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

Tools
Consequential LCA with biochemical model (integrated)

Functional Unit
1 metric tonne of biomass (dry basis)

Geographic & time scope
Europe EU27 (time scope: 2015-2030)

Assessment method
ILCD-recommended: global warming (GW), acidification (AC), aquatic eutrophication (AE)

Biomasses investigated
Whey, brewer’s grain, wheat straw, nature grass, beet molasses, beet top, beet pulp, potato pulp

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

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

Marginal regions
Responding to an increased demand by increasing production and export (future)

Share of intensification and expansion for each region (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

Increased fertilizers use due to intensification (future)

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)