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Biogas production from catch crops

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BACKGROUND

By the end of 2020, up to 40% of the manure produced in Denmark (16 million ton manure) should be treated by anaerobic digestion according to Danish program “Green growth”. The increase of manure biogas yield and the search of new cheap co-substrates, with high biogas yield, are major issues in order to obtain an economically feasible process in biogas plants.

Catch crops are grown as supplementary crops after harvest of primary crop with the purpose of binding nutrients in the soil. They protect the aquatic environment reducing the need of fertilizer. Moreover, catch crops constitute a by-product of sustainable crop production that can potentially be used as a biomass resource for bioenergy production without interfering with the production of food and fodder crops.

Identifying the most suitable strategy to maximize catch crop biogas conversion together with a favorable regime of cultivation would improve biogas plants economy contributing to “Green growth” target while obtaining agricultural benefits such as pesticides and fertilizer reduction or aquatic environment protection.

OBJECTIVES

• To investigate the biogas potential of different catch crop species.
• To study biomass yield and binding nutrients ability of different catch crop species.
• To find the most suitable candidates for plant scale biogas production in Denmark.
• To study harvesting time, storage and processing strategies for selected catch crops.

MATERIALS AND METHODS

Methane potential

- Batch vials at mesophilic 37°C.
- Triplicates.
- Anaerobic sludge (AS) was used as inoculum.
- Blanks (only inoculum) to determine the endogenous methane production of AS.

RESULTS

Catch crop samples

- Screening: More than 60 samples (18 different catch crops) from field trials by Agrotech A/S in 2010 and 2011.
- The catch crops were seeded in August and harvested in late October and early November on different locations in Jutland, Denmark.

Catch crop

<table>
<thead>
<tr>
<th>Catch crop</th>
<th>%TS</th>
<th>%VS/TS</th>
<th>ton-TS/ha</th>
<th>CH4 % max</th>
<th>L-CH4/kg-VS</th>
<th>m3-CH4/ha</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oil seed radish</td>
<td>10.7</td>
<td>12.6</td>
<td>82.84</td>
<td>0.12</td>
<td>60.12</td>
<td>330-360</td>
</tr>
<tr>
<td>Brassica napus</td>
<td>15.0</td>
<td>17.1</td>
<td>82.83</td>
<td>1.08</td>
<td>37.82</td>
<td>250-300</td>
</tr>
<tr>
<td>Brassica rapa</td>
<td>13.7</td>
<td>13.9</td>
<td>84.88</td>
<td>0.68</td>
<td>62.09</td>
<td>360-380</td>
</tr>
<tr>
<td>Brassica napus spp.</td>
<td>16.0</td>
<td>90</td>
<td>90</td>
<td>1.75</td>
<td>53.72</td>
<td>290</td>
</tr>
<tr>
<td>Brassica napus spp.</td>
<td>13.4</td>
<td>87</td>
<td>90</td>
<td>0.99</td>
<td>60.24</td>
<td>370-380</td>
</tr>
<tr>
<td>Brassica oleifera</td>
<td>16.9</td>
<td>90</td>
<td>90</td>
<td>0.21</td>
<td>53.63</td>
<td>410</td>
</tr>
<tr>
<td>Brassica rapa spp.</td>
<td>17.1</td>
<td>90</td>
<td>90</td>
<td>0.05</td>
<td>62.98</td>
<td>405</td>
</tr>
<tr>
<td>Brassica napus spp.</td>
<td>15.6</td>
<td>16.5</td>
<td>90-91</td>
<td>0.39</td>
<td>67.00</td>
<td>350-410</td>
</tr>
<tr>
<td>Brassica oleifera</td>
<td>15.3</td>
<td>89-90</td>
<td>90</td>
<td>0.70</td>
<td>58.52</td>
<td>350</td>
</tr>
<tr>
<td>Brassica napus spp.</td>
<td>22.8</td>
<td>93</td>
<td>90</td>
<td>0.98</td>
<td>54.60</td>
<td>260</td>
</tr>
<tr>
<td>Brassica oleifera</td>
<td>13.6</td>
<td>81</td>
<td>81</td>
<td>0.50</td>
<td>56.64</td>
<td>270</td>
</tr>
</tbody>
</table>

Total solid (TS) content was in the range of 10-23 %TS and percentage of volatile solids (VS) with respect to TS was around 90% VS/TS for all of the trials. Biomass yields of the different catch crops were between 0 and 2.7 t-TS/ha with an average of 1 ton TS/ha.

Westervold ryegrass, wild oat and winter vetch presented the highest methane yields in terms of L-CH4/kg VS. However, when observing methane yields in terms of m3-CH4/ha, oil seed radish, white mustard and turnip rape obtained the highest yields since those crops presented the highest biomass yields (Table 1, Figure 2).

CONCLUSIONS

• Combination of catch crops cultivation with biogas production looks promising.
• With an average of 1 ton TS/ha, 90% VS/TS and a methane yield of 320 m3-CH4/t-VS, the biogas production from catch crop cultivation in Denmark would be around 78 million m3 CH4/year.
• Co-digestion with manure, biomass characterization, pretreatments and storage strategies will be investigated. A selected catch crop species will be tested in large-scale biogas plant. Costs for harvest, transport, handling and storage will be also evaluated.

ACKNOWLEDGEMENTS

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