Prairies, séquestration du carbone et effet de serre

Jean-François J.-F. Soussana

Prairies, séquestration du carbone et effet de serre

Jean-François Soussana
Unité de Recherche sur l'Ecosystème Prairial,
INRA, Clermont-Ferrand

Séminaire Franco-Britannique
17 Juin 2009

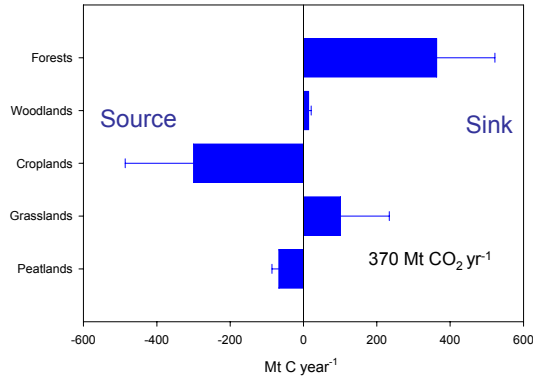
ALIMENTATION
AGRICULTURE
ENVIRONNEMENT

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

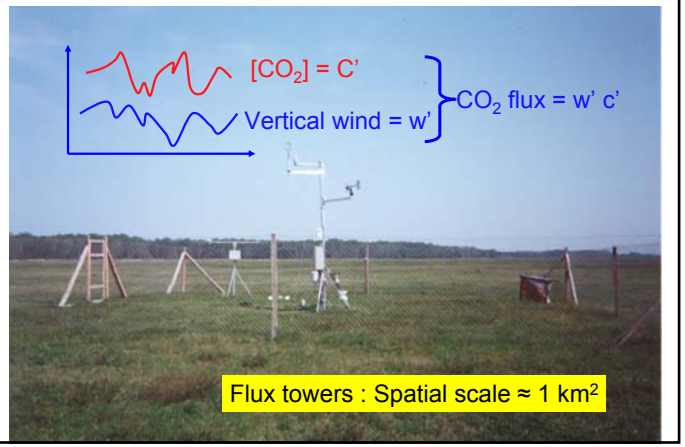
(Janssens et al. Science, 2003).



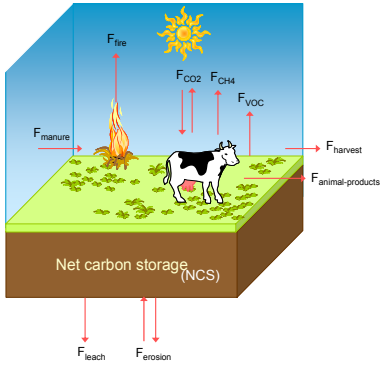
Estimated carbon sink: 7-11 % of fossil fuel emissions

Geographic Europe

The eddy covariance method for measuring CO_2 fluxes



C fluxes in a grassland ecosystem



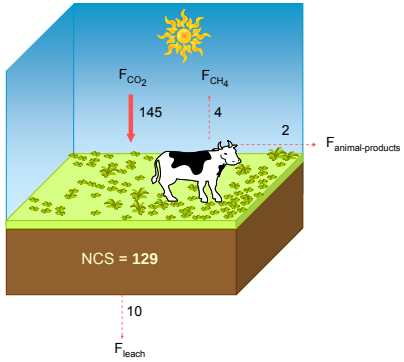
$NCS = (F_{CO2} - F_{CH4\text{-}C} - F_{VOC} - F_{fire}) + (F_{manure} - F_{harvest} - F_{animal\text{-}products}) - (F_{leach} + F_{erosion})$

Simplified balance in a temperate managed system:

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

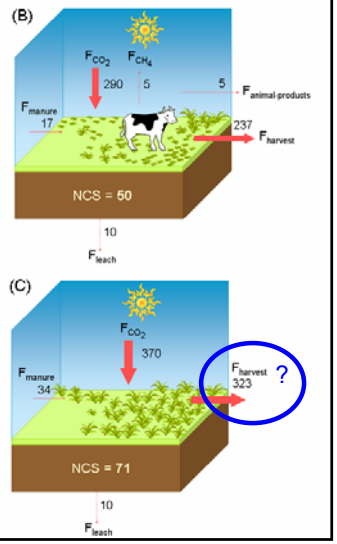
(Soussana and Tallec, 2009, Animal, in press)

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

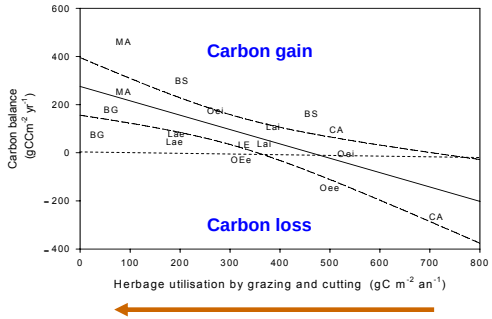


Mean of 2 sites
(Soussana et al., 2007, AGEE; Soussana & Tallec, 2009, Animal)

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



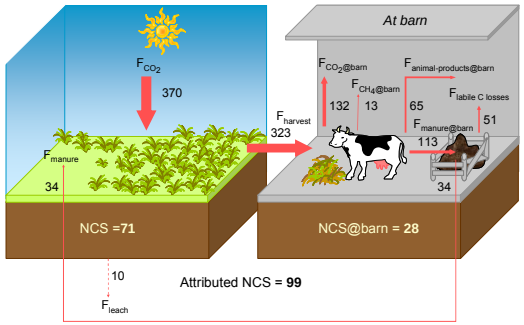
Carbon sequestration (NCS) at 10 European grassland sites



- 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)

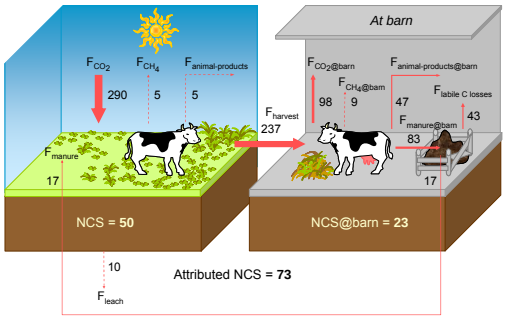
Fate of harvested C at cut sites (g C m^{-2} yr^{-1})



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

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

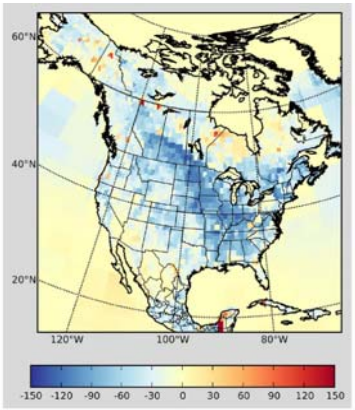
Fate of harvested C at cut and grazed sites (g C m^{-2} yr^{-1})



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

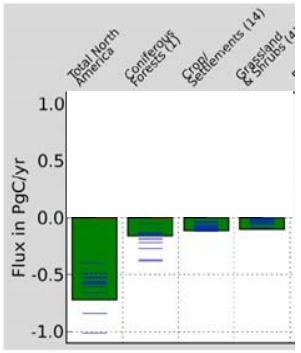
Mean of 4 sites
(Soussana et al., 2007, AGEE; Soussana & Tallec, 2009, Animal)

Land carbon sink distribution in Northern America



(Peters et al. 2007, PNAS)

Land carbon sink in Northern America

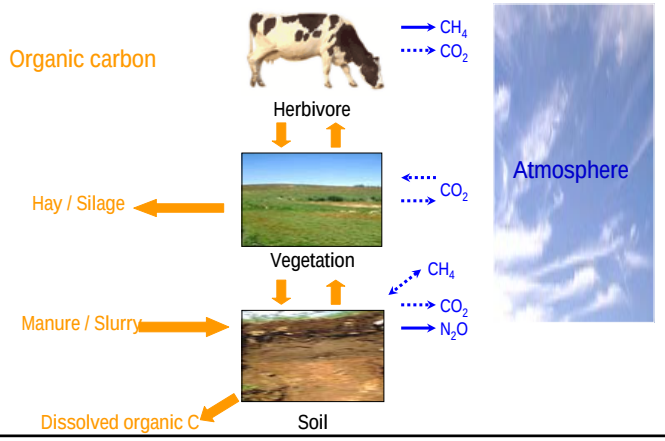


(Peters et al., 2007, PNAS)

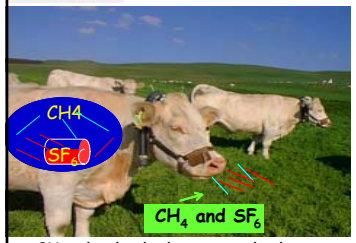
Outline

- 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

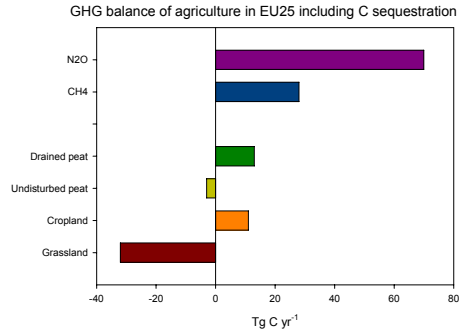
(g CO_2-C equivalents m^{-2} yr^{-1})

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



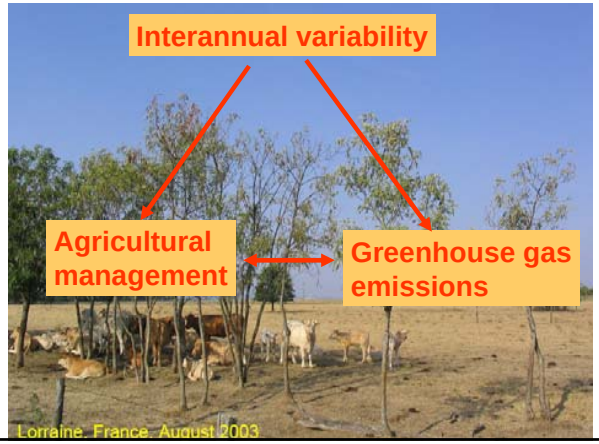
Grassland C sequestration would play a significant role for the European agriculture sector

(Schulze et al., submitted to Nature Geosciences)

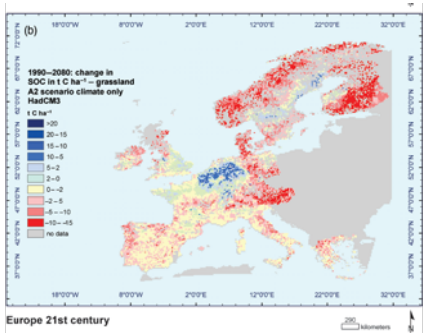
Outline

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

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

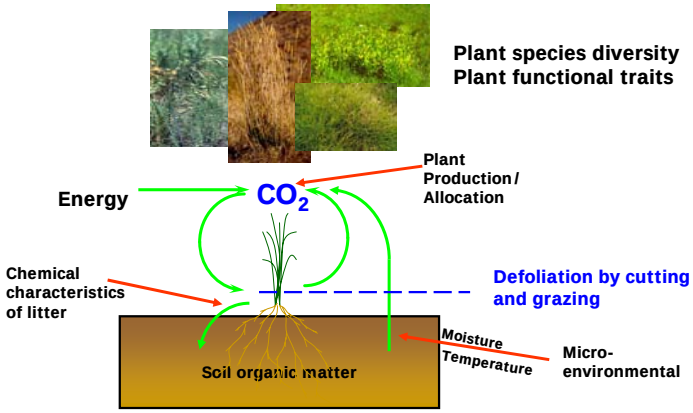


Climate change impact on grassland soil carbon sequestration



(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