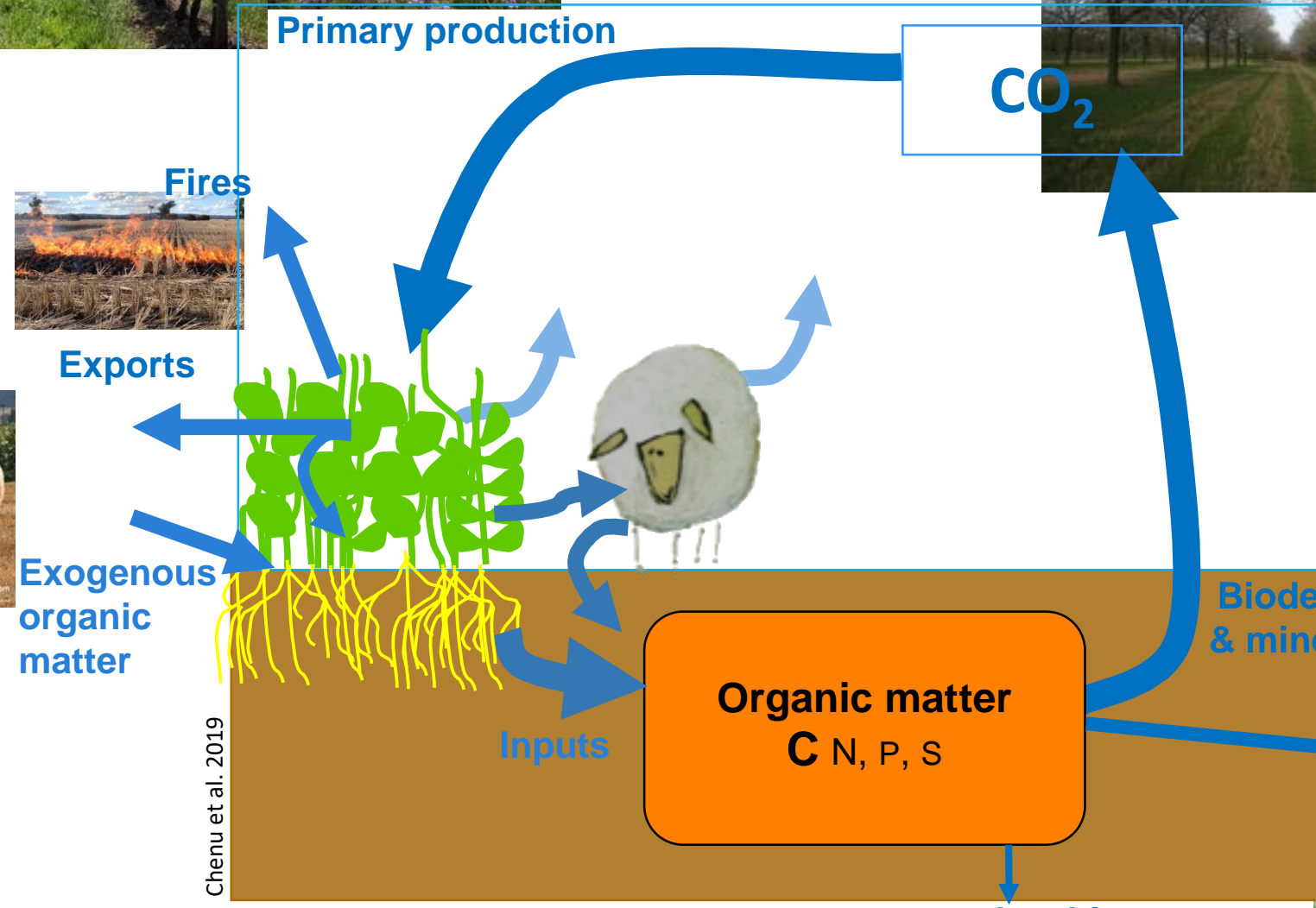
Maintain and increase soil carbon: how and how much?

Carbon cycle at the local scale

Storage
Sequestration



Practices to increase SOC stocks in agriculture



Practices to increase SOC stocks in agriculture

Meta-analyses *Fujisaki et al. (2018) for tropical soils (duration 7 to 22 years)*

Management practices	n	SOC changes Mg C ha ⁻¹ yr ⁻¹
Organic inputs	16	0.45 ± 0.14
Mineral fertilization	37	0.24 ± 0.06
Mineral + organic inputs	38	0.34 ± 0.04
Rotation	12	0.83 ± 0.17
Reduced tillage	47	0.32 ± 0.06
Reduced tillage + inputs	64	0.56 ± 0.08
Mean		0.41 ± 0.06

Environ. Res. Lett. 13 (2018) 124020

<https://doi.org/10.1088/1748-9326/aab5f>

Environmental Research Letters

LETTER

Revisiting IPCC Tier 1 coefficients for soil organic and biomass carbon storage in agroforestry systems

Rémi Cardinael^{1,2,3}, Viviane Umulisa^{4,5}, Anass Toudert⁴, Alain Olivier⁶, Louis Bockel⁴ and Martial Bernoux⁴



SOC storage potential at regions/nations scales

e.g. France

Pellerin, Bamière et al. 2019
in press

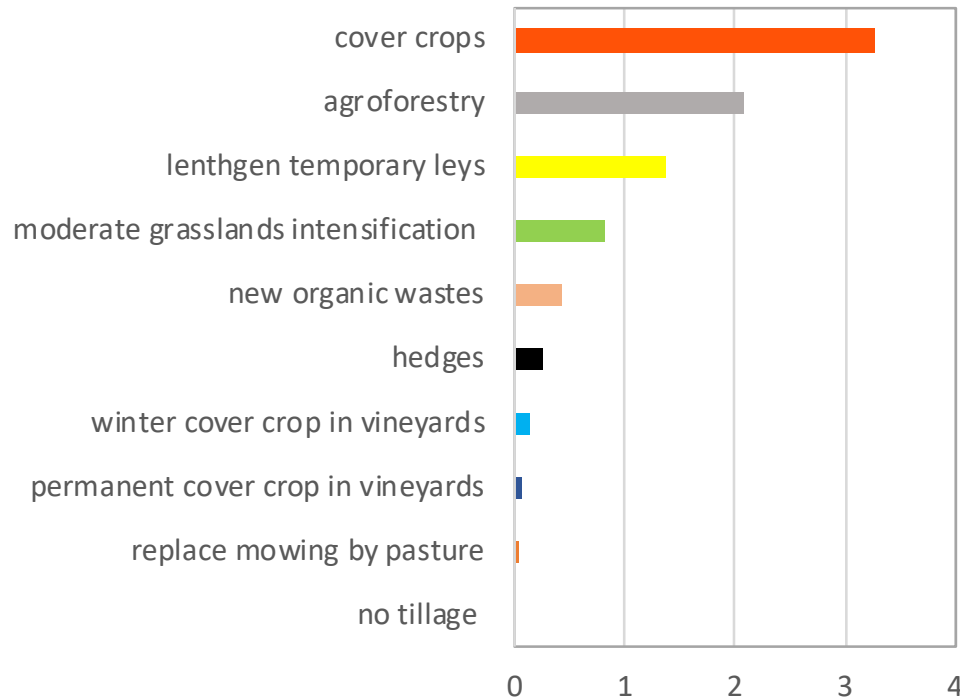
Total French GHG emissions 458 Mt CO₂e 7%

French agricultural emissions 77 Mt CO₂e 41%

Total SOC stocks 3585 Gt C

SOC storage potential in agricultural soils ?

SOC additional storage (Mt C year-1)
Mainland France



30 y, combination of practices:

~~+8.43 Mt C.y⁻¹ -> 31 Mt CO₂e y⁻¹~~



Economic assessment ?

SOC storage potential at regions/nations scales

e.g. France

Pellerin, Bamière et al. 2019

in press

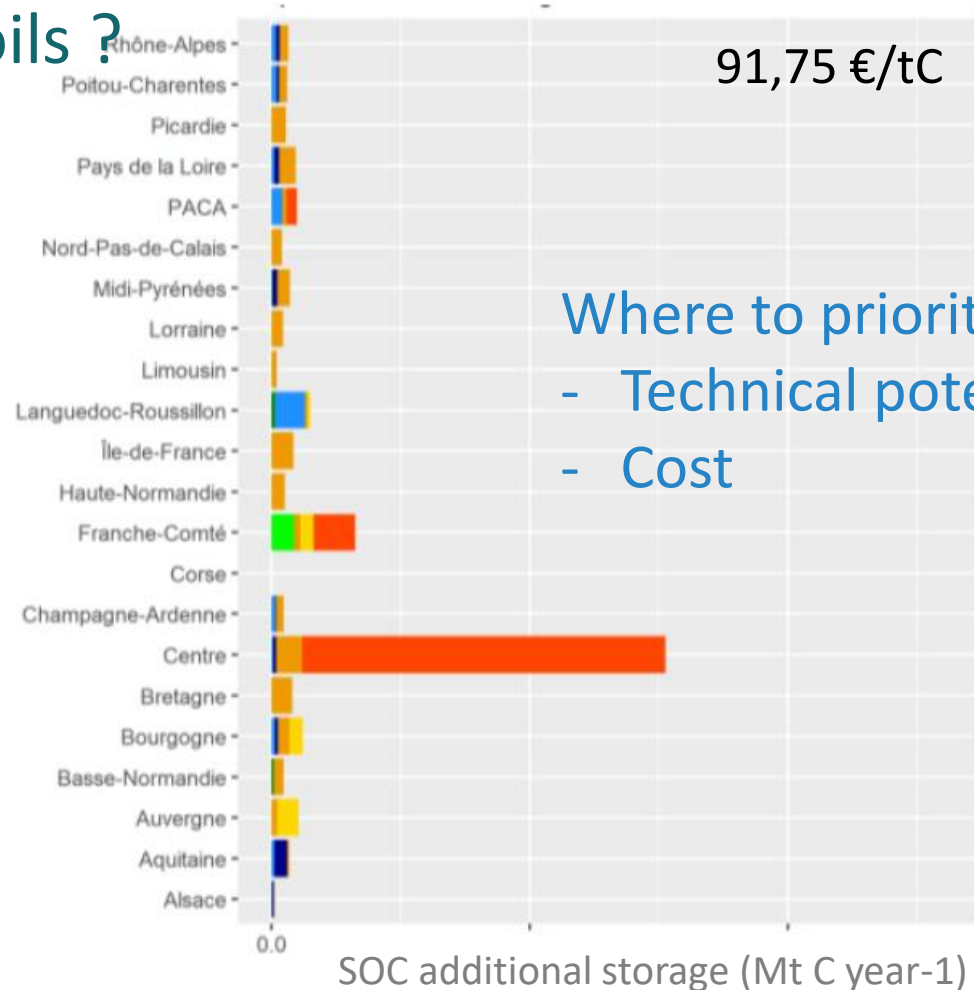
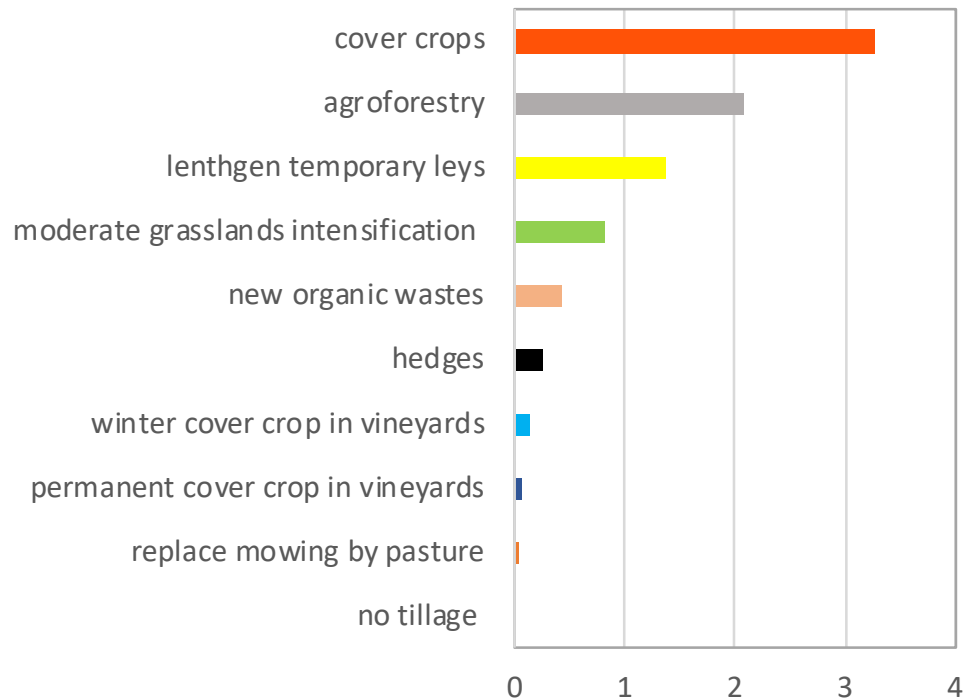
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French agricultural emissions 76.7 Mt CO₂e 41%

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SOC storage potential in agricultural soils ?

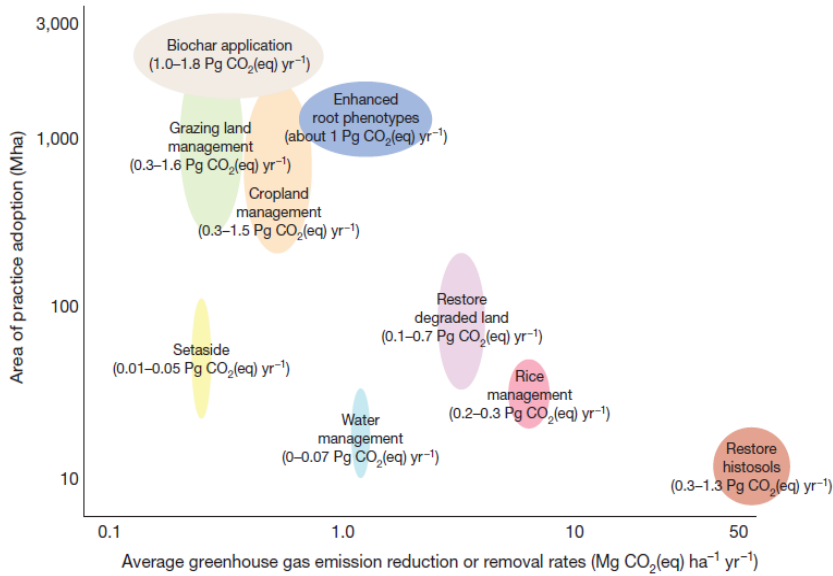
SOC additional storage (Mt C year-1)
Mainland France



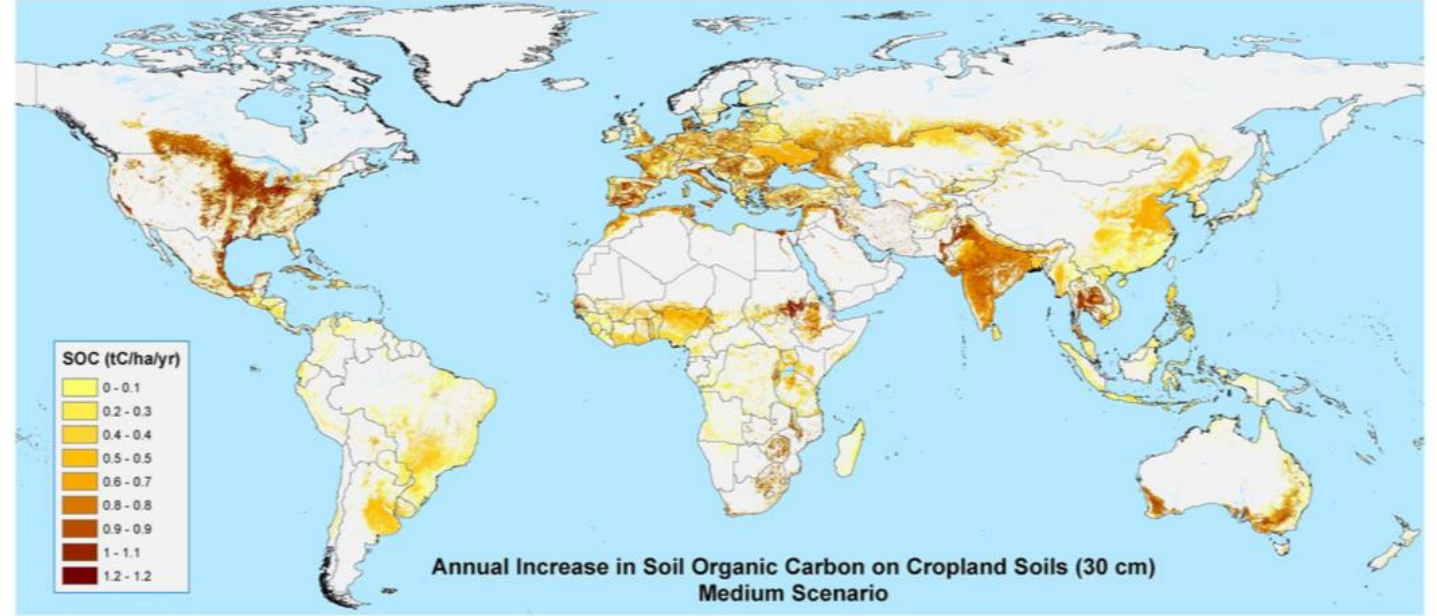
Where to prioritize efforts?

- Technical potential
- Cost

Global agricultural estimates



Paustian et al., Nature, 2016



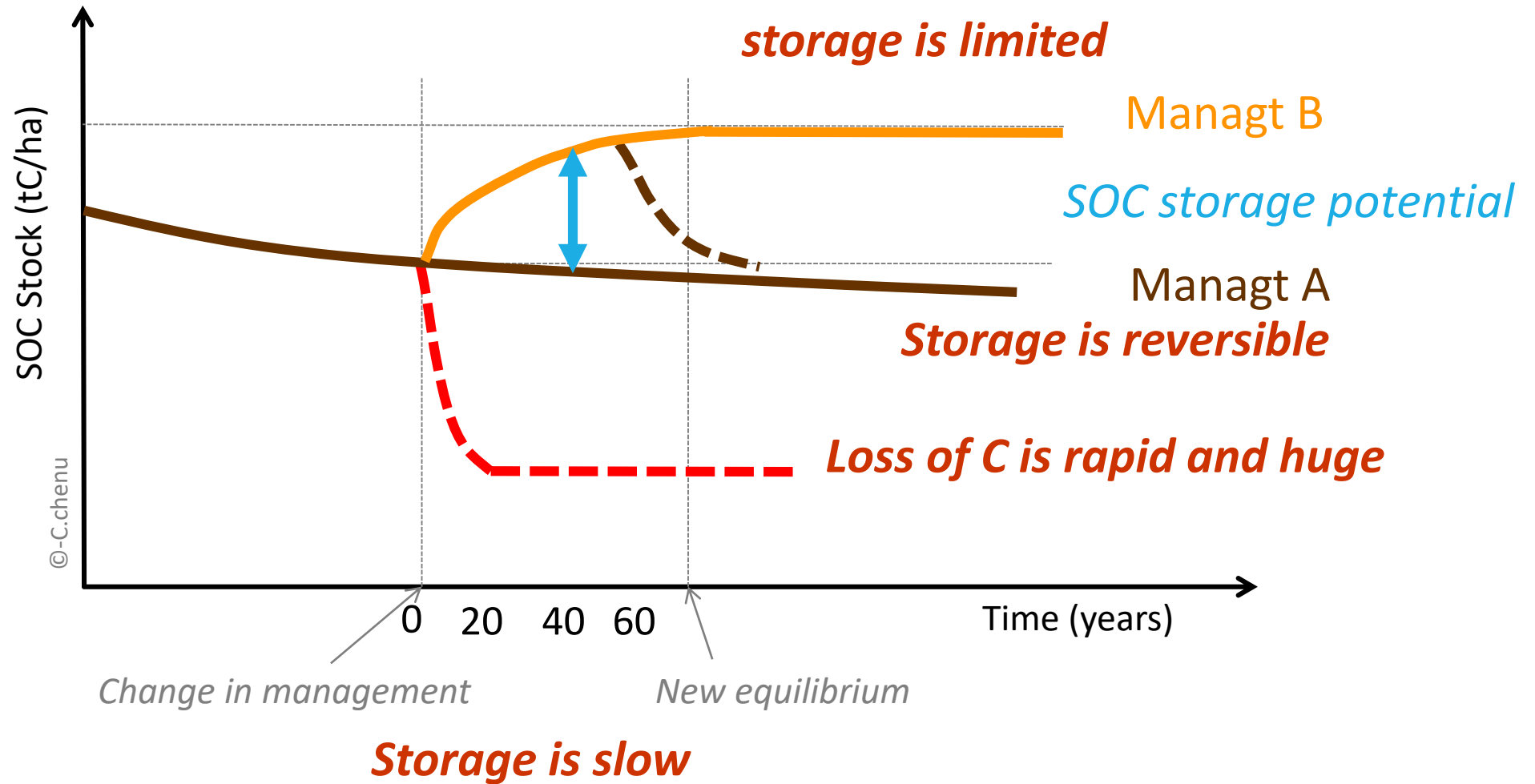
Zomer et al., 2017

- Technical potential
- Data compilation, meta-analysis
- Large uncertainties

	GtC year ⁻¹
Smith et al. 2008	1.4
Paustian et al. 2016	2.2
Zomer et al. 2017	0.9-1.7
Soussana et al. 2019	2.1

Maintain and increase soil carbon:
limits, barriers, risks?

C storage : how much for how long ?



Biophysical barriers to SOC storage

water

Biomass production



Trost et al. 2013, Nath et al. 2018...

nutrients

Biomass production SOM stabilization

Kirkby et al. 2014

Van Groenigen et al. 2017

- N surpluses in intensive agriculture systems
- Biological N fixation
- Livestock & urban waste recycling

Soussana et al. 2017

biomass



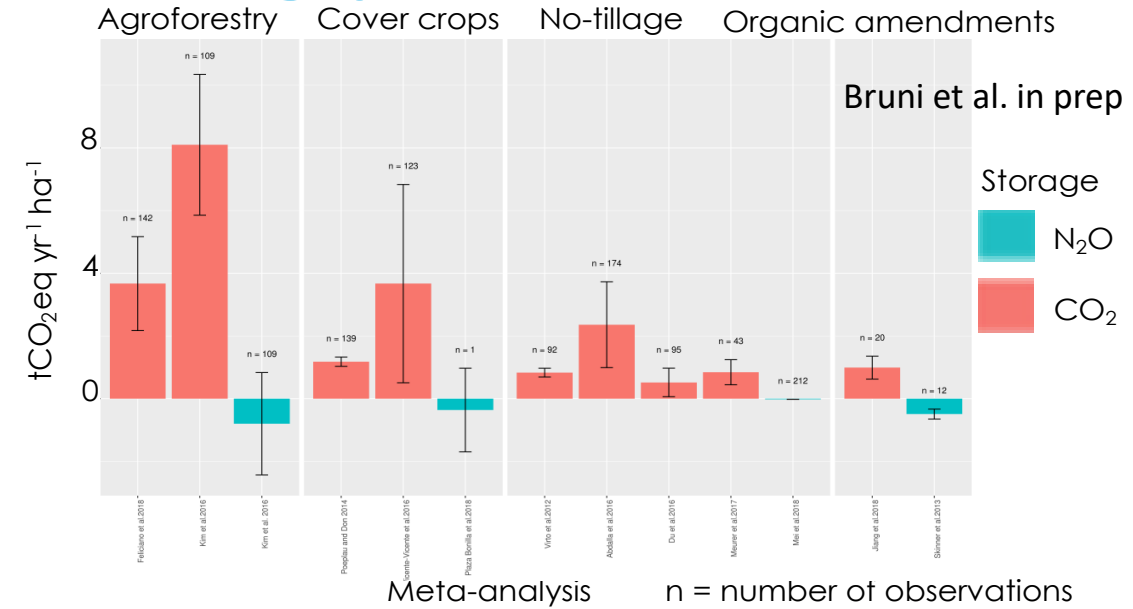
soils



Technical, economic, social, cultural, legal barriers

Risks of SOC storage or SOC storing practices

- Negative environmental impacts ?
 - GHG emissions
 - Water quality
 - Pesticides
 - Resources consumption : water, nutrients
- Negative social impacts ?
 - Land use change to « carbon farming »
 - Pressure on land tenure and family farming



Selection of management options

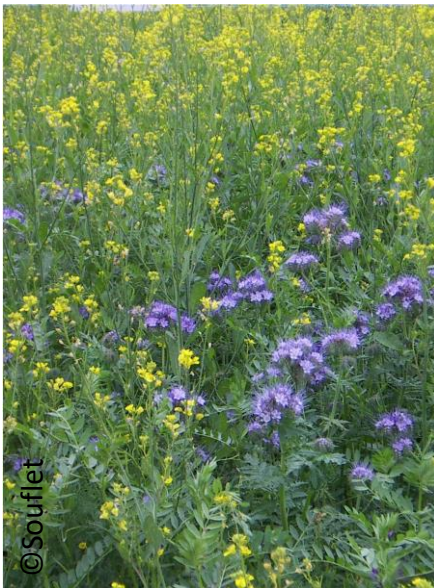
No regret options ? *food production, adaptation, mitigation, environment, co-benefits.*

Farmers - Society

Stop burning crop residues



Cover crops



Agroforestry



Restore degraded land



Piliostigma, Sahel :
+ yields & + stability
+ WUE, + water + nutrients

DownToEarth

Paddy fields burning: Smog shrouds national capital

The smoke resulting from burning crop residues combined with vehicular emissions make the air we breathe deadly

By Usman Nasim

Last Updated: Monday 07 December 2015

Crop Burning: Punjab and Haryana's killer fields

Punjab produces about 19-20 million tonnes of paddy straw and about 85-90 per cent of this paddy straw is burnt in the field

Air Pollution: Viable Alternative Emerges To Burning Paddy Straw In Punjab

In a bid to cur pollution caused by the practice of stubble burning, Worldwide Fund for Nature India is working in collaboration with a private firm to use rice straw as an energy feeder in boilers

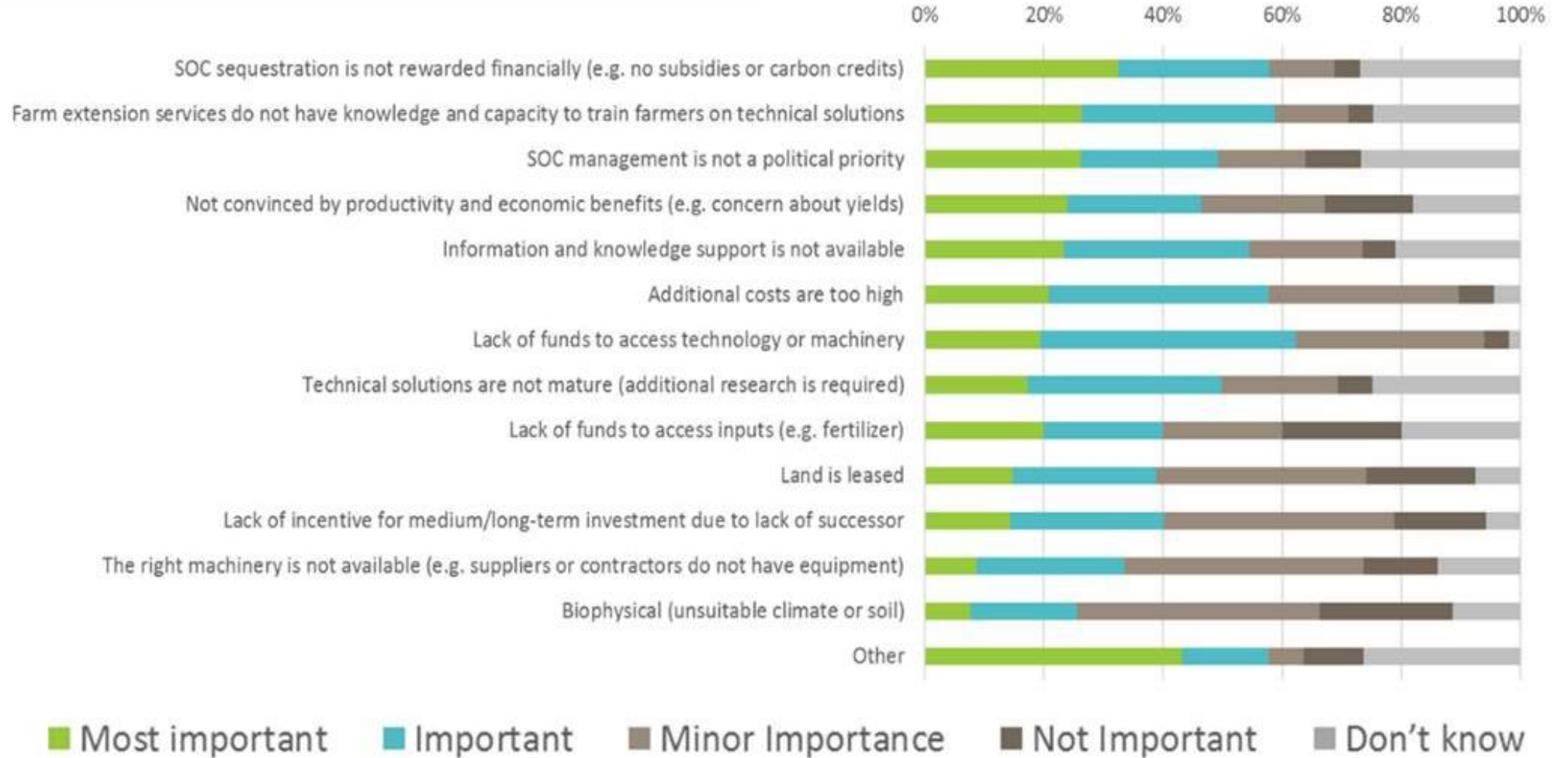
Air Pollution, News, Punjab | IANS | May 20, 2019 11:26 AM | 0

Challenges for implementation?

Barriers to implementation



Stakeholders consultation. Farmers (world, ≈ 1500)



Enabling environment



Economic returns
Training, capacity building
Extension services & support
Credit, investment
Land tenure security
Incentives

Take-home messages

Soil carbon is key to address vulnerabilities of agriculture to climate change and food security issues

- Preserving and increasing soil organic carbon brings **multiple benefits**
- Increasing soil C in agricultural soils is **feasible**, but heterogeneous
- **Not a single good practice** but adequate combination of practises in a given context
- Associated **risks** : can be predicted, should be avoided
- **Spatially differentiated**: potentials, constraints, benefits. Spatially target the action
- There are “**no regret**” options
- **Technical potential >> socio-economic potential**



Thank you for your attention

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