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.

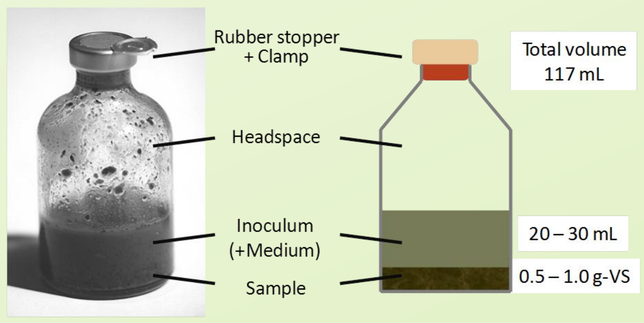

Figure 1. Vial used for Batch experiments.

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.

RESULTS

Table 1. Results obtained for the catch crops harvested in 2010.

Catch crop		%TS	%VS/TS	ton-TS/ha	CH_4 % max	Methane yield L-CH_4/kg-VS	Methane yield m^3-CH_4/ha
Oil seed radish	*Raphanus sativus var.oleiformis*	10.7-12.6	82-84	1.28-1.67	60.12	330-360	410-450
White mustard	*Sinapis alba*	15.0-17.1	82-83	1.08-2.71	57.82	250-300	395-470
Oil seed rape	*Brassica napus spp.oleifera*	13.7-13.9	84-88	0.68-0.74	62.09	360-380	220-230
Turnip rape	*Brassica rapa ssp. oleifera*	16.0	90	1.75	53.72	290	450
Marrow stem kale	*Brassica oleracea var. medullosa*	13.4	87	0.99	60.24	370-380	295-305
Westerwold ryegrass	*Lolium multiflorum var.westerwoldicum*	16.9	90	0.21	55.63	410	80
Winter rye	*Secale cereale*	17.1	90	0.05-0.27	62.58	405	60
Wild oat	*Avena sativa*	15.4-16.5	90-91	0.39-0.45	67.00	350-410	135-155
Winter Vetch	*Vicia villosa*	15.3	89-90	0.70	58.52	350	220
Hemp	*Cannabis sativa*	22.8	93	0.98	54.60	260	240
Sunflower	*Helianthus annuus*	13.6	81	0.50	56.64	270	110

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.

Westerwold ryegrass, wild oat and winter vetch presented the highest methane yields in terms of L-CH_4/kg VS. However, when observing methane yields in terms of m^3-CH_4/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).

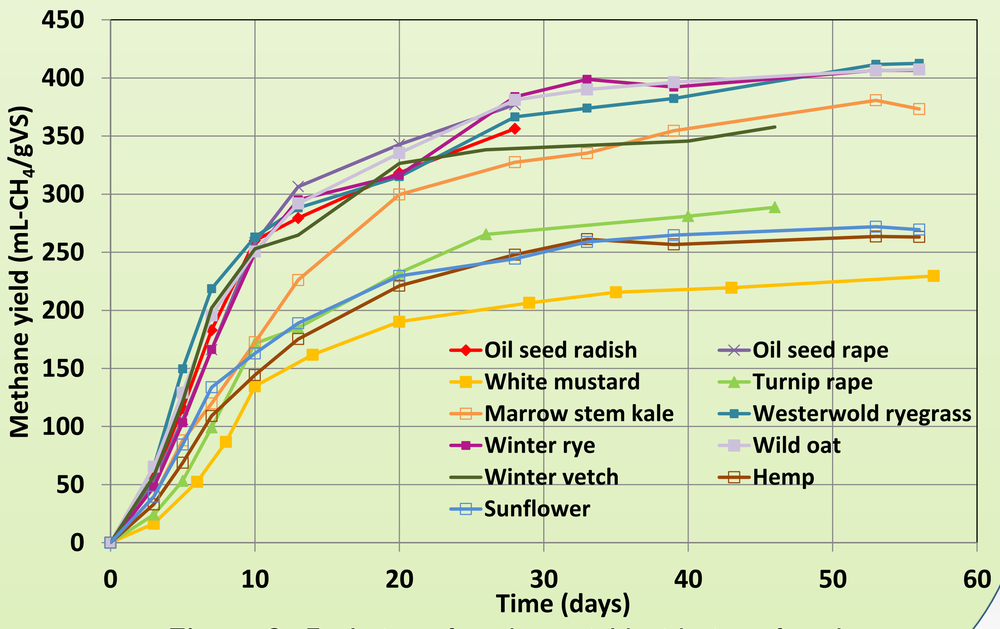

Figure 2. Evolution of methane yield with time for the catch crops harvested in 2010.

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 m^3-CH_4/t-VS, the biogas production from catch crop cultivation in Denmark would be around 78 million m^3-CH_4/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.

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