Aggregated plant functional traits as affected by management practices impact C stocks in temperate grasslands

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Global changes

- Increase of greenhouse gases (GHG) concentrations
- Agricultural activities contribute largely to GHG emissions
- Some agroecosystems mitigate CO₂ emissions by C storage in soils

### Role of grasslands

- Ecological services: C sequestration
- 1/3 of the world terrestrial soil C stock

### Soil C stock (0-30cm):

<table>
<thead>
<tr>
<th>Cover types</th>
<th>Carbon stock (t C/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arable lands</td>
<td>43</td>
</tr>
<tr>
<td>Grasslands</td>
<td>70</td>
</tr>
<tr>
<td>Mixed forests</td>
<td>70</td>
</tr>
<tr>
<td>Alpine grasslands</td>
<td>93</td>
</tr>
</tbody>
</table>

*(Arrouays et al., 2002)*

![Graph of Concentrations of Greenhouse Gases from 0 to 2005](IPCC, 2007)
C stocks are mainly located belowground, in roots and soil

(Soussana et al., 2004)

Plants drive

- directly C input (photosynthesis)
- directly and indirectly C output (plants and microorganisms respiration)
INTRODUCTION

Plant resource-use strategies

Leaf traits syndrome

(Wright et al., 2004)

Exploitative species

Productive

High resource capture
Fast growth abilities

High C input

Fast tissue turnover
Fast litter decomposition

High C output

Conservative species

Less productive

Low resource capture
Slow growth abilities

Low C input

Slow tissue turnover
Slow litter decomposition

Low C output
INTRODUCTION

Species trait values (SLA, LDMC...)

Weighted according to the mass ratio hypothesis (Grime, 1998):
weighted by the relative abundance of species

Community weighted traits (SLA_{cw}, LDMC_{cw}...)
(Garnier et al., 2004)
Determine how weighted plant functional traits modify C stocks in grasslands, as affected by management practices.
Basse-Normandie

Grasslands:
50% of the agricultural surfaces

7 grassland stations

French Agronomic Research Institut (INRA) experimental station, Le Pin-au-Haras
7 grassland stations (400m² surface area)

<table>
<thead>
<tr>
<th>Stations</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
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<tbody>
<tr>
<td>Permanent (P) / Temporary (T)</td>
<td>P</td>
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7 grassland stations (400m² surface area)

Floristic composition

Leaf traits

*Community weighted traits* *(SLA_{CW}, LDMC_{CW}...)*

Plant, root and soil sampling

Before each grazing or mowing period during the 2012 season (10 replicates/station)

- **SLA**: specific leaf area
- **LDMC**: leaf dry matter content
- **LNC**: leaf nitrogen content
- **LCC**: leaf carbon content
- **LC/N**: leaf carbon / nitrogen ratio

*De Vries ring* *(100 cm²)*

*Soil core* *(∅ 6 cm, ↓ 10 cm)*
Floristic and functional composition of the 7 grassland stations

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<td>M</td>
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<tr>
<td>Dominant species relative cover</td>
<td>100%</td>
<td>50%</td>
<td>0%</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Ryegrass</td>
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<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>$\text{SLA}_{\text{CW}}$</td>
<td>17.8 (0.9)</td>
<td>27.8 (1.2)</td>
<td>26.7 (0.7)</td>
<td>21.2 (1)</td>
<td>19.1 (1.1)</td>
<td>21.5 (0.5)</td>
<td>23.3 (1)</td>
</tr>
<tr>
<td>$\text{LDMC}_{\text{CW}}$</td>
<td>261.4 (11.2)</td>
<td>233.7 (13.7)</td>
<td>228.6 (4.7)</td>
<td>236.4 (6.9)</td>
<td>215.9 (10.7)</td>
<td>191.3 (8.3)</td>
<td>175.4 (4.9)</td>
</tr>
</tbody>
</table>

- Floristic composition typical of Normandy grasslands
- Differ in terms of weighted functional traits
Wide range of grassland production

Production and SOM content are negatively correlated
**RESULTS**

- Wide range of grassland production
- Production and SOM content are negatively correlated
- Root biomass and SOM content are positively correlated

![Graph showing correlations between SOM, production, and root biomass](graph.png)

\[ R^2 = 0.59 \quad p < 0.001 \]

\[ R^2 = 0.25 \quad p < 0.001 \]
Strong positive relationship between LDMC and SOM content

LDMC appears to be the best predictor of SOM content
Productive grasslands

- High SLA
- Low LDMC
- High C input
- Fast SOM degradation (structural C)
- High C output

Less productive grasslands

- Low SLA
- High LDMC
- Low C input
- Slow SOM degradation (lignin, cellulose)
- Low C output
Among community weighted functional trait, $\text{LDMC}_{\text{cw}}$ could be an indicator of grassland C storage.

In our study, low productive grasslands (associated with more conservative strategies) showed a stronger potential for C sequestration than highly productive grasslands.

In contradiction with Lavorel & Grigulis (2012), Fornara & Tilman (2012)

In accordance with Bardgett & Wardle (2003), Garnier et al., (2004), De Deyn et al. (2008)

Need for further studies on a wide range of grasslands and management practices
Thank you for your attention!

And thanks to:
INRA Experimental Station of Le-Pin-au-Haras
Technical staff
EGF organisers
Detail soil C pools: soluble C measurements.

Fluxes between C pools using $^{13}$CO$_2$ labeling.

Seasonal dynamics of C stocks in grasslands (defoliation/regrowth) in relation with management practices.