Bioenergy production from agri-industrial biomass residues
a consequential LCA

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Bioenergy production from agri-industrial biomass residues: a consequential LCA

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Intro

Biofuels from residues (of industrial and agricultural production) promise sustainable bioenergy and greenhouse gases mitigation. However, many studies tend to forget that these biomasses are today used for specific purposes (e.g., feeding). Thus, their use for energy may trigger an increase in the international demand of feed products that may finally induce an expansion of cropland into other ecosystems (and/or an intensification). Failing to account for these consequences may lead to results that misrepresent the actual environmental impacts.

Materials and method

<table>
<thead>
<tr>
<th>Tools</th>
<th>Consequential LCA with biochemical model (integrated)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Functional Unit</td>
<td>1 metric tonne of biomass (dry basis)</td>
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<tr>
<td>Geographic &amp; time scope</td>
<td>Europe EU27 (time scope: 2015-2030)</td>
</tr>
<tr>
<td>Assessment method</td>
<td>ILCD-recommended: global warming (GW), acidification (AC), aquatic eutrophication (AE)</td>
</tr>
<tr>
<td>Biomasses investigated</td>
<td>Whey, brewer’s grain, wheat straw, nature grass, beet molasses, beet top, beet pulp, potato pulp</td>
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</tbody>
</table>
| Scenarios                  | i) Bioethanol production; molasses-for-biogas (CHP)
                                   ii) Bioethanol production; molasses-for-feed
                                   iii) Biogas-for-transport (PSA upgrading)
                                   iv) Biogas-for-CHP
                                   All scenarios involve use of residual solids for CHP |

Marginal regions

- Responding to an increased demand by increasing production and export (future)
- Share of intensification and expansion for each region (future)
- Increased fertilizers use due to intensification (future)

iLUC model

- Deterministic approach based on simplified modeling of future agricultural markets

Maize

- Expansion: 0.57 kg CO₂-eq. kg⁻¹
- Intensification: 0.18 kg CO₂-eq. kg⁻¹

Soybean

- Expansion: 2.9 kg CO₂-eq. kg⁻¹
- Intensification: 0.01 kg CO₂-eq. kg⁻¹

Impact contribution

- iLUC cancels savings from fossil fuel substitution
- iLUC impacts also affect AC and AE(N)

Biomasses

- Straw and grass (from nature) most suitable substrates for bioenergy

Scenarios

- Biogas-for-CHP best conversion pathway

Conclusion

General

- Residues with high nutritional value should be preferably used for feed
- iLUC is the most important contributor to the induced impacts

Best biomasses

- Straw and grass promise the highest environmental savings (no competition with feed involved)

Best scenario overall

- Production of biogas (for CHP) because of higher efficiencies

Best scenario for transport fuel

- Bioethanol appears better than biogas (considering PSA upgrading)