Modeling the transition of French Agriculture in a 4per1000 future

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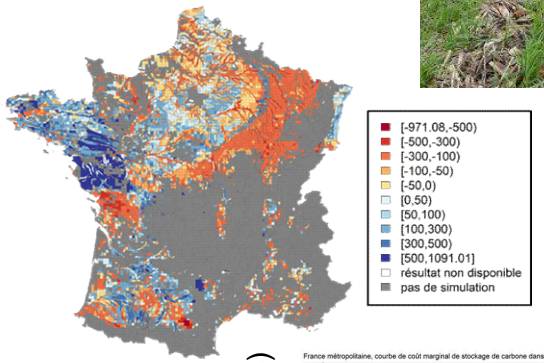
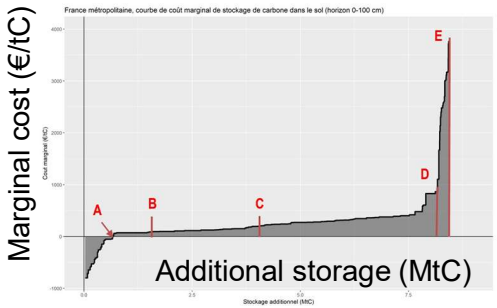
Storing carbon in French agricultural soils
Potential and cost of additional storage

- Identifify soil organic carbon storing practices
- Assess and map their potential for additional carbon storage in soils, at the region and national level
- Assess their implementation costs
- Cost-effectively allocate the C storing effort





- 30 scientific experts from fields ranging from agronomy and soil sciences to economics

Soil C storing practices

Arable crops:

- **Expansion of cover crops :** increase frequency and duration of ground cover
- **No-tillage:** suppression de tout travail du sol sauf contrainte technique et sauf pour la destruction des prairies et des cultures intermédiaires
- **New organic C inputs:** not already spread on agricultural soils under current management practices (e.g. composted greenwastes, sewage sludges and biowastes, digestates)
- **Expansion of temporary grasslands:** at the expense of silage maize, or increase in existing temporary grasslands lifespan
- **Agroforestry :** 75 trees/ha, 24 m inter-row, soils > 1m, plots >1ha
- **Hedges :** plots >8ha

Soil C storing practices

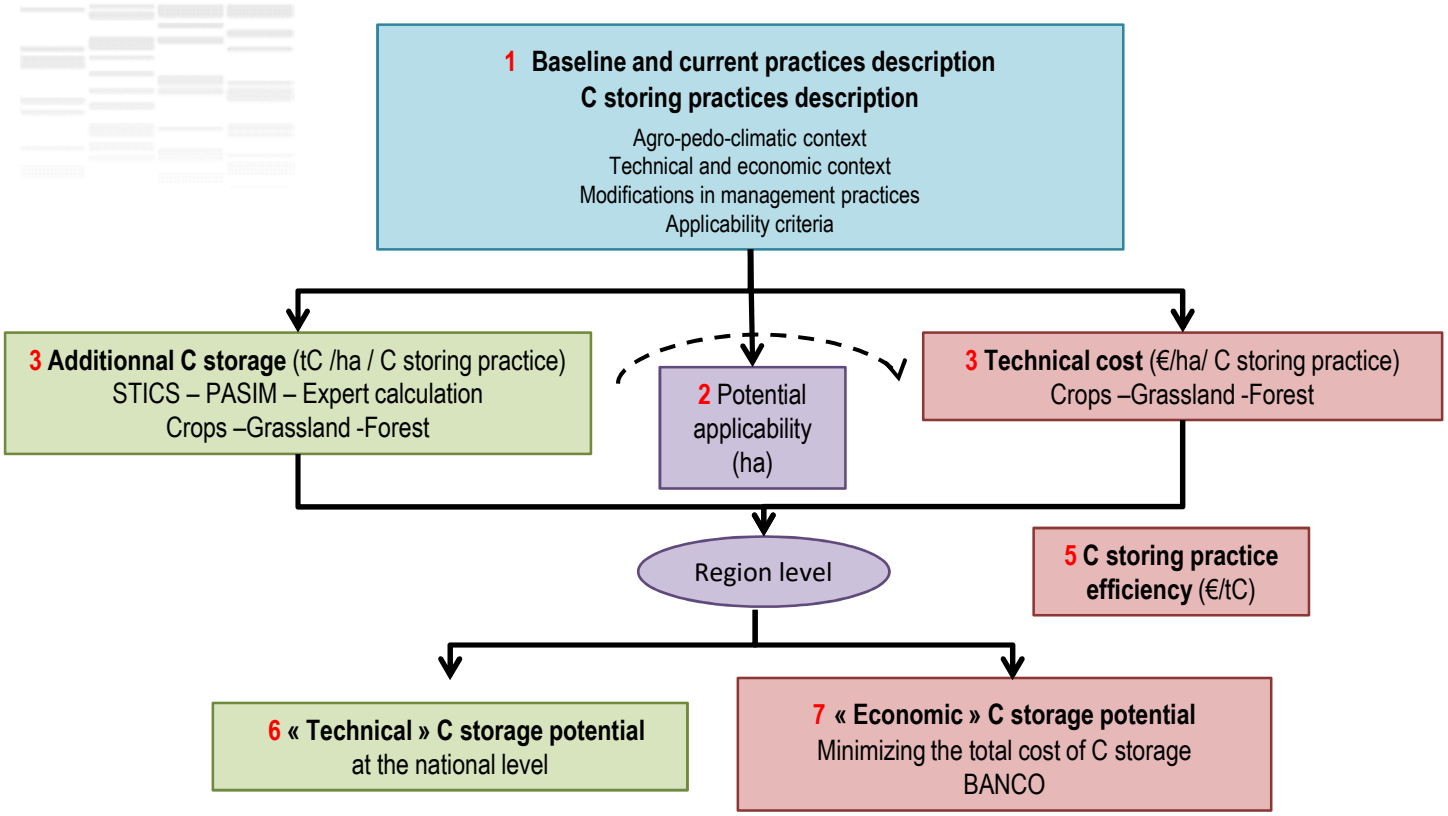
Permanent Grasslands:

- **Moderate intensification of extensive grasslands:** +50 kg N/ha
- **Animal grazing instead of mowing :** substitution of 1-2 mowing by grazing

Vineyards:

- **Grass cover of vineyards:** expansion of permanent or temporary cover on every row

Methodology : overview

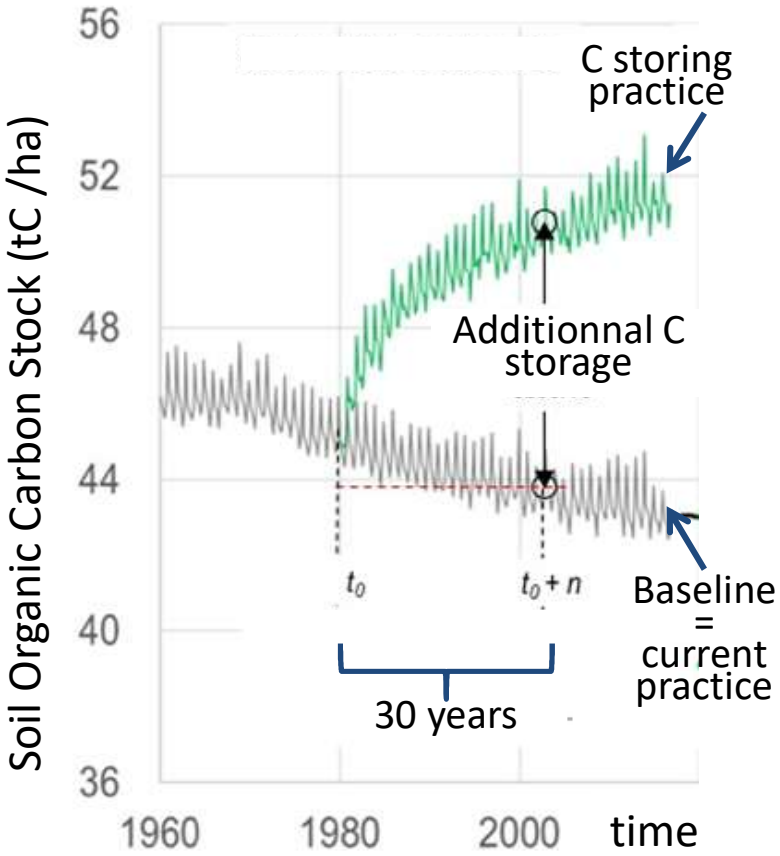


Methodology : soil C storage assesment

- **additional C storage** (tC/ha/yr) =

$$\frac{(C\ stock\ storing\ practice - C\ stock\ baseline)}{30}$$

- For each C storing practice, a complete greenhouse gases budget is calculated



Methodology : implementation cost assesment

« additional cost » = « cost » C storing practice – « cost » current practice

Cost = loss or gain for the farmer

- **Δ overheads**
  - Δ inputs (fertilizer, feedstuff, …)
  - Δ crop management operations (labour, machinery, fuel)
  - Dedicated investments (e.g. tree planting)
- **Δ revenue**
  - Δ yield
  - New revenue (e.g. sale of wood)
  - Change in land allocation (e.g. crop area substituted with trees or hedges)
- Excluding « optional subsidies »
  - E.g. Common Agricultural Policy payments, agri-environmental measures, regional subsidies
- Constant annuity with a 4.5% discount rate

Methodology : assumptions and data sources

Costs calculated assuming constant land allocation and livestock numbers, constant technological context and price system, all corresponding to the 2009-2013 reference period

- **Static historical reference period 2009-2013 : 5 year average**

- **Use of public statistics and data sources :**
  - Crop areas : Annual statistics of agriculture
  - Reference yields, prices, and crop gross margins : Farm Accountancy Data Network
  - Cropping practices : National survey on cropping practices

- **Impacts of C storing practices on yields**
  - Simulated yield variation (%) applied to the reference yield
  - Constant milk and meat yield => adjustment of the feed ration
  - Yield variations of temporary grasslands and sillage maize are compensated with a substitute feed ration

Additionnal C storage potential and costs

SOC storing practices	Additional soil C storage	Additional soil C storage	*Complete GHG budget*	Cost for farmer	Soil Carbon Storage cost	Soil Carbon Storage cost
	(tC/ha/yr)	(tCO2e/ha/yr)	*(tCO2e/ha/yr)*	($/ha/yr)	($/tC)	($/tCO2e)
Expansion of temporary grasslands	**0,192**	**0,703**	*-0,903*	**98** (-43; 284)	**511** (-261; 1 800)	**139** (-71; 491)
Moderate intensification of extensive grasslands	**0,213**	**0,781**	*0,010*	**30** (13; 41)	**140** (65; 1 284)	**38** (17; 350)
Grazing instead of mowing (permanent grasslands)	**0,362**	**1,328**	*-1,054*	**79** (-91; 158)	**219** (-3 014; 560)	**59** (-822; 152)

1€ = 1,08 US$

Cost-effective allocation of the additional C storage effort

Cost for farmer (region, practice) $/ha/yr
Additional C storage (region, practice) tC/ha/yr
Potential applicability (region, practice) ha
Compatibility (practice, practice')

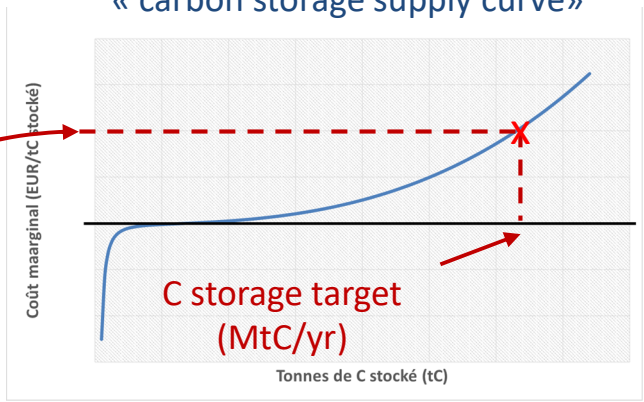
Crop and grassland models
Litterature
Experts

Cost minimizing model
(BANCO)

National additional C storage target

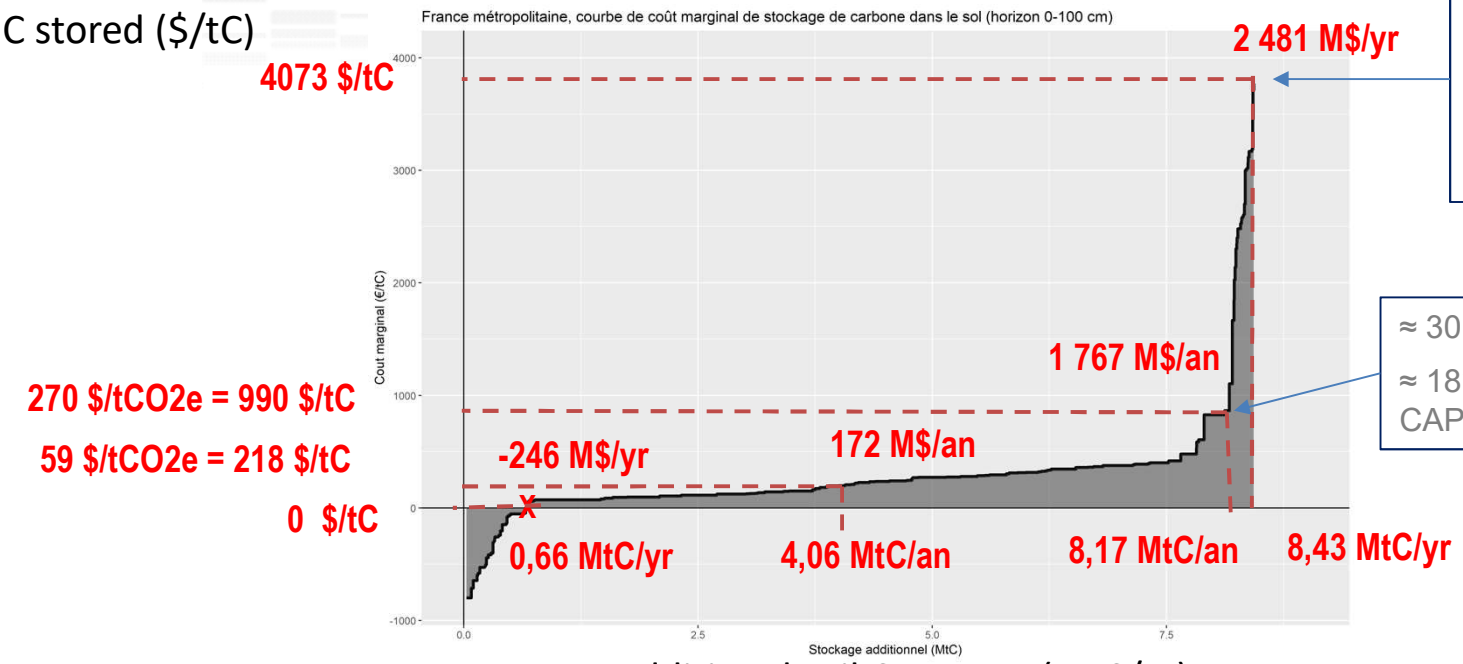
Uptake level (region, practice) (ha)
Cost of the last ton of C stored ($/tC)
Total C storage cost ($/yr)

« carbon storage supply curve»



Marginal C storage cost curve

Cost of the last ton of C stored ($/tC)



≈ 31 MtCO2e /yr

≈ 6,8% of nat. GHG emissions

≈ 41% of agricultural sector emissions

≈ 30 MtCO2e /yr

≈ 18% of French CAP budget

Additional soil C storage (MtC/yr)

Conclusion and policy implications

- There is no « one-size-fits-all » solution to increase carbon storage in soils …
- … rather a combination of good practices at the right place

=> It is important to account for heterogeneity for the design of a cost-effective policy

- Study used in the frame of the EU Common Agricultural Policy reform for the design of the French national voluntary eco-scheme

- In France, high soil C storage targets can only be achieved with the full enforcement of cover crops and agroforestry, and with the expansion of temporary grasslands in crop rotations.
- Need to ensure coherence between existing policies and, ideally, account for bundles of ecosystemic services in an integrated policy.
- A policy aiming at supporting additional C storage in arable land must not come at the expense of the preservation of existing carbon stocks in permanent grasslands and forests

Thanks for your attention!

http://institut.inra.fr/Missions/Eclairer-les-decisions/Etudes/Toutes-les-actualites/Stocker-4-pour-1000-de-carbone-dans-les-sols-francais