Investigation of biopump strategy in France

SHEN Zhou  Supervisors: Ligia Barna & Lorie Hamelin & Aras Ahmadi

@cambioscop  zshen@insa-toulouse.fr

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Carbon vulnerable lands in France

Possible land: 11,187 - 24007.4 km²

Land use types in France

- Dense urban land
- Scattered urban land
- Industrial and commercial zones
- Roads
- Rapeseed
- Straw cereals
- Legumes and other protein crops
- Temperate broadleaf forest
- Temperate coniferous forest
- Woody Moorland
- Maize / Corn
- Beaches and dunes
- Water
- Root and tubers

SOC: soil organic carbon

1 Ingla, J. 2017.
Biopump case

Aim: To induce a CO2 removal and transit towards a low fossil carbon economy simultaneously.

1) Build the whole LCA process to evaluate the climate change mitigation quantitatively;
2) Which plant is more suitable to grow as biopump in the French carbon vulnerable land;
3) Which product has the best performance here, which parameter plays the key role;
4) For the future, which factor we need to focus if conducting our biopump strategy.

Biopump literature review

Selecting criteria
• SOC increase capacity
• Yield
• Agricultural intensity
• ……

Scoring and ranking
• Perennial plants
• Annual plants

Selected biopumps

Hemp
*Cannabis sativa*
Lifetime: annual
Yield: 9.2 t/ha

Black locust
*Robinia pseudoacacia*
Lifespan: 35 years
Yield: 551 t/ha at the end

Reference:
1 Ledo, Alicia, et al. (2019)
Process diagram
(Black locust)
SOC simulation

Time scale:
105 years, to complete three rotations of black locust

Accumulated C input of black locust and hemp

\[ \text{Mg/ha} \]

Table Input of AMG, soil characteristics:

<table>
<thead>
<tr>
<th>Carbon vulnerable land</th>
<th>Measured depth cm</th>
<th>Clay g/kg</th>
<th>CaCO₃ g/kg</th>
<th>pH</th>
<th>Bulk density g/dm³</th>
<th>Coarse fragment %</th>
<th>SOC concentration g/kg</th>
<th>SOC stock Mg/ha</th>
<th>C/N</th>
</tr>
</thead>
<tbody>
<tr>
<td>30</td>
<td>215.97</td>
<td>26.26</td>
<td>6.6</td>
<td>1.4</td>
<td>6.63</td>
<td>10.79</td>
<td>42.35</td>
<td>22.0</td>
<td></td>
</tr>
</tbody>
</table>

SOC simulation

- The SOC increase of black locust is 0.45 Mg/ha, of hemp is 0.06 Mg/ha; Black locust could meet the requirement of 0.4%;
- The total SOC increase of black locust is 46.92 Mg while of hemp is 6.08 Mg in the carbon vulnerable land.

Perspective

- Analyze the LCA result based on the inventory, evaluate the environmental impact of biopump;
- Conducting dynamic LCA to draw the carbon flow with time.
Carbon flows: a simple example of *Miscanthus*

**Scenario 1**

F: biogenic carbon fraction stored in the products  
L: product lifetime

F100L100

**Scenario 2**

F100L1

**Scenario 3**

FxLy/Fx’Ly’

Reference:
1 Black & white icons come from Noun project, https://thenounproject.com/
2 Tiruta-Barna, Ligia, 2016
Fig. 1 Net CO$_2$ flows. Results are expressed for miscanthus cultivated on 1 ha marginal land.

Fig. 2 The global mean temperature change GMTC(K). Results are expressed for miscanthus cultivated on 1 ha marginal land.

- CO$_2$ emission peaks are due to agriculture operations at the rotation time (20 y) and no product fabrication at this moment.
- The net CO$_2$ emission till 2100 varies from -3.63 to -1143.71 Mg CO$_2$ /ha between F100L1 and F100L100.
- If placed in the climate context (2050 – 2100), product with 1 year lifetime won’t contribute to the climate mitigation.
- To maximize the reduction of the mean temperature change, the lifetime should be as long as possible.
Thanks for your attention

zhen@insa-toulouse.fr  @cambioscop

Reference
Black & white iron in this ppt come from Noun project, https://thenounproject.com/

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