

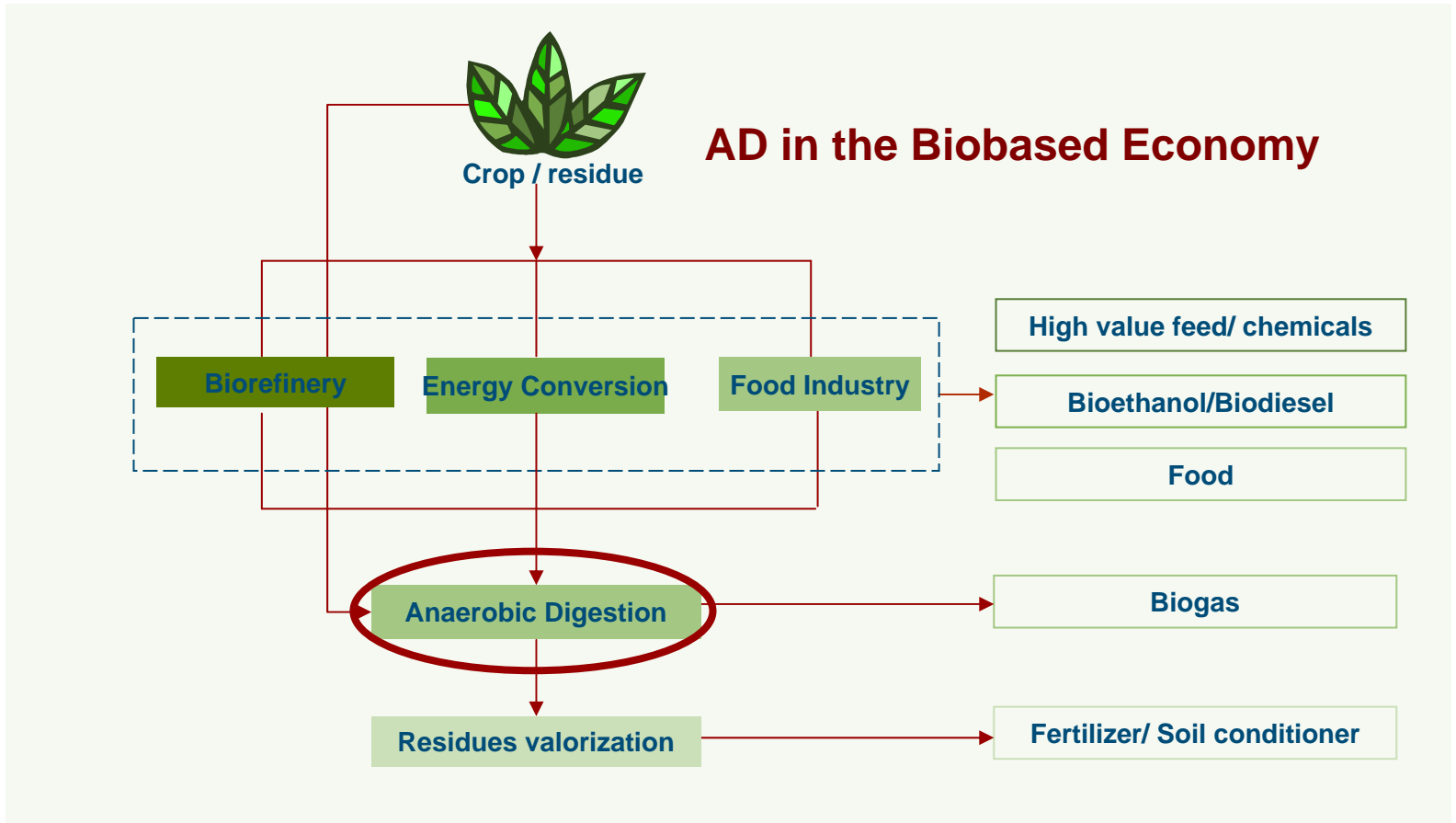


Biomethane potential of energy crops

Intrinsic value or test dependent?

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Anaerobic digestion of crops can play an important role in the biobased economy by itself or by complementing other biomass energy chains

Why energy crops?



Aerobic sludge



Industrial waste



OFMSW

Substrate	BMP (lCH ₄ /gVS)	Methane yield (m ³ CH ₄ /ton _{ww})
Slaughterhouse waste	0.57	150
OFMSW	0.5-0.6	100-150



Crop residues



Manure

Straws, sugar beet tops	0.2 - 0.4	36-145
Pig manure	0.29 - 0.37	17-22
Cow manure	0.11 - 0.24	7-14

Why energy crops?



Renewable resource, carbon neutral



Produced worldwide, in large amounts, at modest input

Possibilities to store and use energy on demand



Of interest for co-digestion

Opportunities for farmers

Which energy crops?

250.000 species of higher plants in the world

1000 species comprise the species cultivated to provide, food, industrial and construction materials

11 species provide 80% of edible plant material



Which energy crops?



Selection criteria

- Methane potential of the plant material
- Potential biomass production (Yield/Ha).
- Other factors:
 - Resistance to pest and diseases
 - Cultivation inputs
 - Biogas end-use
 - Reference system being replaced.

Which energy crops?



AD methane production depends on the **biodegradability** of the plant material.

intrinsic property of a test substance reflecting its susceptibility to undergo a biologically mediated degradation.

Assessed via anaerobic biodegradability assays:

- **Amount:** BMP Test-Biochemical Methane Potential
- **Rate:** Hydrolysis assessment

Which energy crops?

BMP range **0.15 - 0.54** | CH₄/gVS

Standard deviation **5-10%**

However among authors values can differ strongly for a single plant specie.



Grass: **0.27 - 0.41** | CH₄/gVS



Clover: **0.14 - 0.55** | CH₄/gVS

Which energy crops?

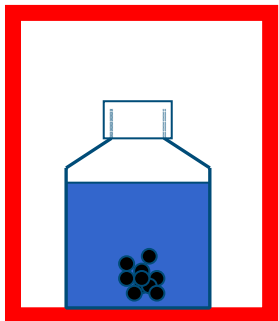
Why this variation?



From the substrate:

Ex. Different variety, harvest time, growth conditions. 30-60%.

(Pouech et al. 1998)(Lehtomaki 2006)



Or...from the test...

Anaerobic Biodegradability tests are not standardized

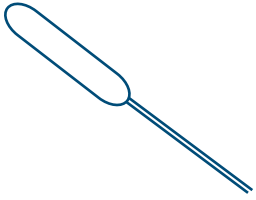
There is substantial uncertainty in the determination

(Hansen et al , 2004);(Rozzi and Remigi, 2004);
(Muller, 2004);(Colleran et al. 1992)

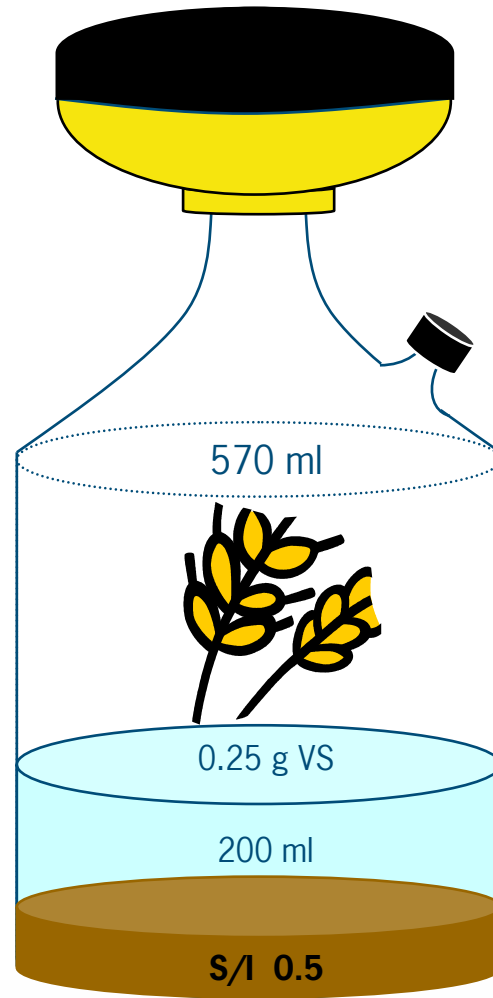
Factors that may influence the assessment...

- **Macronutrients and trace elements**
- **Equipment:** type of bioassay (batch, continuous)
- **Operating conditions:** temperature, pH, sampling frequency.

(Hansen et al , 2004);(Rozzi and Remigi, 2004);
(Muller, 2004);(Colleran et al. 1992)



EXPERIMENTAL SET-UP



EXPERIMENTAL SET-UP



EXPERIMENTAL SET-UP

Substrate treatment

- Three substrates
- Four treatments: 1cm fresh material, frozen 1cm, frozen blended, dry grinded

Inoculum type and S/I ratio

- Two types of inoculum (suspended and granular) and combination.
- Three S/I ratio: 0.5; 1.5; 2.5

Buffer molarity

- Phosphate buffer
- Four molarities 5 mM, 20 mM, 30 mM and 40mM

RESULTS

Substrate treatment

- Crops with high lignocellulose content are less anaerobically biodegradable. (Chandler 1980, Tong 1990)
- Blending and grinding improve access to cell solubles in the samples containing less structural material.
- The hierarchy of the materials remained unchanged

RESULTS

Inoculum type and S/I ratio

High BMP when using a sludge mixture or increasing the S/I ratio, hypothesis:

- Difference in enzyme systems and/or relative amount of enzymes
- Other synergistic effect resulting from the different pathways of utilization of intermediates

RESULTS

P buffer system

- Total biogas production was affected above 20 mM
- Acetoclastic methanogenesis was mainly disturbed.
- pH remained in the range 7-7.3 in all cases
- Blank inhibition affected the net results

FINAL REMARKS

- So far differences of up to **50%** had been found when varying test conditions.
- The need for an standardized test is imminent, as well as,
- The need for reporting findings in a complete way:
 - Characteristics of plant material digested
 - Characteristics of the test performed

What would be a good BMP test?

Different objectives

Find results close to reality?

or

To get the maximum amount of biogas
and use it for screening purposes?

- Dry grinded substrates
 - Sludge mixture
 - Low S/I ratio
- Add buffer (low conc.) and nutrients

Other advantages:

- Easier to get representative sample
- Improves replicability
- Easier to storage and transport samples
- Faster test
- Hydrolysis rates can be calculated without measuring intermediates

**THANK YOU
FOR YOUR
ATTENTION**

