Comparative assessment of different manure valorisation technologies from an environmental perspective

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SPAIN

This study was carried out within the framework of the European project ManureEcoMine
(Project number: 603744)
Nutrient removal using conventional and advanced biological processes
Biological systems for wastewater treatment based on granules and biofilms
Advanced monitoring and control of wastewater anaerobic treatment
Enzymatic degradation of recalcitrant compounds
Life Cycle Assessment (LCA)
Environmental Risk Analysis
LCA methodology

- LCA → comprehensive evaluation of the environmental consequences that a product or service have on the environment throughout its life cycle.

- LCA method has been standardized by means of the following standards:

Figure 1. Life Cycle Assessment perspective.
LCA methodology

Goal and scope definition

Inventory data collection

Inputs from Technosphere
- Electricity: 1000 kWh

Outputs to Environment
- CH₄: 60 kg
- N₂O: 0.1 kg

Impact assessment

Environmental results

<table>
<thead>
<tr>
<th>Impact categories</th>
<th>A</th>
<th>B</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Climate change</td>
<td>10</td>
<td>60</td>
<td>-1</td>
</tr>
<tr>
<td>Acidification</td>
<td>5</td>
<td>15</td>
<td>-5</td>
</tr>
<tr>
<td>Eutrophication</td>
<td>0.8</td>
<td>1</td>
<td>0</td>
</tr>
</tbody>
</table>

Interpretation
- Conclusions
- Recommendations
- Improvement options
Livestock waste management

Sources of pollution:

- Manure storage
- Transport
- Manure application to land

Nitrates Directive
(91/676/CEE)
Biogas production from manure:

- Renewable energy production
- Lower greenhouse gas emissions
- Fertilisation value (avoiding mineral fertilisers)
- Less nuisance from odours and flies
- Economical advantages for the farmers
CASE STUDY: Manure management

GOAL

- Comparative environmental assessment of the impacts associated with different alternative scenarios focused on livestock manure management for energy production and nutrients valorization

SCOPE

- Gate-to-grave perspective
- Functional unit (FU): 1 ton of manure treated
System boundaries – Scenarios A/B

Figure 3. Flowchart of the processes involved in Scenario A.

Figure 4. Flowchart of the processes involved in Scenario B.
Figure 5. Flowchart of the processes involved in Scenario C.
# Life Cycle Impact Assessment – 6 Impact Categories

<table>
<thead>
<tr>
<th>METHODOLOGY</th>
<th>RECIPE MIDPOINT (H) 1.12</th>
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<tbody>
<tr>
<td>SOFTWARE</td>
<td>SIMAPRO 8.0.5.13</td>
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<table>
<thead>
<tr>
<th>IMPACT CATEGORY</th>
<th>ACRONYM</th>
<th>UNIT</th>
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</thead>
<tbody>
<tr>
<td>CLIMATE CHANGE</td>
<td>CC</td>
<td>kg CO₂ eq</td>
</tr>
<tr>
<td>TERRESTRIAL ACIDIFICATION</td>
<td>TA</td>
<td>kg SO₂ eq</td>
</tr>
<tr>
<td>FRESHWATER EUTROPHICATION</td>
<td>FE</td>
<td>kg P eq</td>
</tr>
<tr>
<td>MARINE EUTROPHICATION</td>
<td>ME</td>
<td>kg N eq</td>
</tr>
<tr>
<td>HUMAN TOXICITY</td>
<td>HT</td>
<td>kg 1,4-DB eq</td>
</tr>
<tr>
<td>FOSSIL DEPLETION</td>
<td>FD</td>
<td>kg oil eq</td>
</tr>
</tbody>
</table>

Table 1. Impact categories selected for evaluation.
Figure 6. Comparative environmental results of the different scenarios assessed (FU = 1 ton organic mixture).
Figure 6 (cont.). Comparative environmental results of the different scenarios assessed (FU = 1 ton organic mixture).
Main conclusions

• According to the comparative assessment, Scenario C would show the best environmental profile in the selected impact categories, with lower environmental burdens compared with Scenario A and Scenario B.

• These favorable results for Scenario C are due to the environmental credits related to the energy production as well as lower emissions derived from the recovered nutrients, and avoided mineral fertilization which partially offset related environmental impacts.

• However, Scenario C requires higher energy consumption due to additional stages of S/L separation and nutrients recovery (struvite precipitation and nitrogen removal), partially offsetting the environmental credits of Scenario C.
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