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# Prairies, séquestration du carbone et effet de serre

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# Prairies, séquestration du carbone et effet de serre

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Séminaire Franco-Britannique
17 Juin 2009

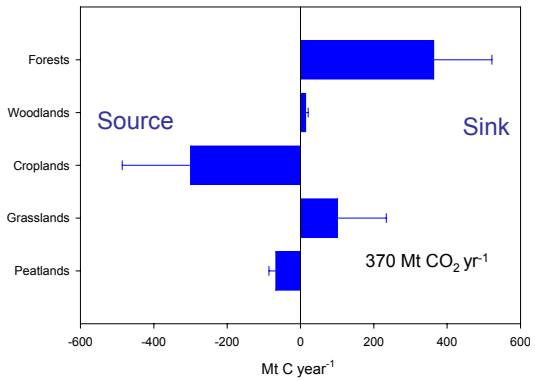
ALIMENTATION
AGRICULTURE
ENVIRONNEMENT

## Outline

1. Carbon sequestration in European grasslands
2. C sequestration in the context of greenhouse gas balance
3. Vulnerability of carbon stocks to climate change and biodiversity loss

## Uncertainties in the land carbon balance of Europe

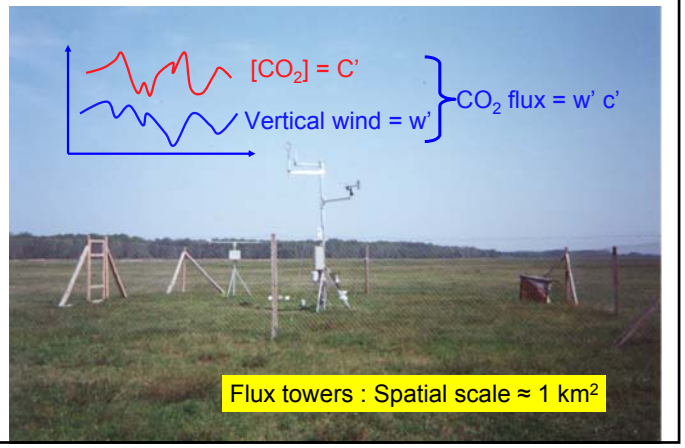
(Janssens et al. Science, 2003).



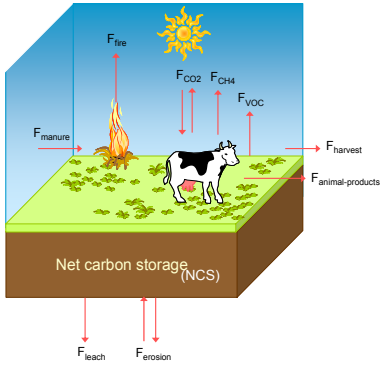

Estimated carbon sink: 7-11 % of fossil fuel emissions

Geographic Europe

## The eddy covariance method for measuring $CO_2$ fluxes



# C fluxes in a grassland ecosystem



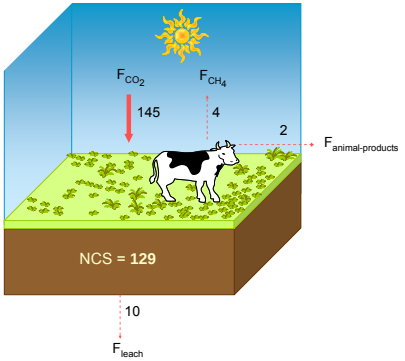

$NCS = (F_{CO2} - F_{CH4\text{-}C} - F_{VOC} - F_{fire}) + (F_{manure} - F_{harvest} - F_{animal\text{-}products}) - (F_{leach} + F_{erosion})$

Simplified balance in a temperate managed system:

$NCS = (F_{CO2} - F_{CH4\text{-}C}) + (F_{manure} - F_{harvest} - F_{animal\text{-}products}) - F_{leach}$

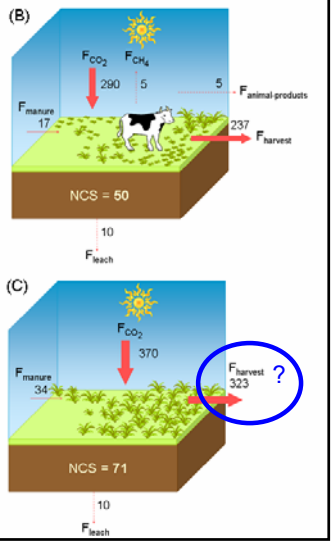
(Soussana and Tallec, 2009, Animal, in press)

# C sequestration (NCS) at grazed only European sites (g C $m^{-2}$ $yr^{-1}$)

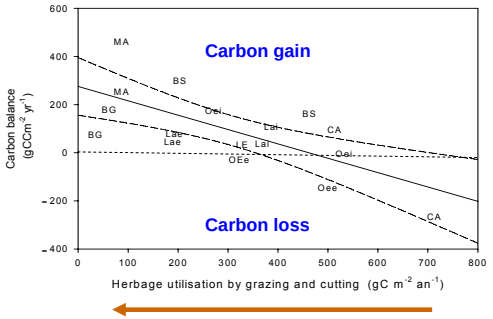



Mean of 2 sites
(Soussana et al., 2007, AGEE; Soussana & Tallec, 2009, Animal)

# C sequestration (NCS) at cut European sites (g C $m^{-2}$ $yr^{-1}$)



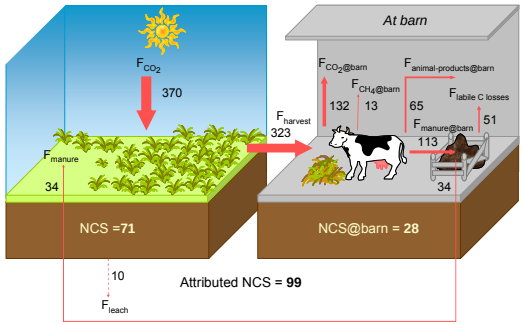

# Carbon sequestration (NCS) at 10 European grassland sites




- The less carbon is used, the more is returned to the soil, which increases C sequestration
- Nitrogen supply also favours carbon sequestration

(Soussana et al. Agriculture, Ecosys. Environment, 2007)

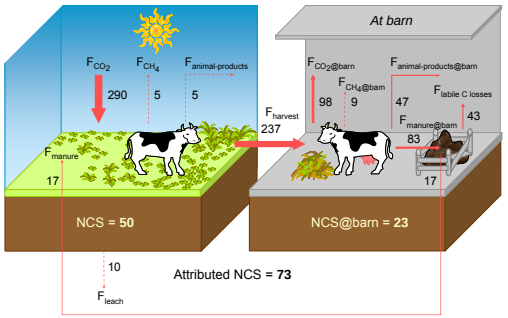
## Fate of harvested C at cut sites ($g\ C\ m^{-2}\ yr^{-1}$)




$$\text{Att-NCS} = \text{NCS} + \text{NCS}_{@barn} = \text{NCS} + f_{humif}\ \text{Max}[0, (1-f_{diges})F_{harvest} - F_{manure}]$$

Mean of 3 sites
(Soussana et al., 2007, AGEE; Soussana & Tallec, 2009, Animal)

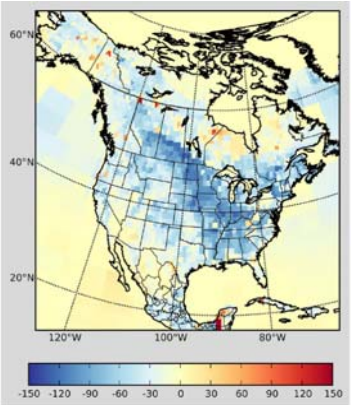
## Fate of harvested C at cut and grazed sites ($g\ C\ m^{-2}\ yr^{-1}$)




$$\text{Att-NCS} = \text{NCS} + \text{NCS}_{@barn} = \text{NCS} + f_{humif}\ \text{Max}[0, (1-f_{diges})F_{harvest} - F_{manure}]$$

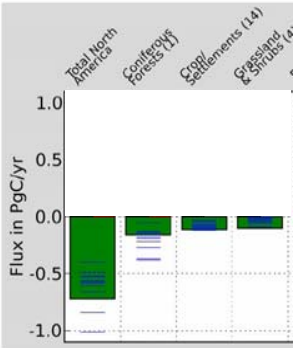
Mean of 4 sites
(Soussana et al., 2007, AGEE; Soussana & Tallec, 2009, Animal)

## Land carbon sink distribution in Northern America




(Peters et al. 2007, PNAS)

## Land carbon sink in Northern America

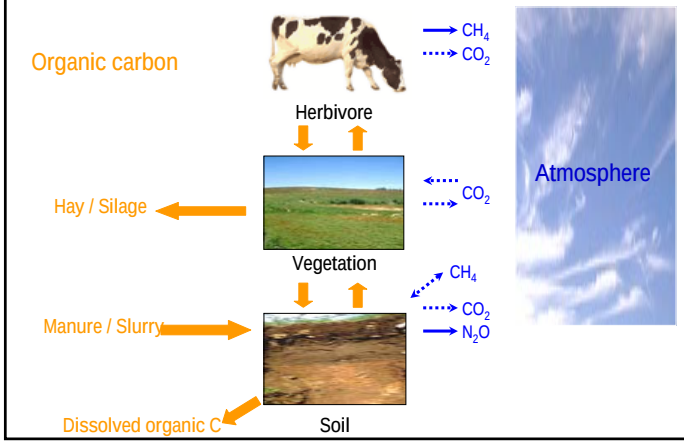



(Peters et al., 2007, PNAS)

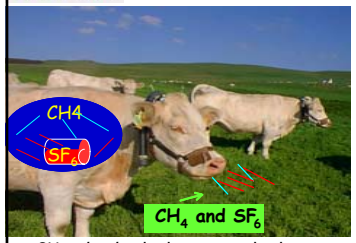
## Outline

- Carbon sequestration in European grasslands
- C sequestration in the context of GHG balance
- Vulnerability of carbon stocks to climate change and biodiversity loss

## Greenhouse gas and organic carbon fluxes in a grassland




## Greenhouse gas balance of 10 European grassland sites




$CH_4$ : *in-situ* dual tracer mehod

$N_2O$: automated chambers

On site emissions of $N_2O$ and $CH_4$ , converted in $CO_2$ equivalents using the GWP of each gas, offset 43 % of the ecosystem C sink

The net greenhouse gas balance, also including off-site emissions of $N_2O$ and $CH_4$ through digestion of cut herbage, is a small net sink by 85 ± 77 g C $m^{-2}$ $yr^{-1}$

(Flechard et al., 2007, Pinares-Pineiro et al., 2007, Soussana et al., 2007)

## GHG balance in $CO_2$ equivalents at European sites

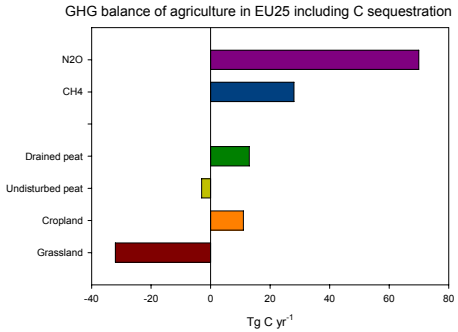
(g $CO_2$-C equivalents $m^{-2}$ $yr^{-1}$)

| Management | NCS | Att-NCS | NGHG | Att-NGHG |
|---|---|---|---|---|
| Grazing | 471 | 471 | 320 | 320 |
| Grazing & cutting | 183 | 268 | -22 | -272 |
| Cutting | 259 | 359 | 230 | -141 |

NGHG: grassland greenhouse gas balance
Att-NGH: attributed greenhouse gas balance (including off site emissions)

(Soussana et al., 2007, Soussana and Tallec, 2009)

## The GHG balance of the agriculture sector in Europe




Grassland C sequestration would play a significant role for the European agriculture sector

(Schulze et al., submitted to Nature Geosciences)

## Outline

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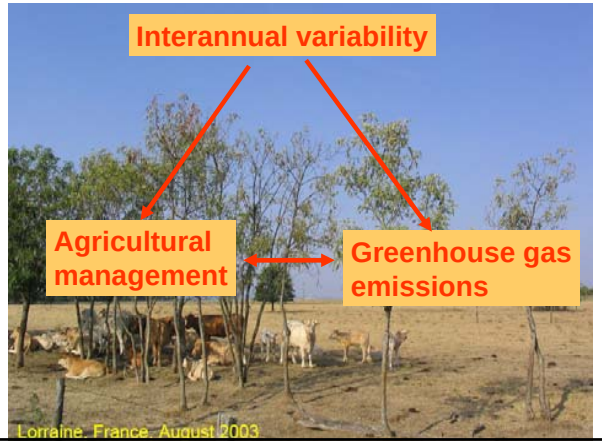
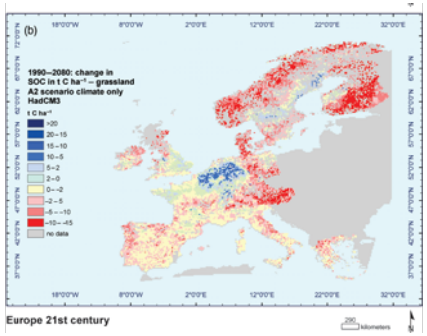
## Impacts of climate variability and extremes on the C cycle in grasslands

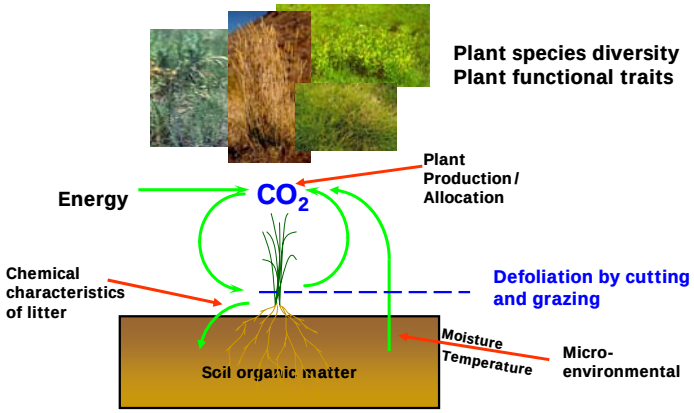



## Climate change impact on grassland soil carbon sequestration

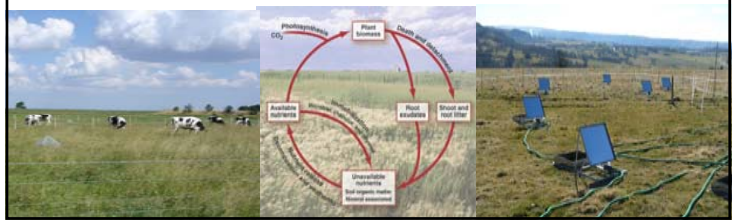



(Smith et al., 2005, Global Change Biol.)

## Biodiversity loss may impact C sequestration




## Concluding remarks

- There is a clear potential for C sequestration in European grasslands
- An internationally agreed methodology is still missing to develop mitigation options in the livestock sector based on C sequestration
- Reducing $CH_4$ and $N_2O$ emissions from the livestock sector is strongly needed, given that soil carbon sequestration is reversible and vulnerable to climate change and biodiversity loss
- Mitigation strategies could be based on the net GHG balance of livestock farms

# Thank you