Utilisation of clover grass silage of different cutting dates for solid fuel production

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Introduction
Due to the ability of nitrogen fixation, clover grass swards play a major role in crop rotations of organic farming systems. Considering farms without livestock, an efficient utilisation of the clover grass is often not possible and alternative applications with economic benefits are warranted. This work is aimed at the assessment of energy recovery from clover grass silages by the integrated generation of solid fuel and biogas from biomass (IFBB, Fig. 1), particularly under consideration of nitrogen flows within the biomass conversion procedure.

Material and methods
- Clover grass sward (Trifolium pratense and Lolium perenne) was cut at four cutting dates and ensiled (Table 1)
- Hydrothermal conditioning at 60°C and mechanical dehydration by screw press
- Analysis of silage and press cake for N, K, P, Cl and ash
- Determination of methane production from press fluid in batch experiments

Table 1: Cutting date, yield and compounds of clover grass

<table>
<thead>
<tr>
<th>Cutting date</th>
<th>Yield</th>
<th>N</th>
<th>K</th>
<th>P</th>
<th>Cl</th>
<th>Ash</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>g kg⁻¹ FM</td>
<td>g kg⁻¹ DM</td>
<td>g kg⁻¹ FM</td>
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<tr>
<td>21 / 05 / 2008</td>
<td>2.7</td>
<td>184.7</td>
<td>22.0</td>
<td>30.4</td>
<td>2.7</td>
<td>3.8</td>
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<td>11 / 06 / 2008</td>
<td>4.0</td>
<td>259.2</td>
<td>14.4</td>
<td>19.7</td>
<td>1.7</td>
<td>3.6</td>
</tr>
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<td>18 / 06 / 2008</td>
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<td>303.5</td>
<td>13.5</td>
<td>17.3</td>
<td>1.6</td>
<td>3.2</td>
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<td>13.2</td>
<td>15.4</td>
<td>1.5</td>
<td>2.2</td>
</tr>
</tbody>
</table>

Results
Nutrient flows and quality of the press cake (Fig. 2a/2b)
- 0.35 to 0.69 of the N was transferred into the press fluid and could be returned to the field after anaerobic digestion. The earlier the clover grass was harvested, the higher was the mass flow of N into the press fluid
- K, P and Cl were transferred into the press fluid to a large extent, leaving only 0.07 to 0.22 in the press cake, without any tendency of cutting date
- Except the ash there is no tendency between the harvest dates concerning the nutrient concentrations in the press cake, whereas all combustion relevant compounds could be reduced remarkably compared to the untreated silage (see Table 1)

Methane yields of the press fluids (Fig. 3)
- Methane yields of press fluids after 13 days of fermentation from clover grass harvested between 21 / 05 to 18 / 06 ranged between 476 and 501 l CH₄ kg VS⁻¹
- The press fluid from the latest cutting date obtained somewhat lower methane yields of 421 l CH₄ kg VS⁻¹

Conclusions
- An early harvest of the clover grass is advised to secure high remaining of nitrogen in the nutrient cycle of organic farms
- Compared to mulching systems an improved fertiliser management would be possible
- Especially if no heat consumers are nearby, bioenergy production through the IFBB system can increase degree of efficiency