The role of environmental gradients and tree functional attributes on tree-understory interactions


World Silvopastoral Congress

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Why tree-understorey interactions?

- Difference in size (height) $\Rightarrow$ light interception, potential for asymmetric competition.

- Trees contribute significantly to soil formation (e.g. Casals et al. 2014, Hoosbeek et al. in review).

- Microclimate (e.g. evaporation (Olivero 2010), soil temperature).

- Determine important ecological functions in the farm underpinning ecosystem services - trade-offs.
What we knew

- In Rivas, Nicaragua, grassland ANPP lower under trees (3 species) than in open, at peak.
What we knew

- In Potou, Senegal, the net effect of trees on grassland ANPP (RII_ANPP) was either neutral or positive. 14 species.

RII = 0  Neutral effect
Interaction outcome x environment

- Both competition and facilitation occur among plants.

- The relative importance of competition and facilitation tends to change with the environment: benign $\Rightarrow$ harsh.

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We asked:

- Does the sign of the tree-grassland interaction function shift from negative to positive with site productivity?

- To which extent do tree attributes affect the net interaction balance?

- Is the net effect of the tree related to other beneficial functions (soil formation - fertility)?
Dataset

- A gradient of environmental conditions: soils and climate.

- 17 Species from Senegal and Nicaragua, n=5.
Dataset

- ANPP wet season (Biomass accumulation during 3 months).
- Exclosures

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Dataset

- Paired sampling

- $\text{RII} = \text{Relative Interaction Index (Armas et al. 2004)}$

\[
\frac{\text{ANPP}_{\text{tree}} - \text{ANPP}_{\text{no tree}}}{\text{ANPP}_{\text{tree}} + \text{ANPP}_{\text{no tree}}} \xrightarrow{-1 \quad +1}
\]

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Dataset

- ANPP of open grassland (control) as a reference of «site productivity»
Results

Site productivity explained a large portion of tree net effects.
# Results

## Effect on RII - ANPP

<table>
<thead>
<tr>
<th>Effect</th>
<th>Treatment</th>
<th>$R^2$</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tree height</td>
<td>Riv+Pot</td>
<td>0.15</td>
<td>0.0003</td>
</tr>
<tr>
<td>LAI rainy season</td>
<td>Potou</td>
<td>0.06</td>
<td>0.049</td>
</tr>
<tr>
<td>RII- Soil total C</td>
<td>Riv+Pot</td>
<td>0.09</td>
<td>0.008</td>
</tr>
<tr>
<td>RII- Soil total N</td>
<td>Riv+Pot</td>
<td>0.00</td>
<td>0.81</td>
</tr>
<tr>
<td>Leaf N</td>
<td>Riv+Pot</td>
<td>0.00</td>
<td>0.79</td>
</tr>
</tbody>
</table>

![Graphs of RII-ANPP vs TREE_HEIGHT_M, LAI wet season, and RII_Ct](image)
Results

Species-specific response.

Celtis integrifolia

Faidherbia albida
Concluding remarks

- Results reinforce evidence about different degrees of competition and facilitation along environmental gradients.

- Facilitation/competition balance affected by:
  - (-) site productivity
  - (-) tree height (size)
  - (-) LAI
  - (+) RII- Soil C

- Important for the design & planning of silvopastoral systems.
Concluding remarks

- Facilitation related to indirect effect of tree on soil formation (organic matter accumulation). No trade-off with this function.

- Specific responses of particular trees important for planning, selection.
Thank you!

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The FUNCiTREE consortium