Soil C and N stocks in the sylvopastoral zone of Senegal is influenced by trees

1- Context

Pastoral livestock systems in Sahel are criticized for their high intensity of GHG emissions and their negative impact on soil and vegetation. A good management of soil and plants can mitigate this negative environmental impact and increase the contents and stocks of organic carbon in soils. This study aims to:

- Explore the influence of trees on carbon and nitrogen content in the topsoil.
- Identify the environmental drivers of the soil carbon stocks: biomass, rainfall, tree cover rate.

2- Materials and methods

- Soil sampling outside and under tree crowns (0-10 and 10-30 cm depth) at 15 of the survey control sites monitored by the CSE.
- Prediction of soil carbon and nitrogen contents using the Near Infrac-Red Spectroscopy (NIRS).
- Use of the core method to determinate soil bulk density and thus calculate Carbon and Nitrogen stocks.

3- Results and discussion

- Average carbon stocks in the upper 0-30 cm soil layers varied from 9.3 to 29.7 / 18.5 t.ha⁻¹.
- Soil carbon and nitrogen contents were higher under the tree crowns, and at 0-10 cm deep.
- The soil C-to-N ratio was significantly higher under tree crowns than outside.
- Stocks of soil C increased along a North-South gradient as influenced by rainfall and tree biomass.
- Total carbon stocks (up to 18.5 t.ha⁻¹) were lower than those in the area (20.6 t.ha⁻¹) reported in Woomer et al. (2004), but higher than as observed for other deserts and bush (15.4 t.ha⁻¹; Henry et al., 2009).
- Indeed, the difference observed was to be related to those in the depth explored (30 vs 40-cm deep).
- Variation in soil C stocks seems to be linked to a North-South gradient in environmental factors as rainfall fluctuations influence the leafing density of trees (Hiernaux et al., 1994) and the productivity of Sahelian pastures (Penning de vries and Djitéye, 1982). Better soil chemical properties already observed under trees in the Northern Sylvopastoral area (Apko et al. 2005) and microclimate under tree cover may induce greater soil microbiological (Diallo et al., 2017).

Correlations between stocks and environmental factors

<table>
<thead>
<tr>
<th>Factors</th>
<th>HH</th>
<th>SH</th>
<th>Totals HH</th>
<th>SH</th>
<th>Totals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rainfall (mm.an⁻¹)</td>
<td>0.39</td>
<td>0.12</td>
<td>0.41</td>
<td>0.50</td>
<td>0.77</td>
</tr>
<tr>
<td>Arbo</td>
<td>Coverage rate (%)</td>
<td>0.32</td>
<td>0.15</td>
<td>0.42</td>
<td>0.26</td>
</tr>
<tr>
<td>Leaf biomass (kg dry matter per ha)</td>
<td>0.31</td>
<td>0.12</td>
<td>0.33</td>
<td>0.41</td>
<td>0.78</td>
</tr>
<tr>
<td>0.0 : R² significant at 5%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

More research needed on soil C and N contents and stocks in the silvo-pastoral area of Senegal:
- Document the influence of microrelief and season.
- Estimate the respective and cumulated contributions of cultivated plants and cattle.
- The positive impact of trees on the C and N contents and stocks in soils of the sylvopastoral area of Senegal.
- A North-South gradient in soil C stocks according to rainfall and tree cover.

Our study highlighted:
- The positive impact of trees on the C and N contents and stocks in soils of the sylvopastoral area of Senegal.
- A North-South gradient in soil C stocks according to rainfall and tree cover.


*Correlations between C stocks and environmental factors.*

**Our study highlighted:**
- The positive impact of trees on the C and N contents and stocks in soils of the sylvopastoral area of Senegal.
- A North-South gradient in soil C stocks according to rainfall and tree cover.

**More research needed on soil C and N contents and stocks in the silvo-pastoral area:**
- Document the influence of microrelief and season.
- Estimate the respective and cumulated contributions of cultivated plants and cattle.

**Difference between under (SH) and outside (HH) the crown in the content of soil C and N ratios respectively at 0-10 cm (a) and 10-30 cm (b) and d deep.**