Enteric methane reduction: Recent research at UCPH/IVH

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KØBENHAVNS UNIVERSITET

Copenhagen Cattle 2023

Established screening technique (Menke & Steingass 80's)

2014

Who else uses this technique?

Carlsberg
Chr. Hansen
Novozymes
Aarhus University

In vitro studies: Gas production indicates rumen microbial activity

Inputs:

- **Inoculum**

- **Basal Feeds with different CHO/protein composition**



Silage **Sugar beet pulp** **Other feeds**

- **+/- feed additives**

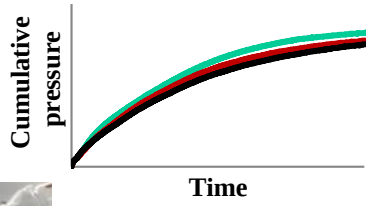
Fermentation: we choose the duration

Triplicates/quadruplicates or more

150 units

Radio signal sends pressure in each module to computer : gas bag collects "burps"

Outputs:



Gas bag taken off and methane concentration measured by single injection GC

Results – that effect ruminant health & nutrition, and carbon footprint

- pH
- Total gas production /g sample or /g degraded sample (/g degraded fiber) to calculate total energy
- Products of fermentation (VFA) composition
- Polyphenol content
- Rumen degradation (dry matter or organic matter)
  - Fiber profile and fiber degradation
- Total gas curve kinetics
- % methane in collected gas: *Total yield of* CO_2; CH_4; H_2 *(per g feedstuff)*
- Microbiome determination

What have we recently done?

Results of *in vitro* screening for methane reduction - species

- *Ascophyllum nodosum AN*
- *Alaria esculenta AE*
- *Chondrus crispus CC*
- *Fucus serratus FS*
- *Himanthalia elongate HE*
- *Laminaria digitata LD (stems and leaves)*
- *Palmaria palmata PP*
- *Pelvetia canaliculata PC*
- *Porphyra umbilicalis PU*
- *Saccharina latissima SL*
- *Ulva lactuca UV*
- *Iodoform (X) in 8 different carrier substances and 8 doses at 24 and 48 hours*
- *Propionibacteria and lactic acid bacteria*
- *Hedera helix*
- *Fraxinus excelsior*
- *Leucaena leucocephala 1&4 years*
- *Salix spp.*
- *Artemisia annua*
- *Terminalia chebula* (HA),
- *Terminila belliricia* (BA)
- Triphala churna (TC) [commercial mixture] 1/3 each *Phyllanthus emblica*, *Terminila belliricia*, and *Terminalia chebula*
- *Foeniculum vulgare*
- *Cichorium intybus*
- *Iranian biochar*
- *Proprietary enzymes (2)*
- *Proprietary lactic acid strains (8)*

"Happy" successful outcomes after fermenting (additives)

- Evaluate degradation / Evaluate total gas
- Evaluate methane yield (= total gas x % methane)
- Compare to base feed used in all samples

- Increase in degradation (more gas) & decrease methane yield 
- Stable degradation and decrease in methane yield 
- Increase in degradation and stable methane yield 

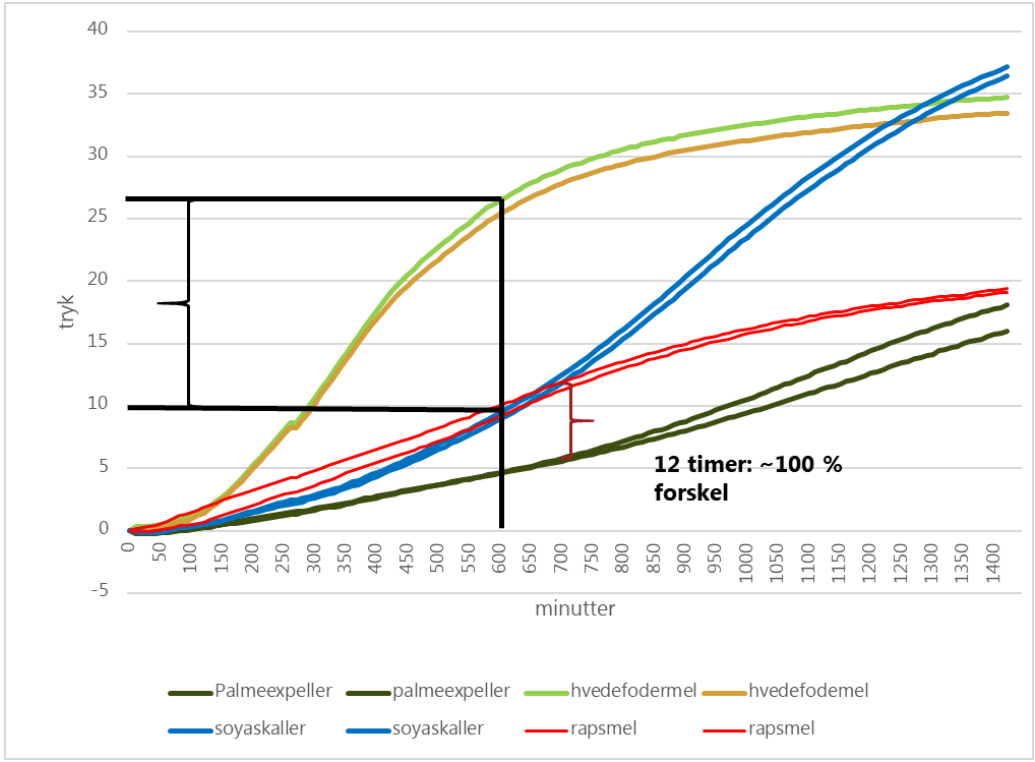
Results of screening (MS = maize silage; SBP = sugar beet pulp)

Project		Degradation- dry matter dDM or organic matter dOM	Methane production	Result
IFD	Iodoform in MS – 0.016-0.128 mg/g DM (8 carrier substances; zeolite)	Negative correlation:dose & degradation dose > 0.032 mg/g	↓ 0% 30% - 98%	🙂🙂 Publ
IFD	Lactic acid bacteria, propionibacteria, iodoform	↔ as MS	↓95 %	🙂
MAB	Fermented seaweed & rapeseed: 10 mixtures	6 mixtures ↑ (~4%)	4 mixtures ↓ (by ~10%) from Maximum ↓ 16% for SL+AE	🙂🙂 Publ.
MAF/ Norwegian produced	Ensiled sugar kelp SL- commercial kelp producer +/- commercial additives ~22% additive	↔ all additives in SBP. ↑ in MS	All sugar kelp ↓ methane in SBP ~15 %. One silage additive ↓ 12% compared to MS	🙂 🙂🙂
MAF/ NORD	Norwegian wild seaweeds: 12 species harvested spring and fall – washed in salt and fresh water ~ 22% additive	1 green and 1 red species ↔ as MS	3 fall harvested seaweeds ↓10 %	🙂 Publ.
MAF	Chicory and fennikel (50% additive) Stems, leaves, mixtures	Chicory ↓ fennikel↑	6% increase in degradation resulted in a (max) ↓ 30%	🙂🙂

ENDPOINTS – 16, 24, 48,72 hours

Is that enough? What happens *during* fermentation?
Are kinetics (temporal changes) important?

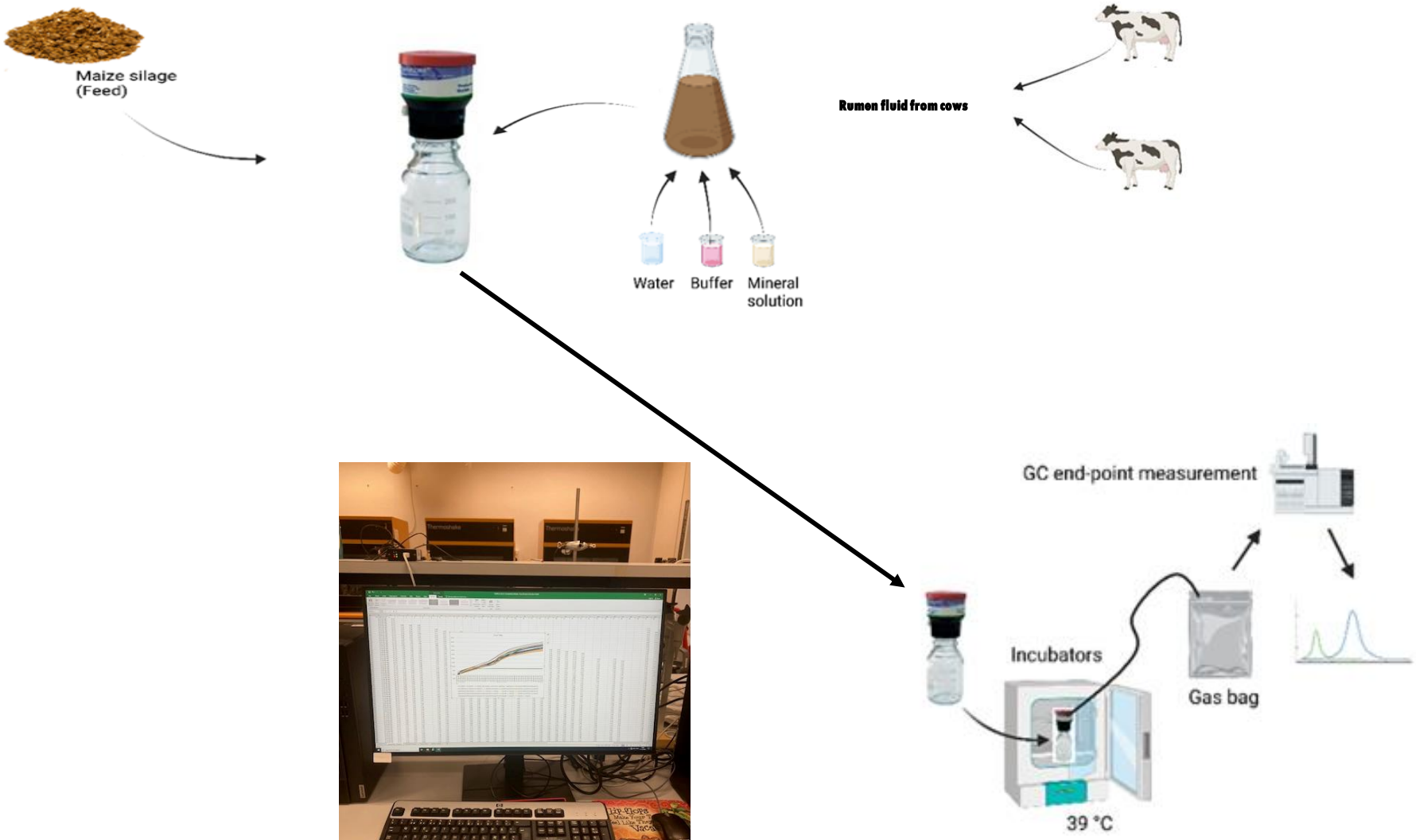
150% difference at 10 hours – similar at 24 hours



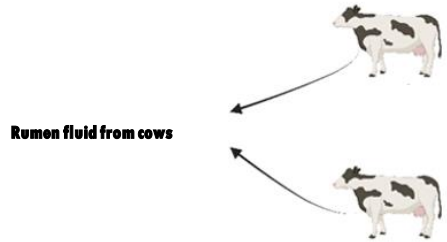
Soy husks
wheat meal

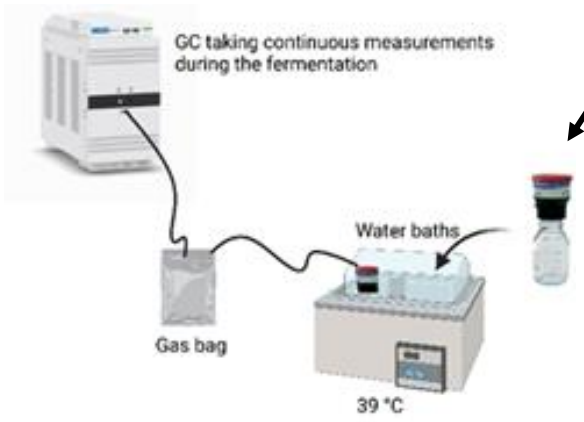
Rapeseed meal
Palm expeller

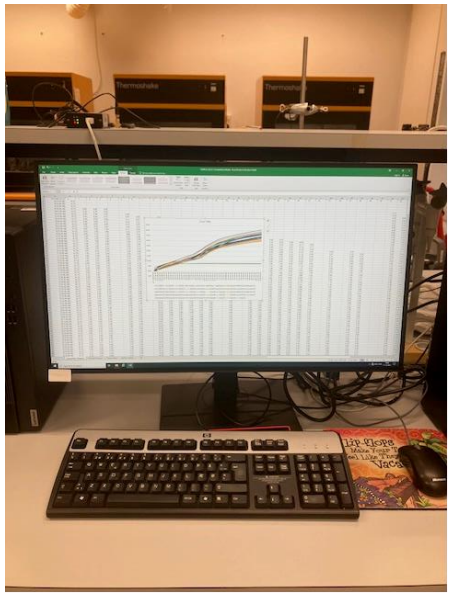
Adapt/optimize existing equipment???

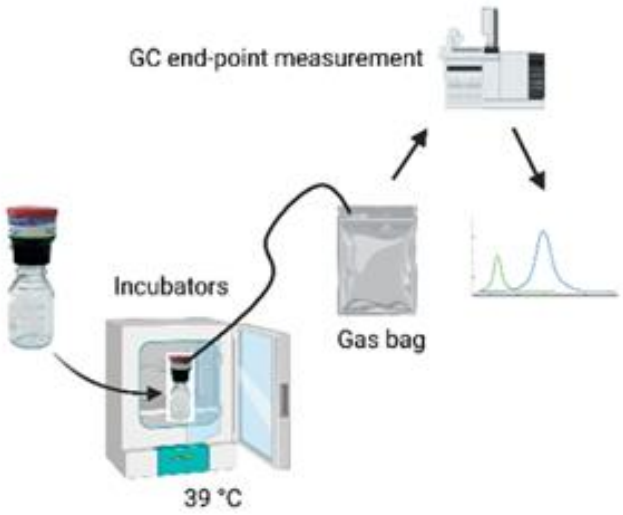


Adapt/optimize existing equipment???

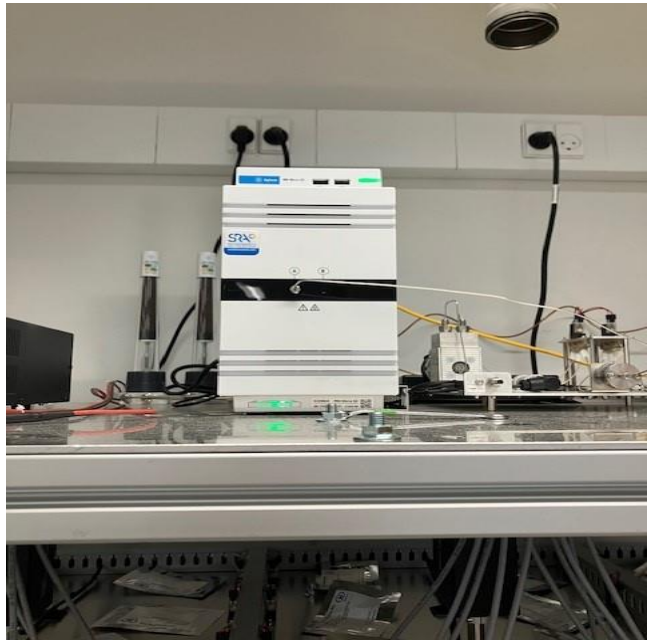






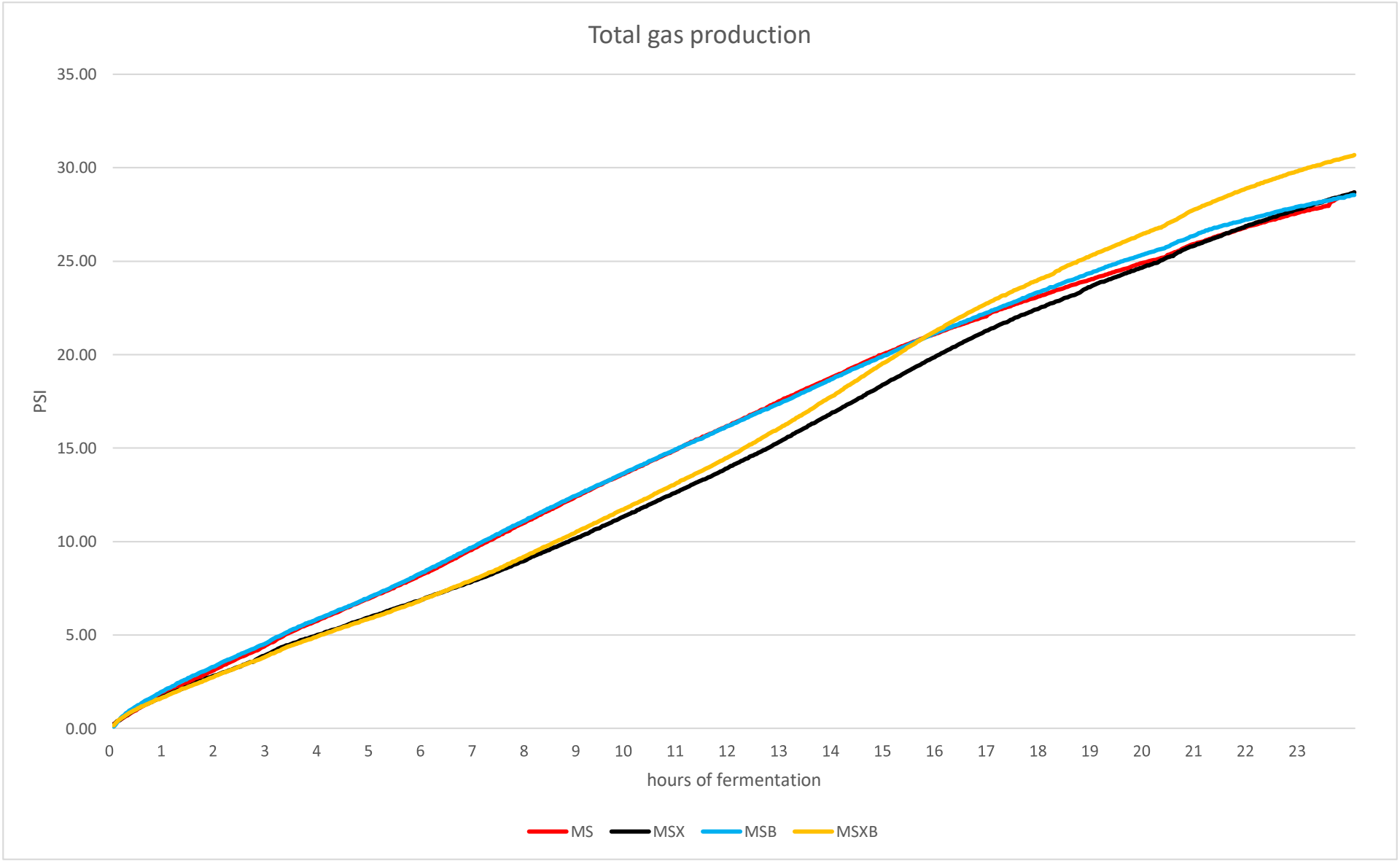


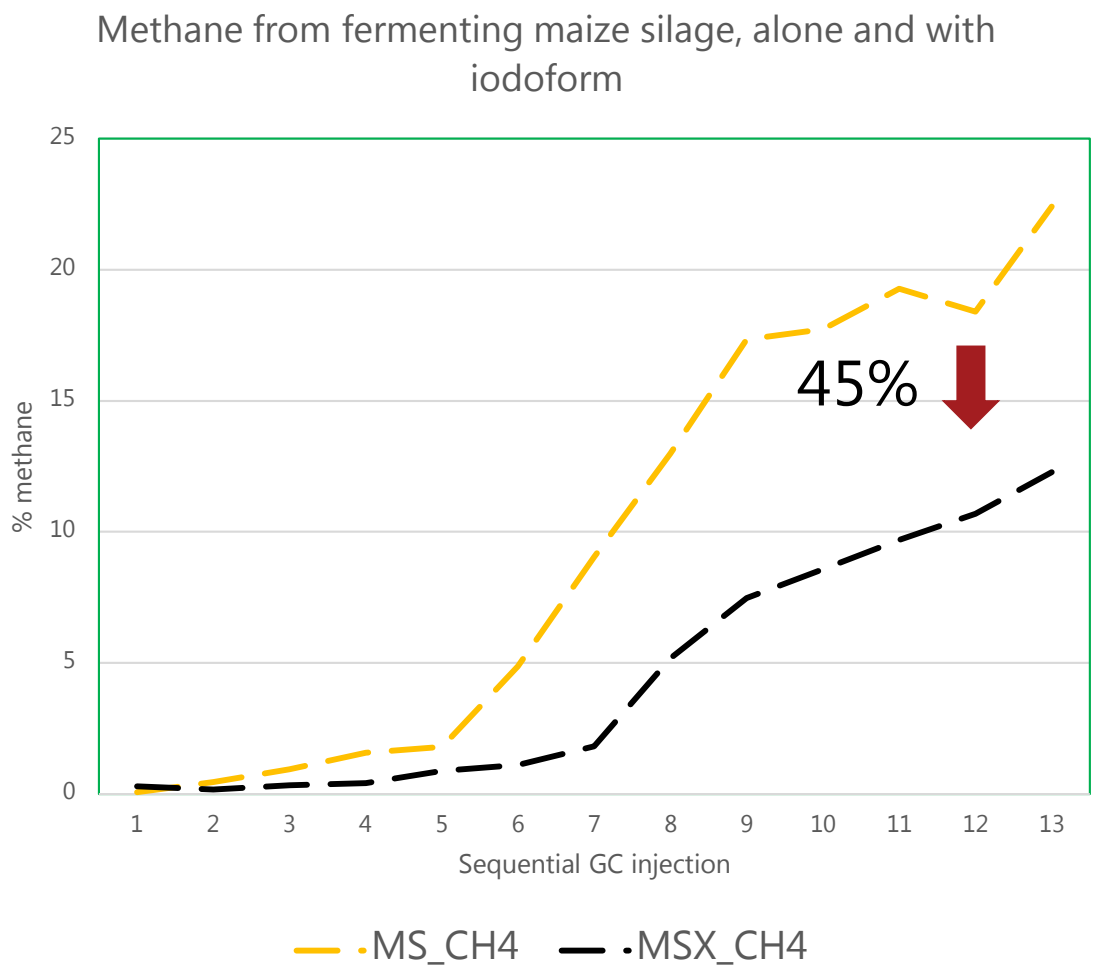
Optimize/adapt the existing equipment

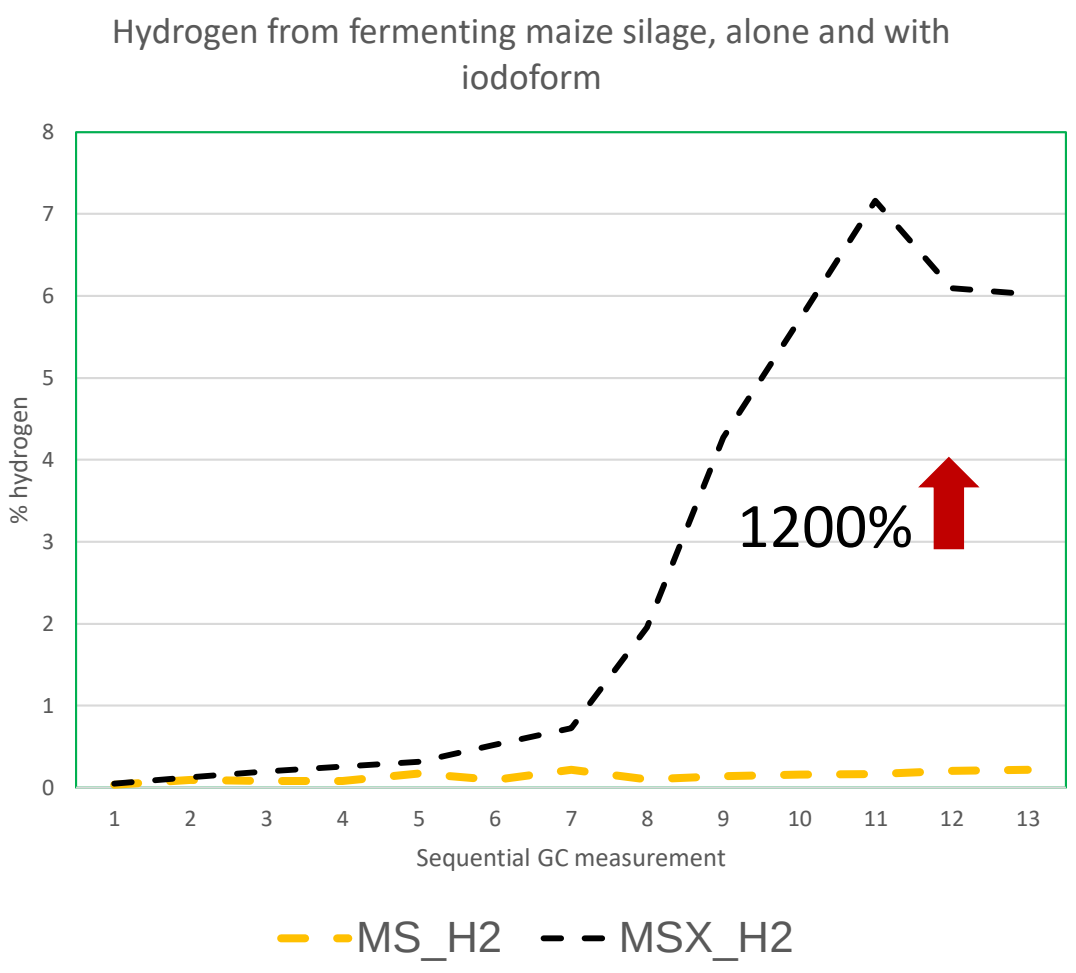


Italian/French company. Micro gas chromatograph with 50 “streams”. Each stream is open until it is ready for a sample injection, then it closes, measures the gas and cleans the bag with N_2 gas

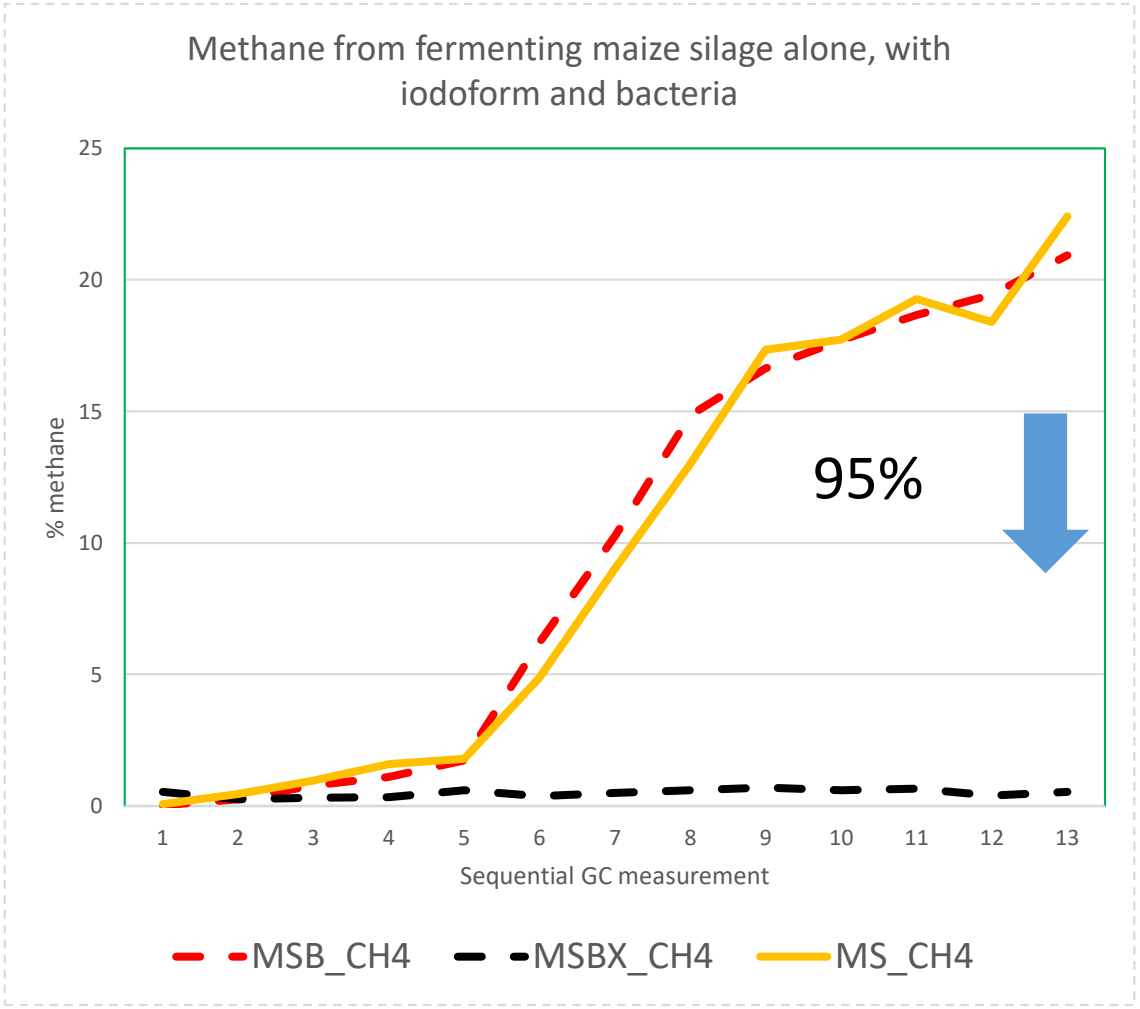
5 shaking water baths with each 10 bottles – **USING THE SAME ANKOM SYSTEMS**

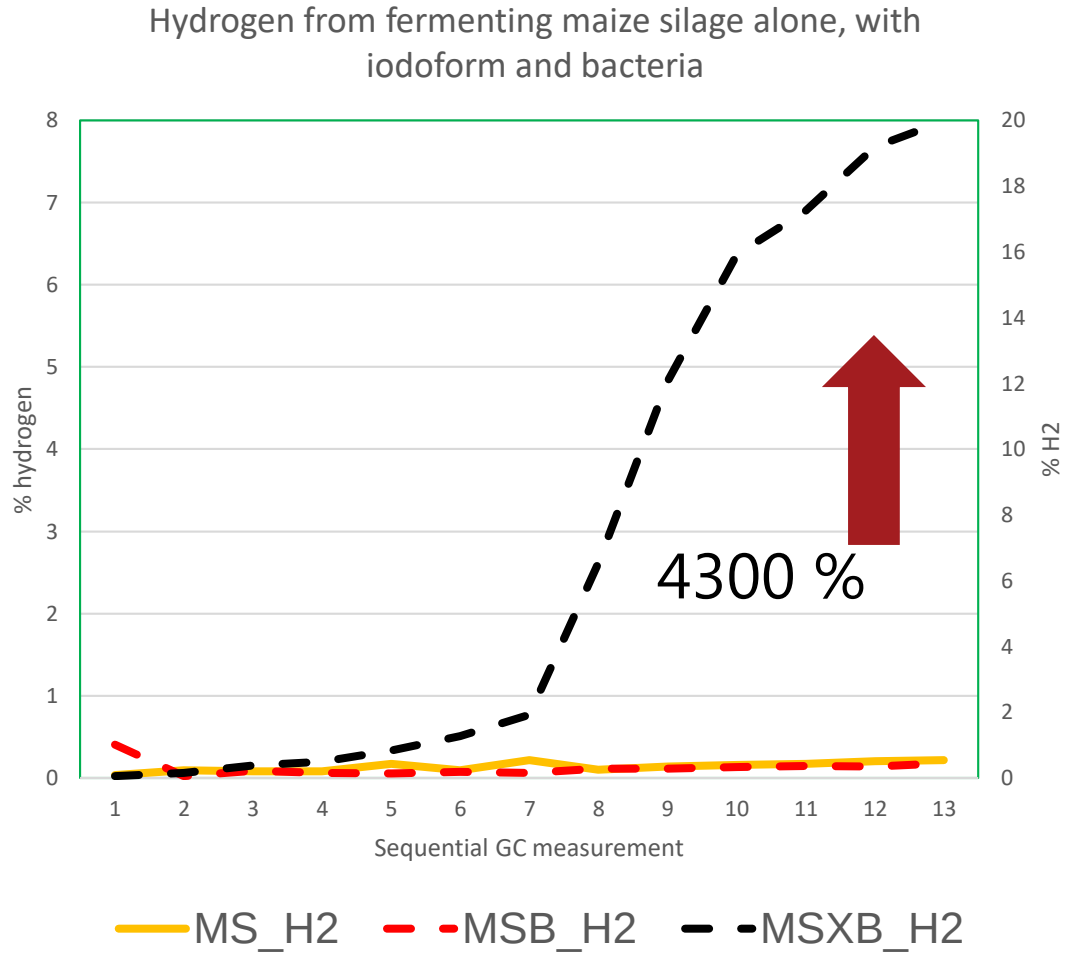

Total gas production
35.00
30.00
25.00
20.00
15.00
10.00
5.00
0.00
PSI
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23
hours of fermentation
MS
MSX
MSB
MSXB





1 hour and 44 minutes between each measurement





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iff

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No Methane

LERØY

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Thank you - Questions?