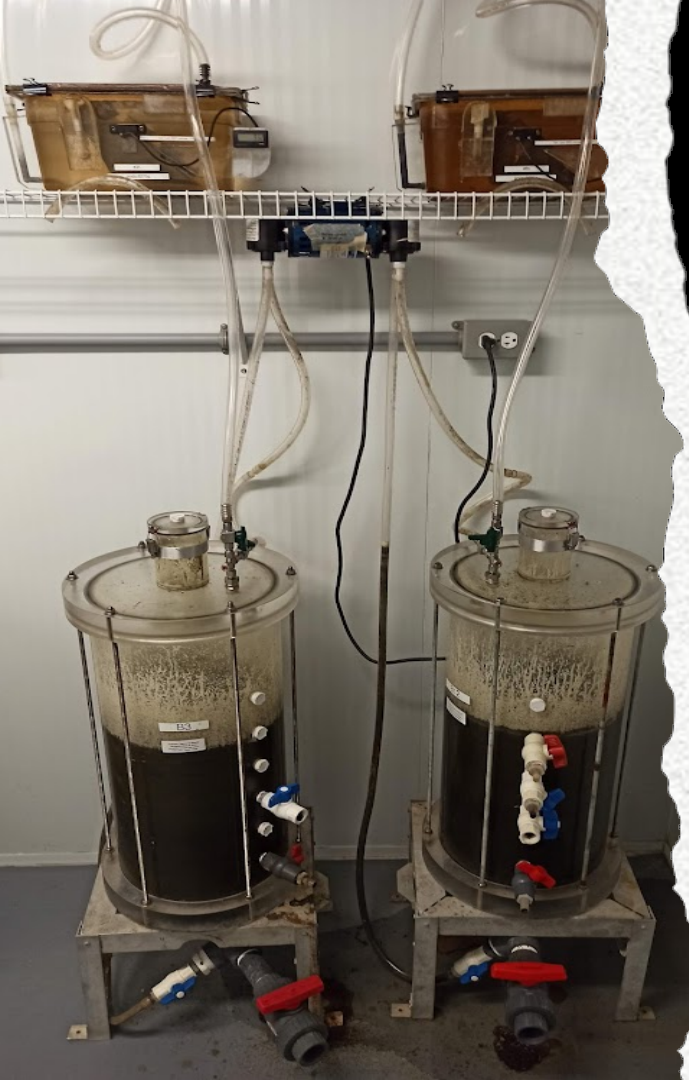


Joint International Congress on Animal Science
European Federation of Animal Science (EAAP)

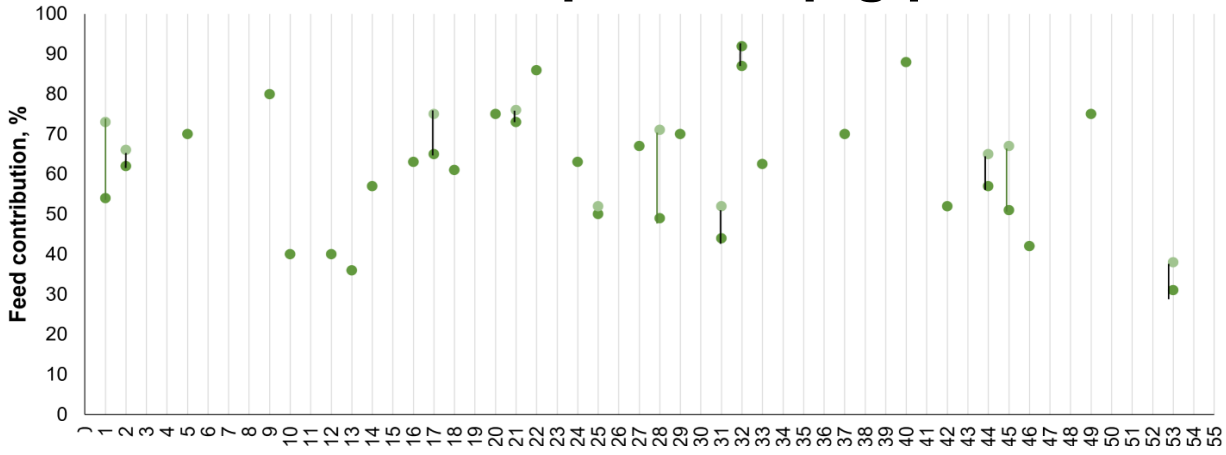
Feeding pigs with low-protein diets: Impact of pig manure nitrogen content on biogas production

Felipe Mathias Weber Hickmann, I Andretta, L Cappelaere, B Goyette, M-P Létourneau-Montminy, R Rajagopal

Lyon, France

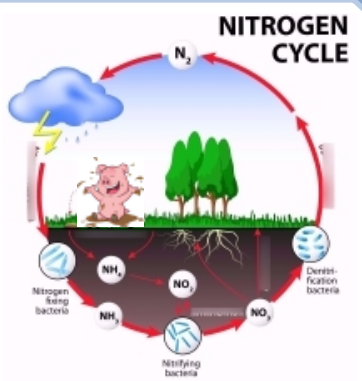
August 31st, 2023

Environmental impacts of pig production



Andretta et al. (2021)

- Feeding accounts for more than 60% of the potential climate change impact
- Manure management accounts for roughly 20%

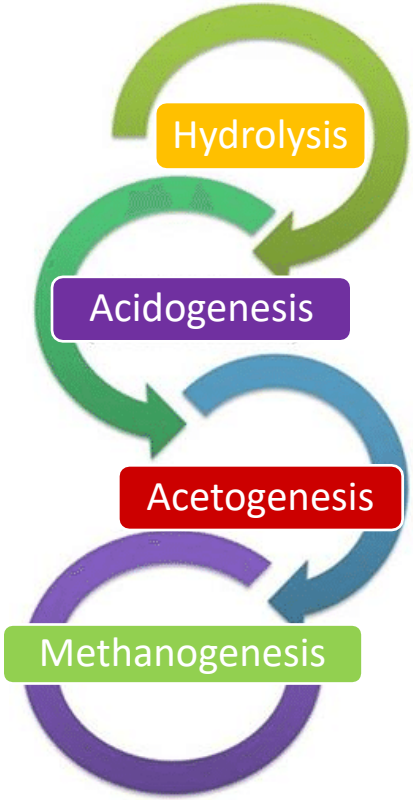


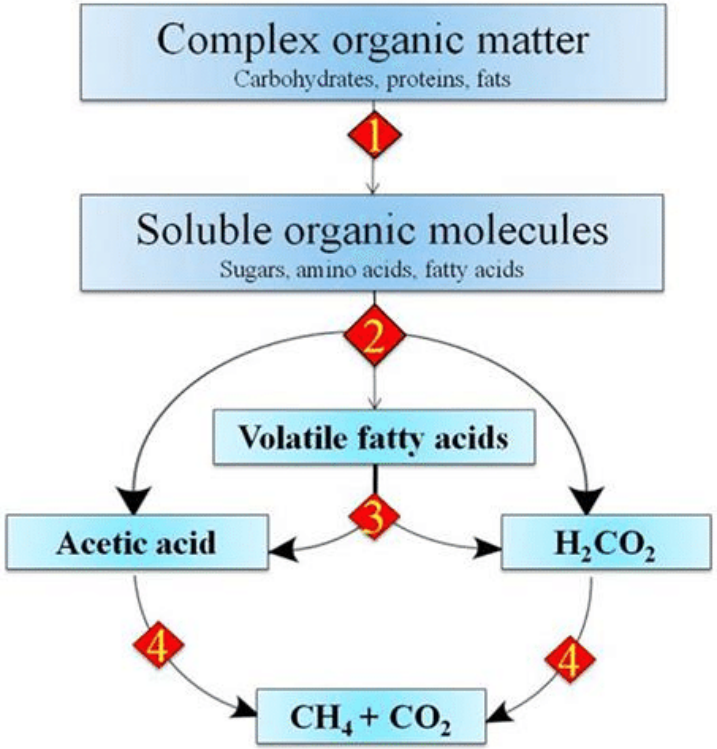
Sustainability of pig production

- Novel feeding strategies
- Valorization of livestock manure

Low crude-protein diets in pigs

Anaerobic digestion





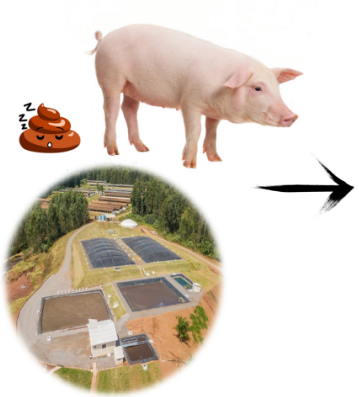
Circular economy

Value

Heat/Electricity

Biogas

Feedstock



Anaerobic digestion

Biogas

Digestate

By-products

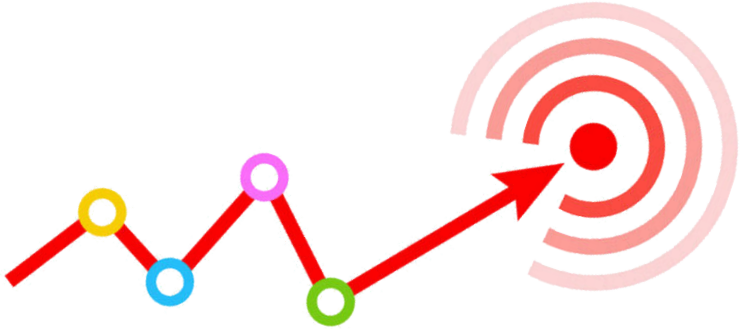
Feed/bedding

Fertilizer

Value

Objective

Evaluate the impact of lowering manure nitrogen content on biogas production through the anaerobic digestion of pig manure



Methodology

T1 (Control) T2 (Low N) T3 (Lowest N)

N N -1.2% N -2.4%

CP level reduction

Methodology

T1 (Control) T2 (Low N) T3 (Lowest N)

N N -1.2% N -2.4%

CP level reduction

---->

T1 (Control) T2 (Low N) T3 (Lowest N)

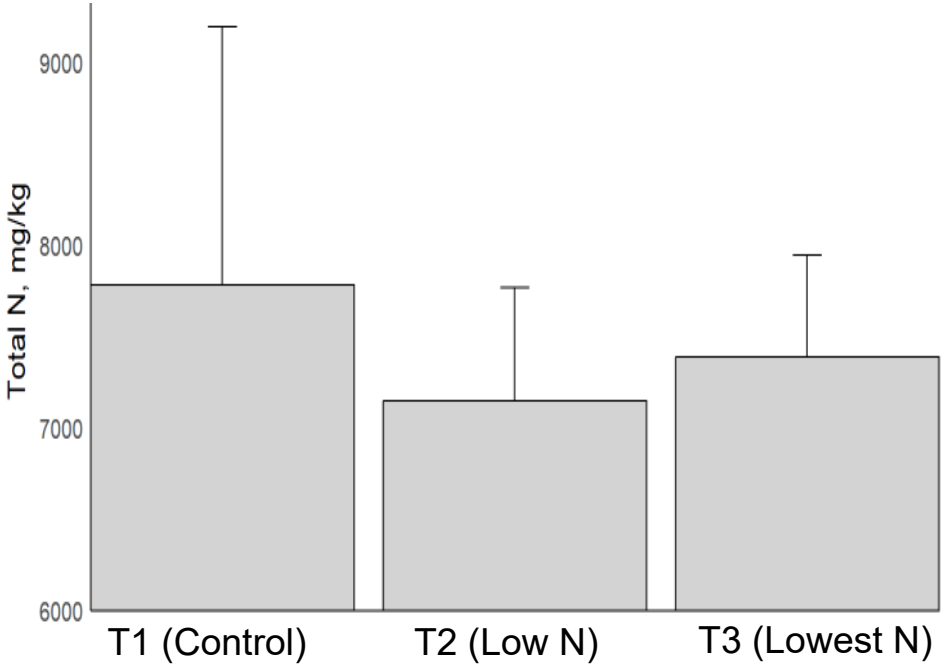
N N -8.2% N -5.1%

7780 mg N Kg^{-1} 7145 mg N Kg^{-1} 7386 mg N Kg^{-1}

Raw manure

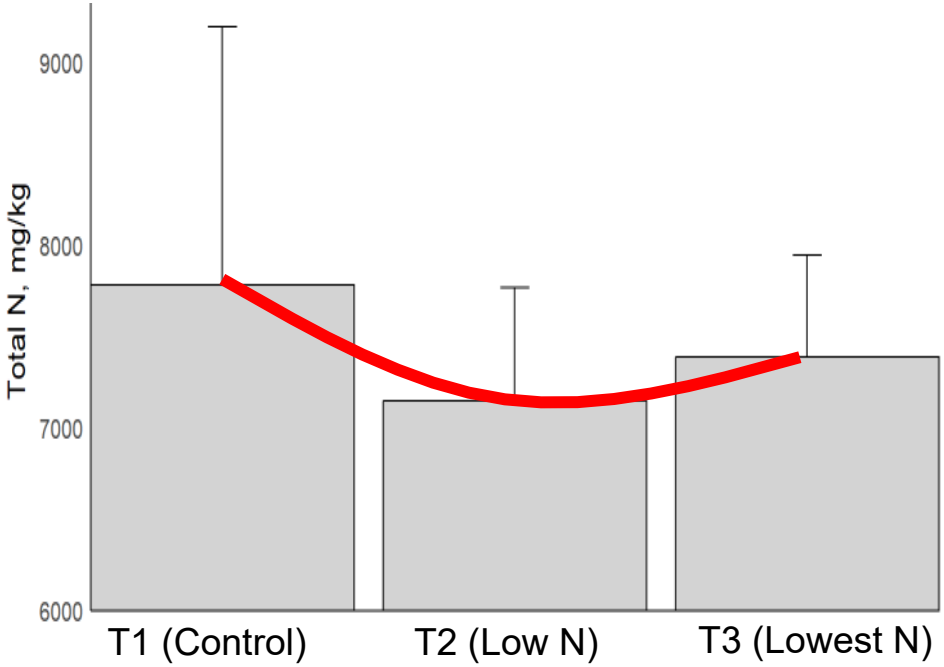
Cappelaere et al.

Manure excretion



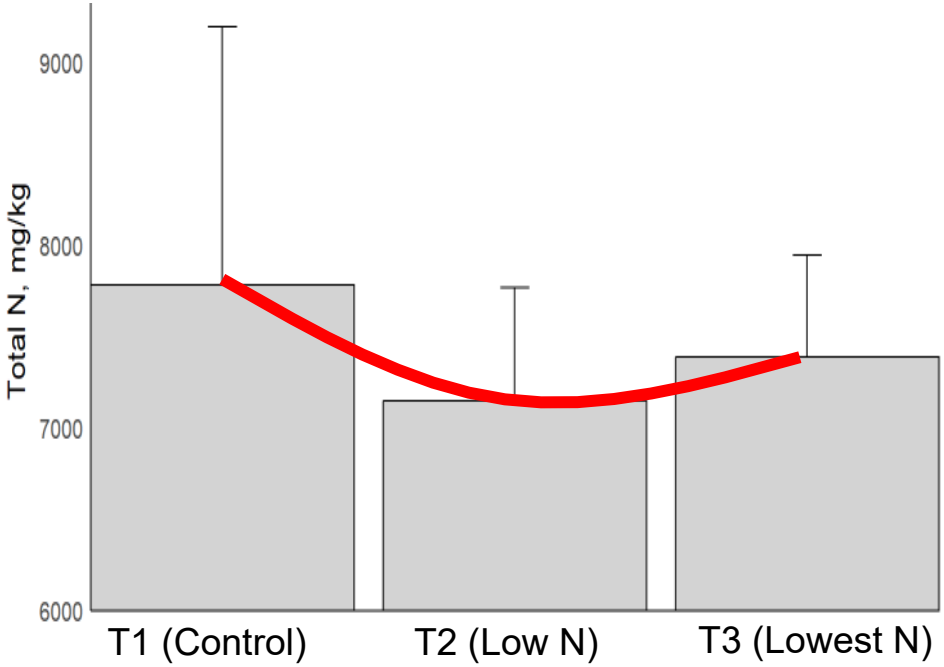
Cappelaere et al.

Manure excretion

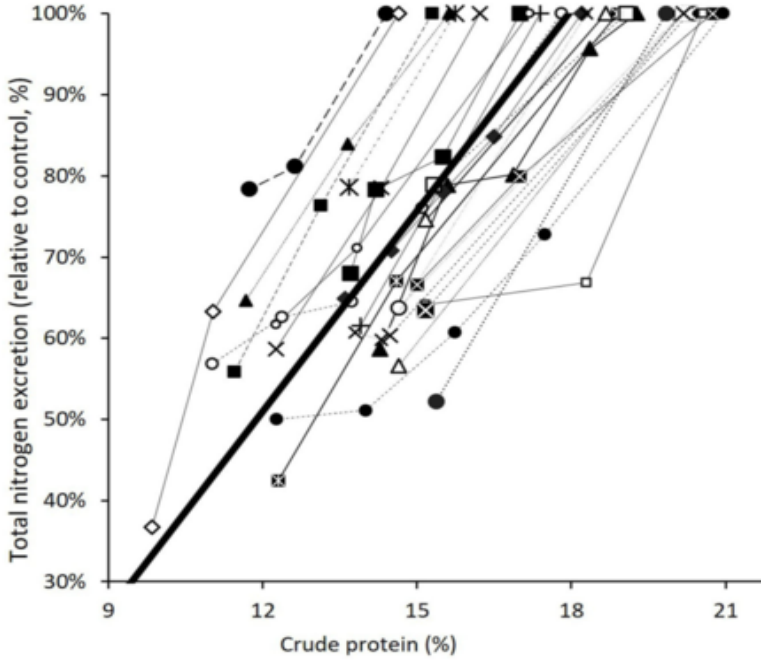


Cappelaere et al.

Manure excretion



Cappelaere et al.



Cappelaere et al 2021

T1 (Control)

N

5874 TKN mg L^{-1}

~~T2 (Low N)~~ T3

N

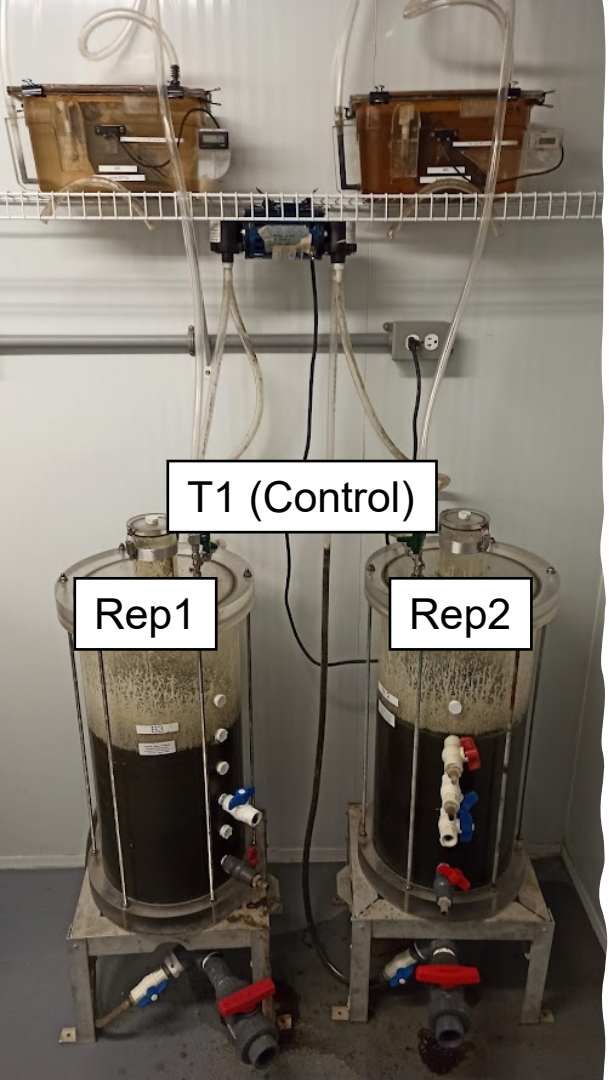
5422 TKN mg L^{-1}

~~T3 (Lowest N)~~ T2

N

5150 TKN mg L^{-1}

Raw manure



T1 (Control)

T3

~~T2 (Low N)~~

T2

~~T3 (Lowest N)~~

N

N

N

5874 TKN mg L^{-1}

5422 TKN mg L^{-1}

5150 TKN mg L^{-1}

Raw manure

+ Liquid inoculum to operate digesters

1:10 feed to liquid inoculum (TS 2.8%) ratio

Biogas production and its composition (CH_4, CO_2, and H_2S) were measured

Different ways of looking into the data/problem

Different ways of looking into the data/problem

1) Evaluate the impact of lowering manure nitrogen content on the anaerobic digestion of pig manure

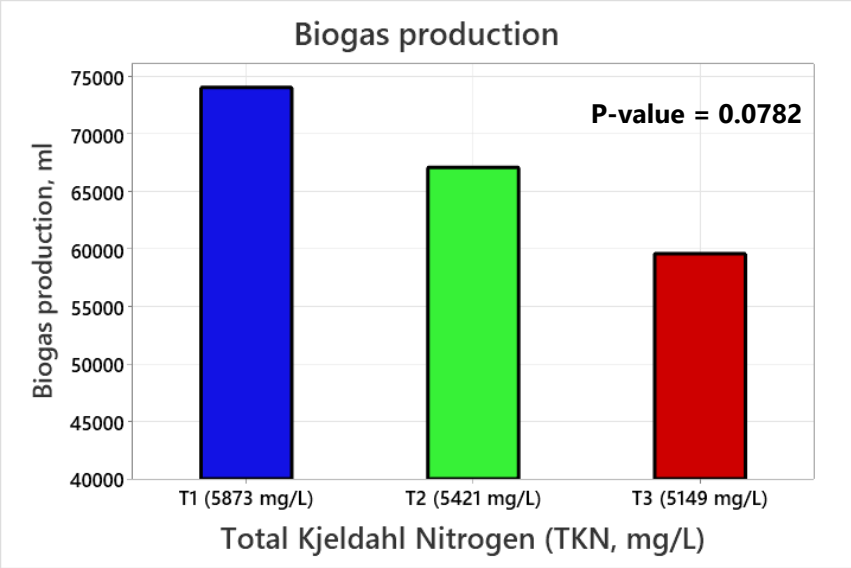
Different ways of looking into the data/problem

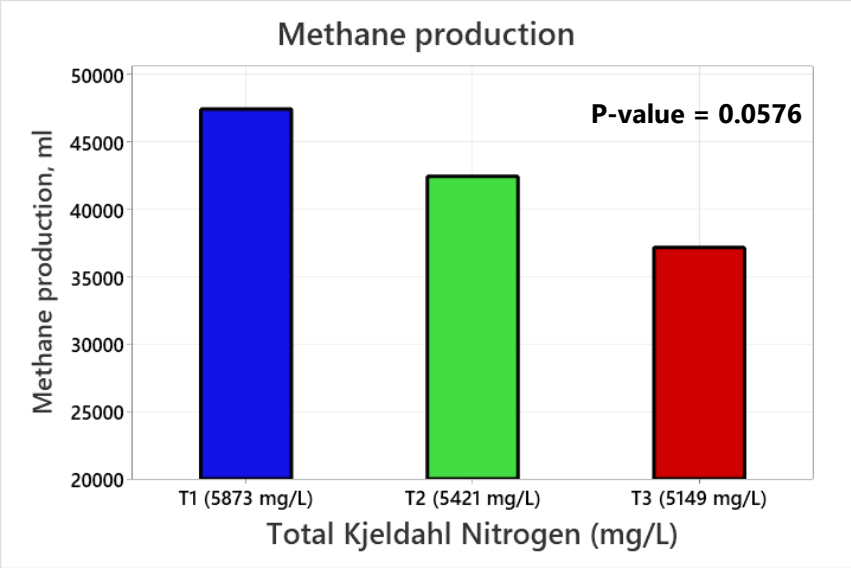
1) Evaluate the impact of lowering manure nitrogen content on the anaerobic digestion of pig manure

2) Optimize processes for treating pig manure that differ in terms of nitrogen content (digestate)

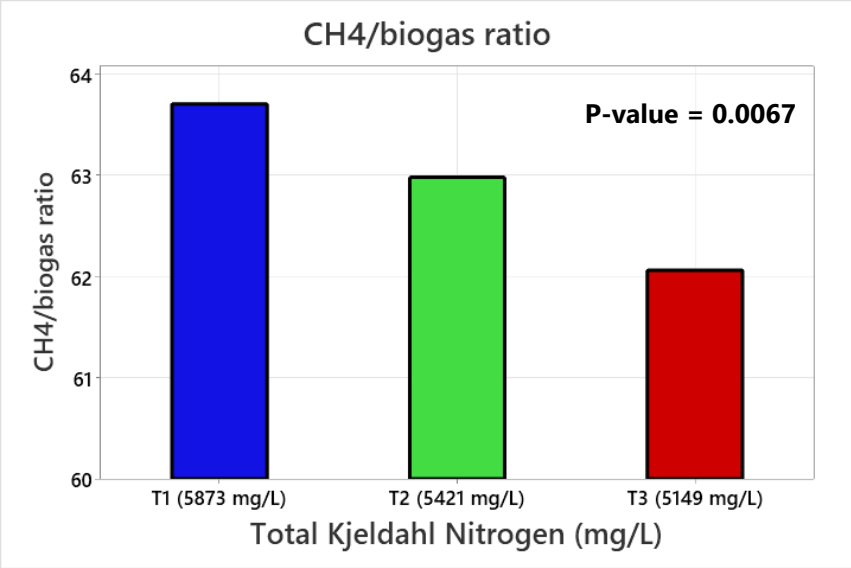
Organic loading rate, methane yield, etc

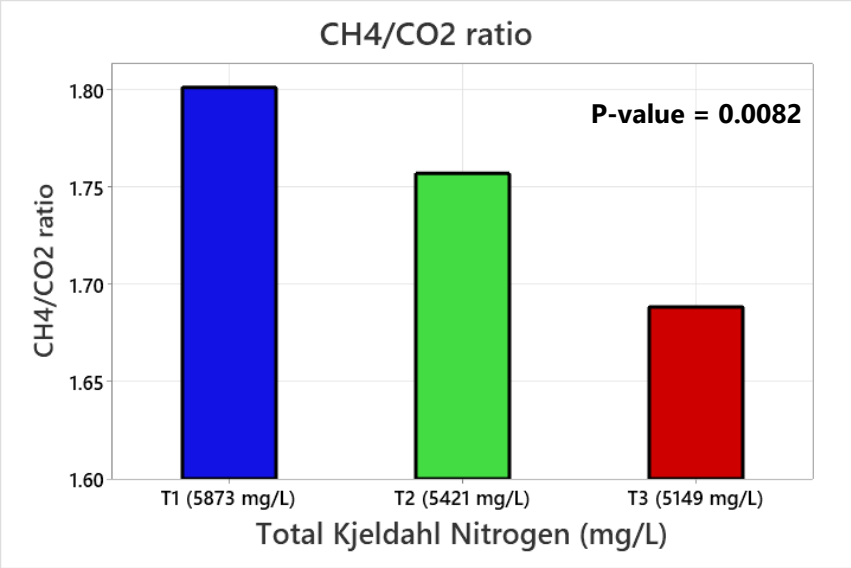
Results

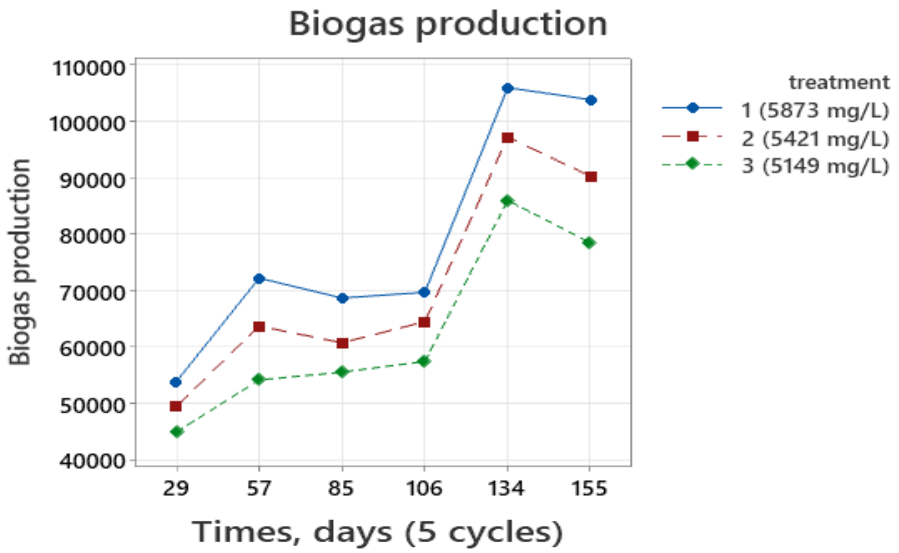

Biogas production
P-value = 0.0782
Biogas production, ml
75000
70000
65000
60000
55000
50000
45000
40000
T1 (5873 mg/L)
T2 (5421 mg/L)
T3 (5149 mg/L)
Total Kjeldahl Nitrogen (TKN, mg/L)

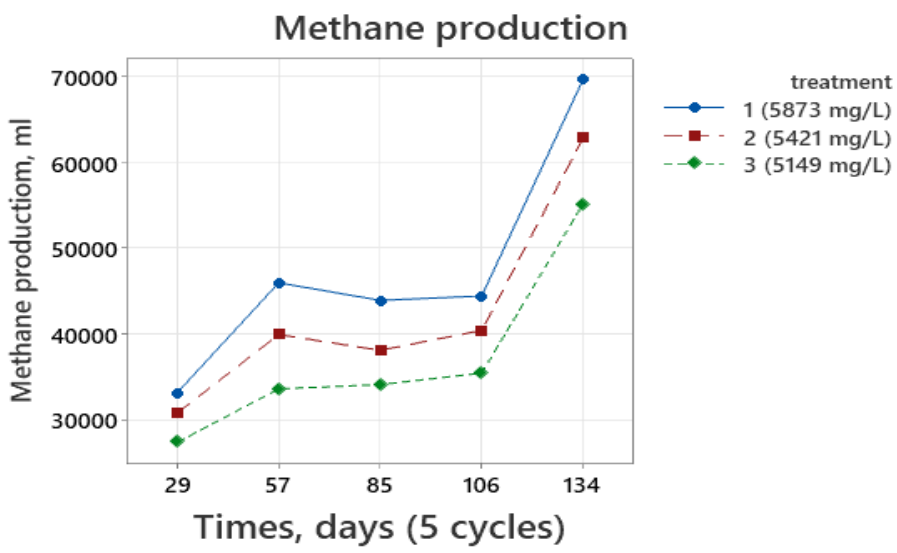

Methane production
P-value = 0.0576
Methane production, ml
50000
45000
40000
35000
30000
25000
20000
T1 (5873 mg/L)
T2 (5421 mg/L)
T3 (5149 mg/L)
Total Kjeldahl Nitrogen (mg/L)

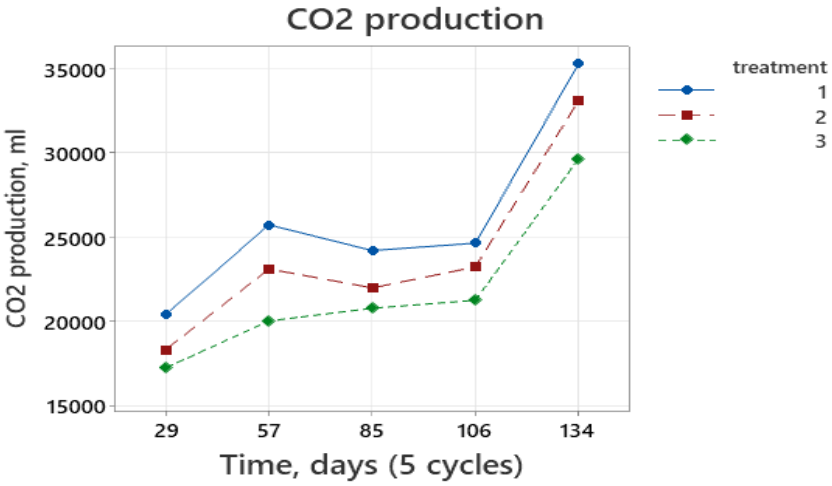
Results

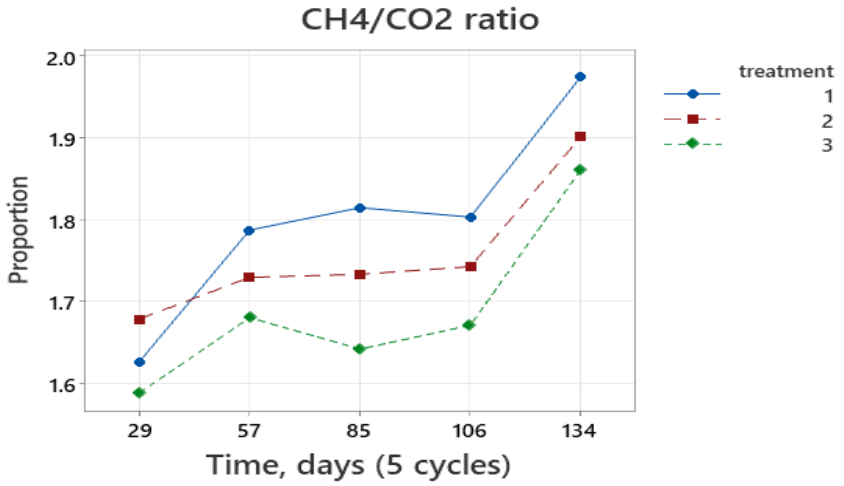

CH4/biogas ratio
P-value = 0.0067
CH4/biogas ratio
64
63
62
61
60
T1 (5873 mg/L)
T2 (5421 mg/L)
T3 (5149 mg/L)
Total Kjeldahl Nitrogen (mg/L)


CH4/CO2 ratio
P-value = 0.0082
CH4/CO2 ratio
1.80
1.75
1.70
1.65
1.60
T1 (5873 mg/L)
T2 (5421 mg/L)
T3 (5149 mg/L)
Total Kjeldahl Nitrogen (mg/L)


Biogas production
Biogas production
110000
100000
90000
80000
70000
60000
50000
40000
29
57
85
106
134
155
Times, days (5 cycles)
treatment
1 (5873 mg/L)
2 (5421 mg/L)
3 (5149 mg/L)


Methane production
Methane production, ml
70000
60000
50000
40000
30000
29
57
85
106
134
Times, days (5 cycles)
treatment
1 (5873 mg/L)
2 (5421 mg/L)
3 (5149 mg/L)


CO2 production
CO2 production, ml
35000
30000
25000
20000
15000
29
57
85
106
134
Time, days (5 cycles)
treatment
1
2
3


CH4/CO2 ratio
Proportion
2.0
1.9
1.8
1.7
1.6
29
57
85
106
134
Time, days (5 cycles)
treatment
1
2
3

Conclusions

- Lowering crude-protein levels in pig diets have some **environmental benefits** with the reduction in the amount of:
  - N being excreted – at least to some extent
  - feed ingredients with high environmental impacts

Conclusions

- Lowering crude-protein levels in pig diets have some **environmental benefits** with the reduction in the amount of:
  - N being excreted – at least to some extent
  - feed ingredients with high environmental impacts
- This feeding strategy though may affect biogas production and its quality

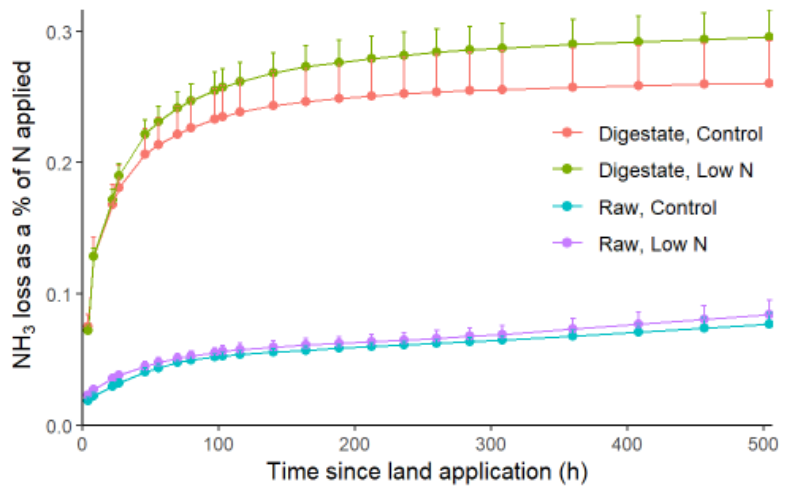
Things to consider

Nitrogen (free NH_3) may limit AD

- ❑ N reduction
- ❑ Solid-liquid separation
- ❑ Total solids; bedding material

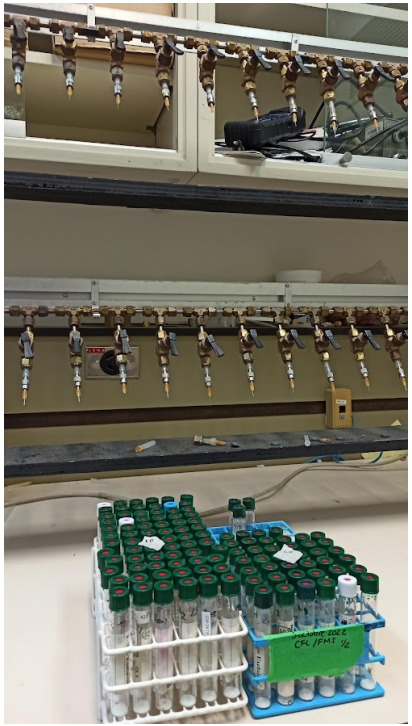
Related projects

	Control	LCP	LCP-K	LCP-Na	P-value
Biogas, ml	829601	847951	852260	835690	0.2882
Methane (CH_4), ml	453832	443961	453479	443260	0.3776
Carbon dioxide (CO_2), ml	270294	259313	267340	269839	0.4639
CH_4/biogas	54.70	54.63	55.12	54.87	0.9467
CH_4/CO_2	1.67	1.71	1.73	1.68	0.7882
NH_3-N content, mg/l	3598.02	3678.94	3647.39	3689.14	0.1235

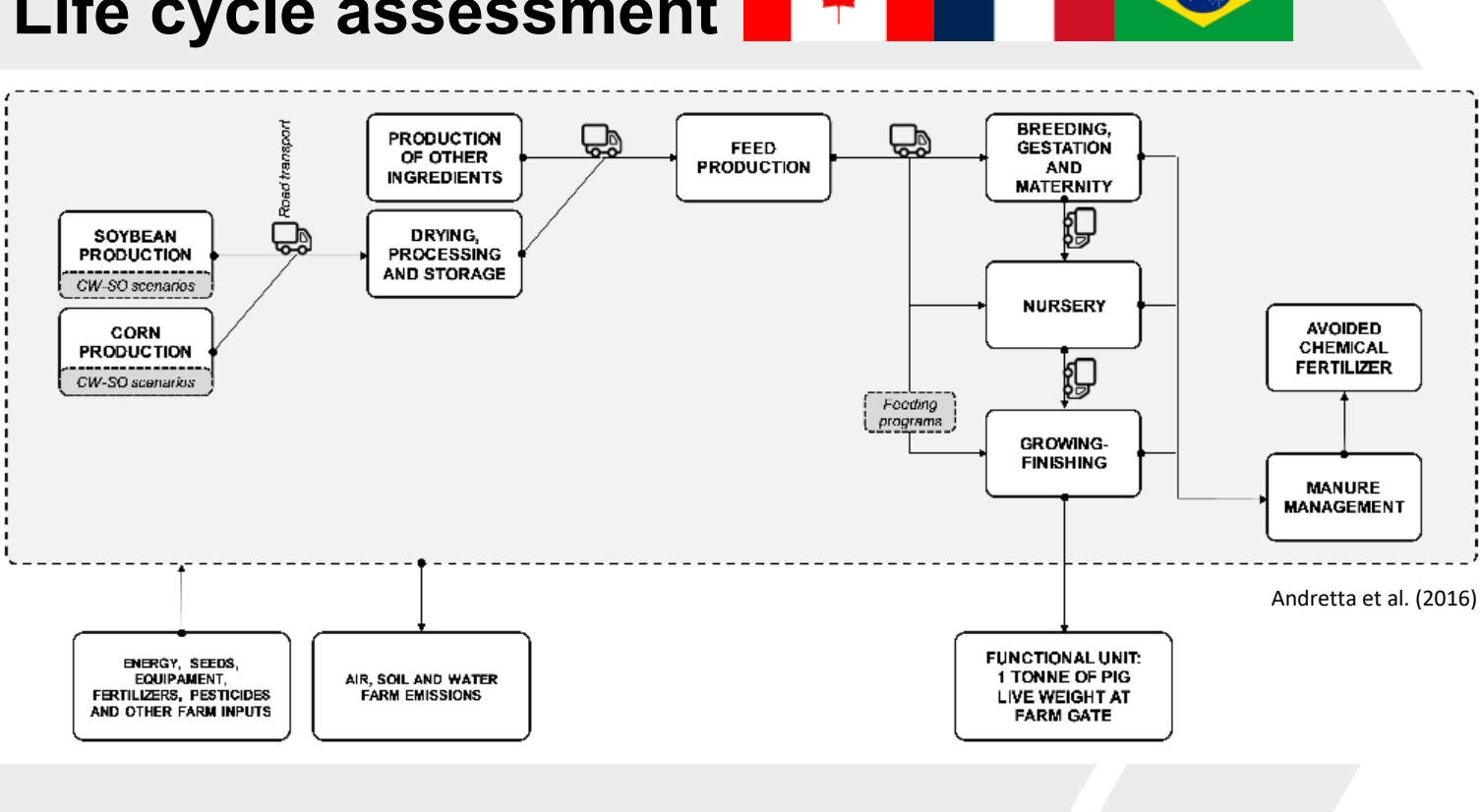


NH_3 volatilization

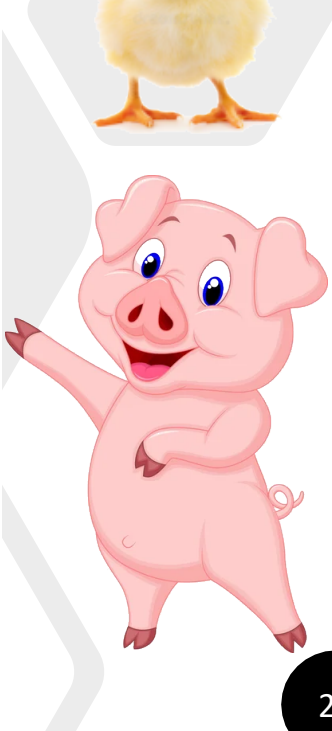
GHG emissions (CH_4, CO_2, and N_2O)



Life cycle assessment



Andretta et al. (2016)



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Agriculture and Agri-Food Canada

CAPES

Thank you
Merci beaucoup
Muito obrigado

Felipe Mathias Weber Hickmann
felipe-mathias.weber-hickmann.1@ulaval.ca