

Nitrogen extraction in biogas plants

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INTER BALTIC BIOGAS ARENA

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Biotechnology for energy and food

UNIQUE METHOD TO EXTRACT
NITROGEN
FROM ORGANIC MATERIAL



PROFITABLE & SUSTAINABLE
MANURE MANAGEMENT AND BIOGAS TECHNOLOGY

A Finnish cleantech innovator



- Founded in 2009
 - Pre-study on hyper ammonia producing bacteria
 - New biological fermentation process
- 2011 - 2013
 - Core technology was developed and tested in laboratory
- 2014 focus in product development
 - Pilot plant in Helsinki and technology verified
- 2015 Commercial activities in Germany
 - Sales organization established and 3 sales signed
- 2016 Global roll-out



Chicken manure as energy source

The annual production of chicken manure is 2.1 billion tons.

Biogas yield is (65% methane) 169 m³/tn.

→ The CH₄ potential is 230 billion m³.

Or as energy 2.3 PWh.

(8 times the Finnish energy consumption 0.3 PWh)

Nutrients in manure

Chicken litter contains a lot of nutrients:

Nitrogen	24 kg/tn
Phosphorus	17 kg/tn (as P ₂ O ₅)
Potassium	14 kg/tn (as K ₂ O)
Magnesium	5 kg/tn (as MgO)
Calcium	42 kg/tn (as CaO).

If the manure were spread to fields as is, the emissions of GHG would be 60 million tons of CO_{2(eq)}/year (compares to burning of 22.5 billion liters of diesel).

Haber-Bosch: 37 GJ/tn NH₃ (815 liters diesel).

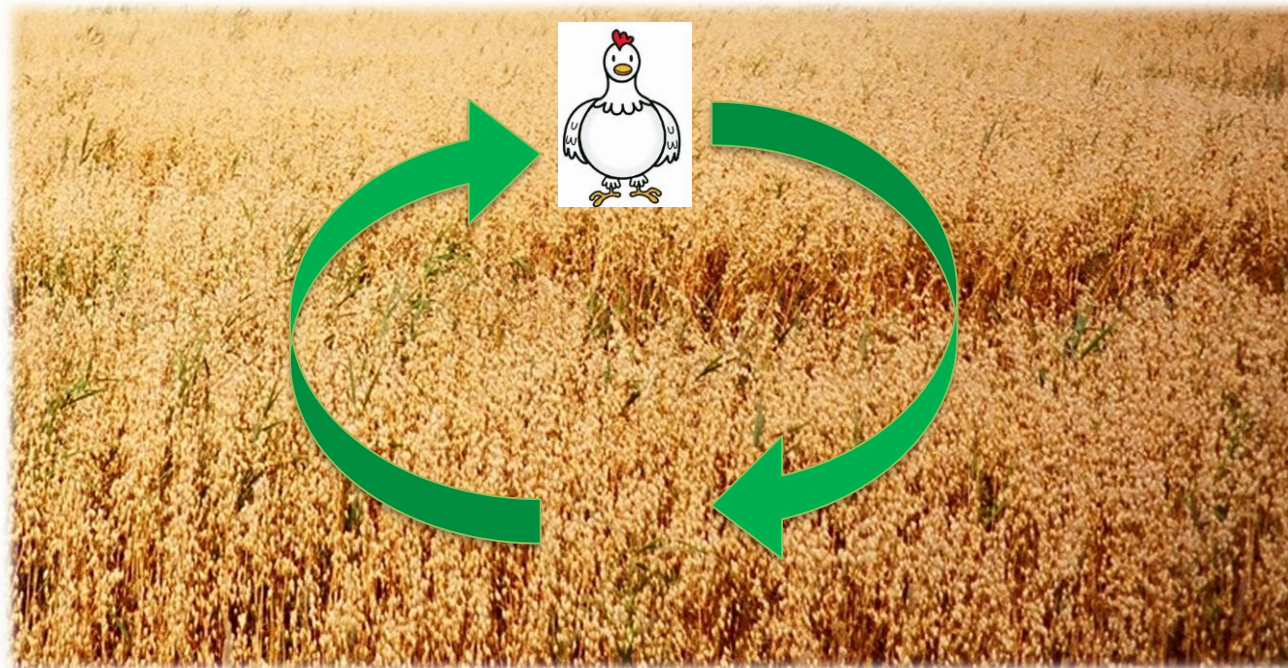
Anaerobic digestion

Table 5.3: References in the literature to inhibitory concentrations of ammonia

Author	Concentration	Comments
[5-33]	$> 3000 \text{ mg} \cdot \text{l}^{-1} \text{NH}_4$	Inhibitory effect
[5-32]	$> 150 \text{ mg} \cdot \text{l}^{-1} \text{NH}_3$	Inhibitory effect
[5-31]	$500 \text{ mg} \cdot \text{kg}^{-1} \text{NH}_3$ $1200 \text{ mg} \cdot \text{l}^{-1} \text{NH}_3$	Stable operation, elevated acid concentrations, inhibitory effect
[5-30]	$< 200 \text{ mg} \cdot \text{l}^{-1} \text{NH}_3$	Stable operation
[5-21]		Degree of degradation %
	$106 \text{ mg} \cdot \text{l}^{-1} \text{NH}_3$	71
	$155 \text{ mg} \cdot \text{l}^{-1} \text{NH}_3$	62
	$207 \text{ mg} \cdot \text{l}^{-1} \text{NH}_3$	61
	$257 \text{ mg} \cdot \text{l}^{-1} \text{NH}_3$	56
[5-34]	$> 700 \text{ mg} \cdot \text{l}^{-1} \text{NH}_3$	Inhibitory effect

The goal

Nitrogen running in a full circle from field to field



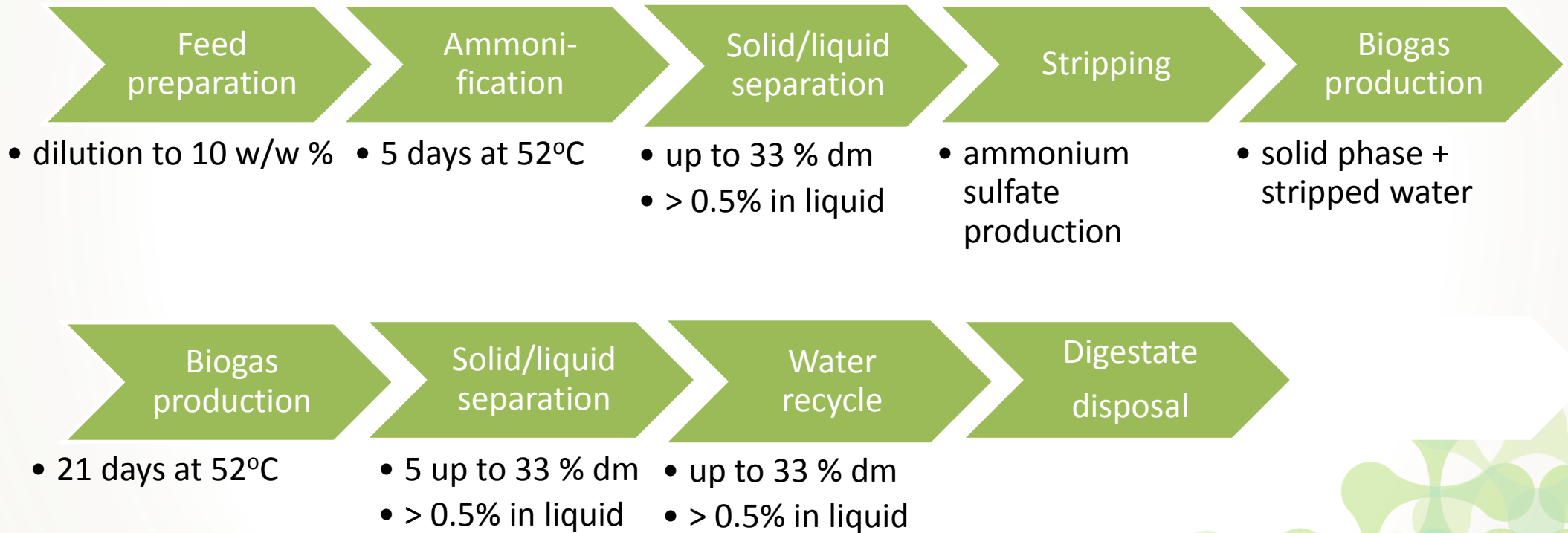
169 m³ biogas

80 kg N-fertilizer

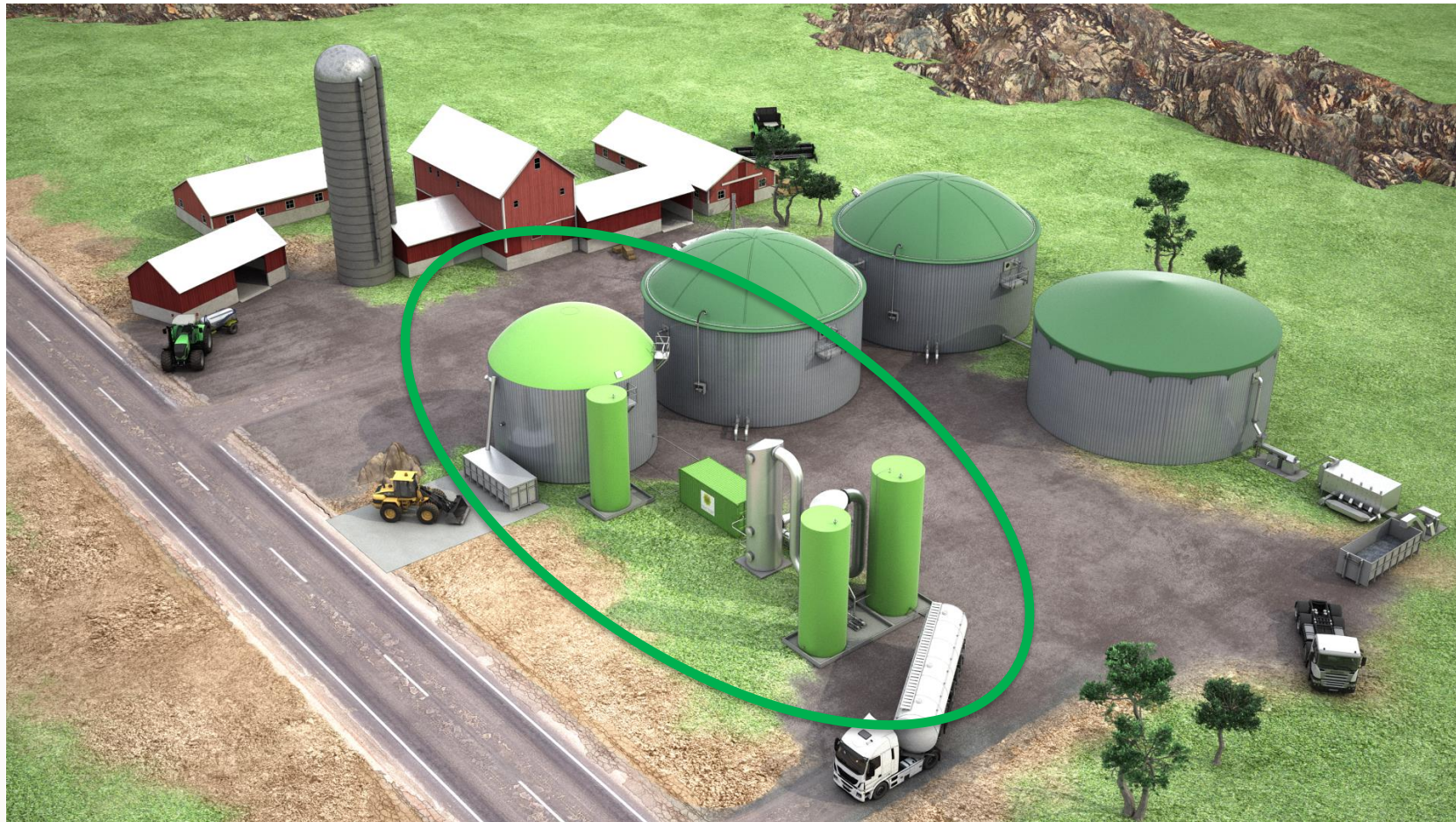
350 kg P-fertilizer

and delivering renewable energy

Nitrogen extraction process



Ductor at a biogas plant



Pilot scale operation parameters

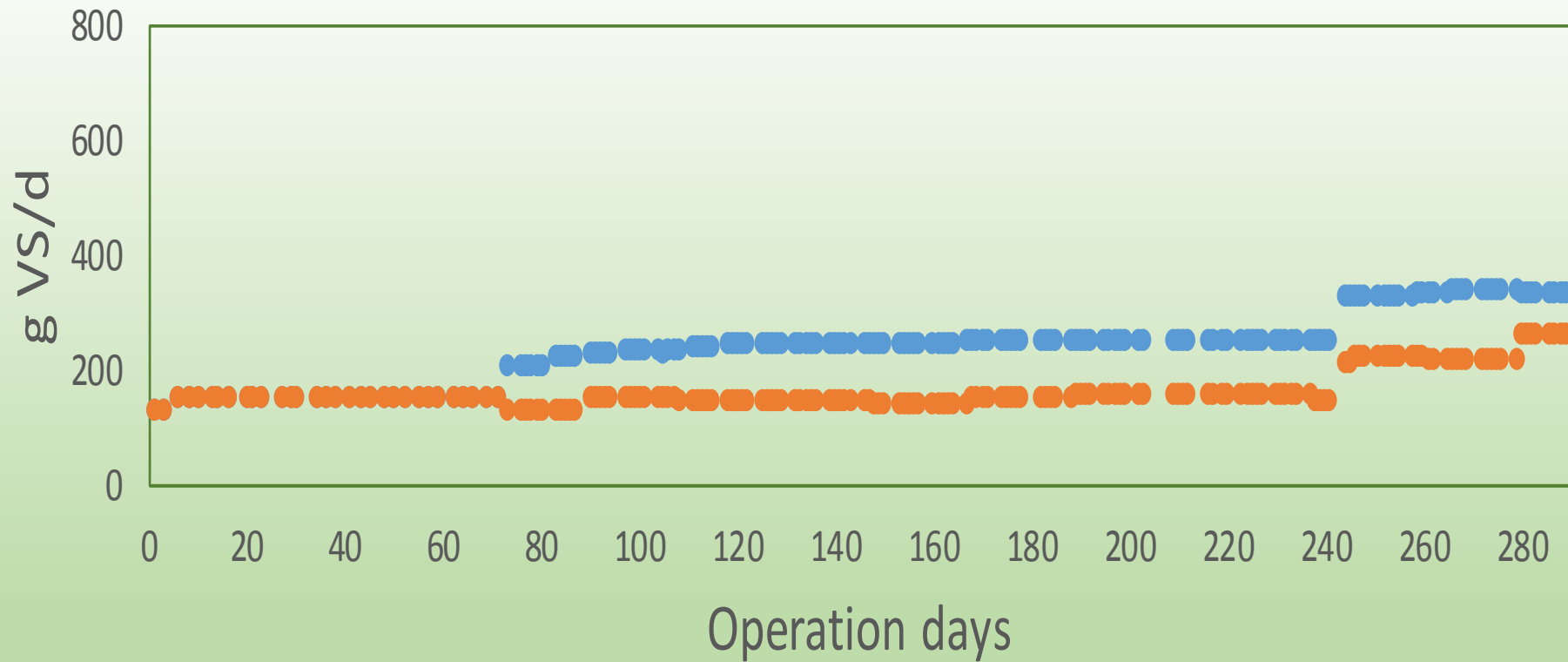
Ammonification reactors: 2*50 liters
Decanter: GEA, Germany
Stripper: Packed bed; Sirra, Finland
Biogas reactors: 2*70 liters
Flow meters: 2*Ritter, Germany
Gas analyzer: SWG 200-1 Biogas analyzer

Ductor fermentation: 10% TS, 52°C, 5 days

Biogas:

- OLR 3 g l⁻¹ day⁻¹; feeding 5/7
- HTR 21 days
- Temperature 52°C
- Biogas inoculum Viikinmäki WWTP

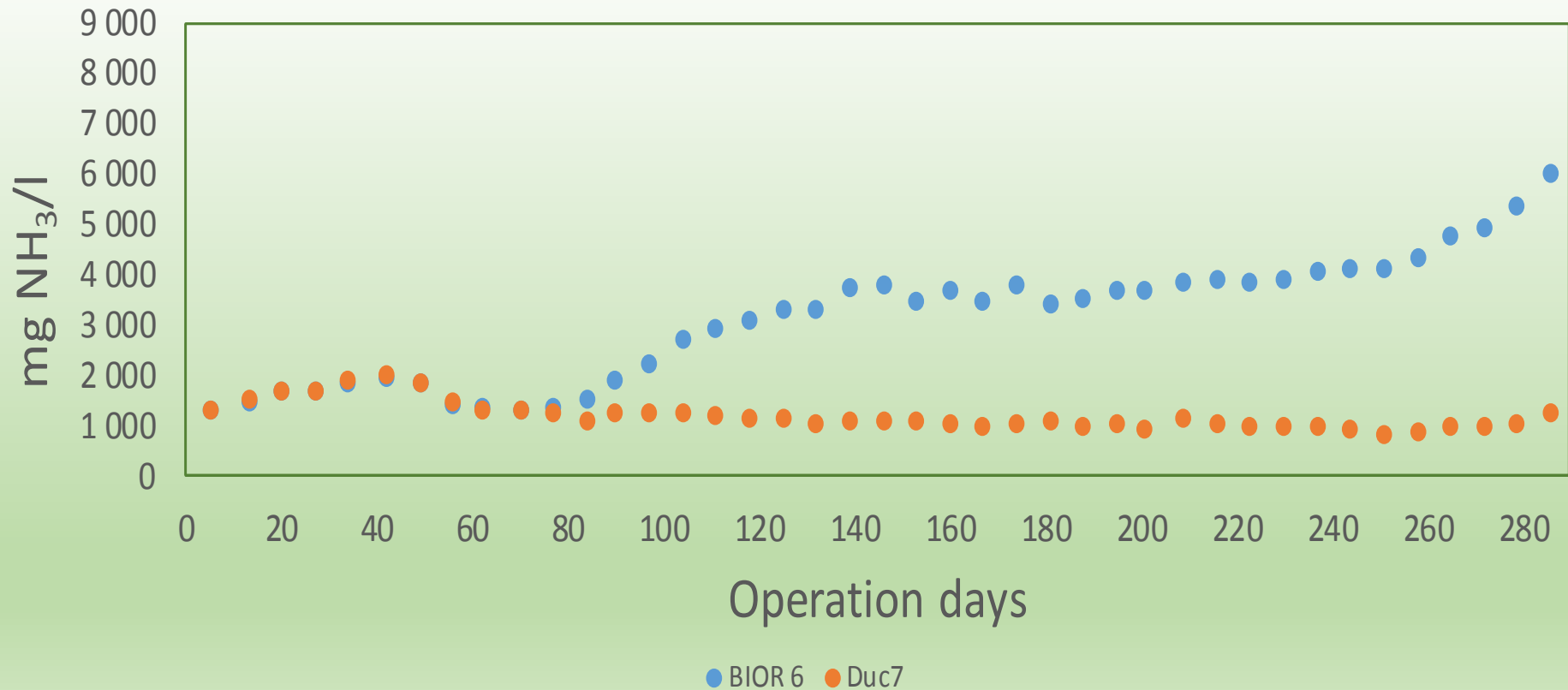
Feed rates



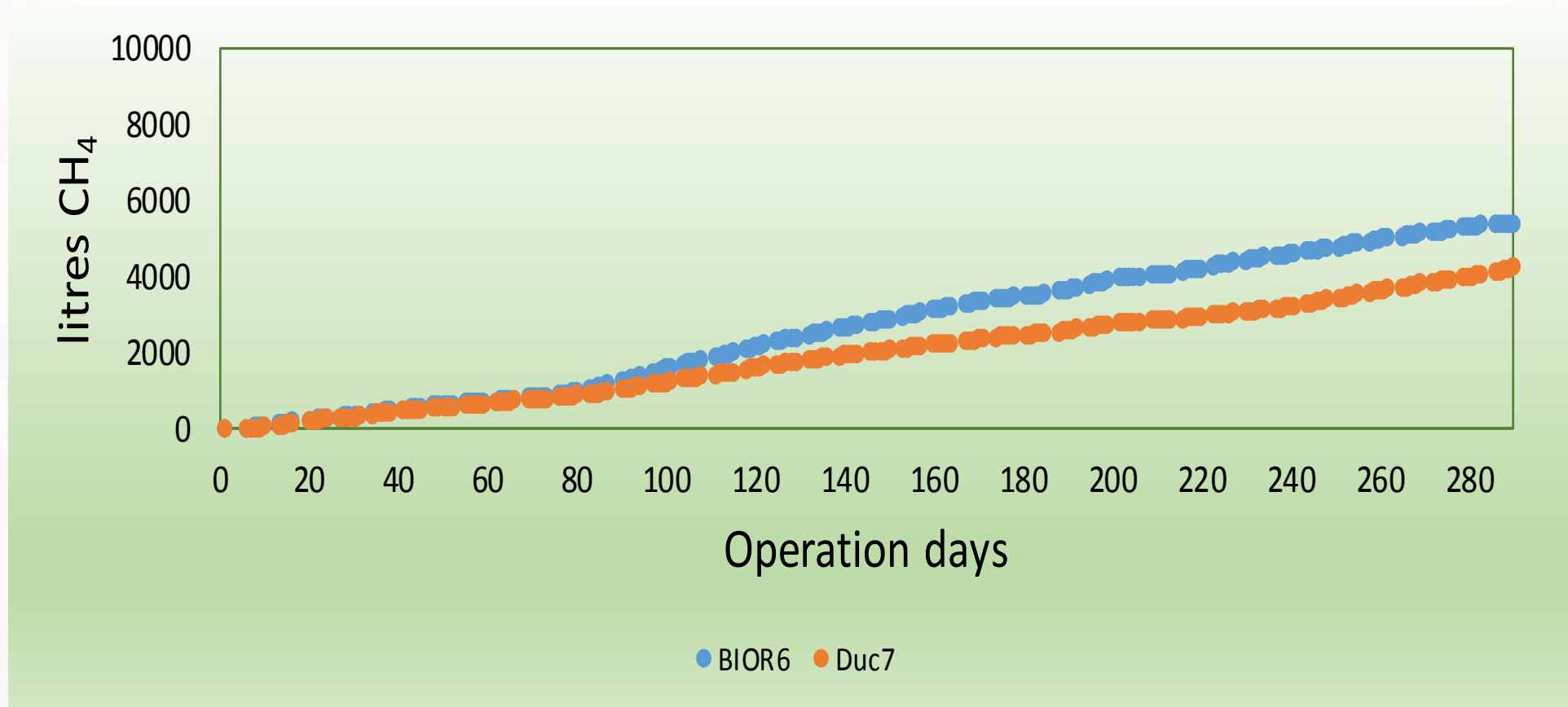
BIOR6= chicken litter w/o NH₃ removal
Duc7 = "ductored" chicken litter

● BIOR6 ● Duc7

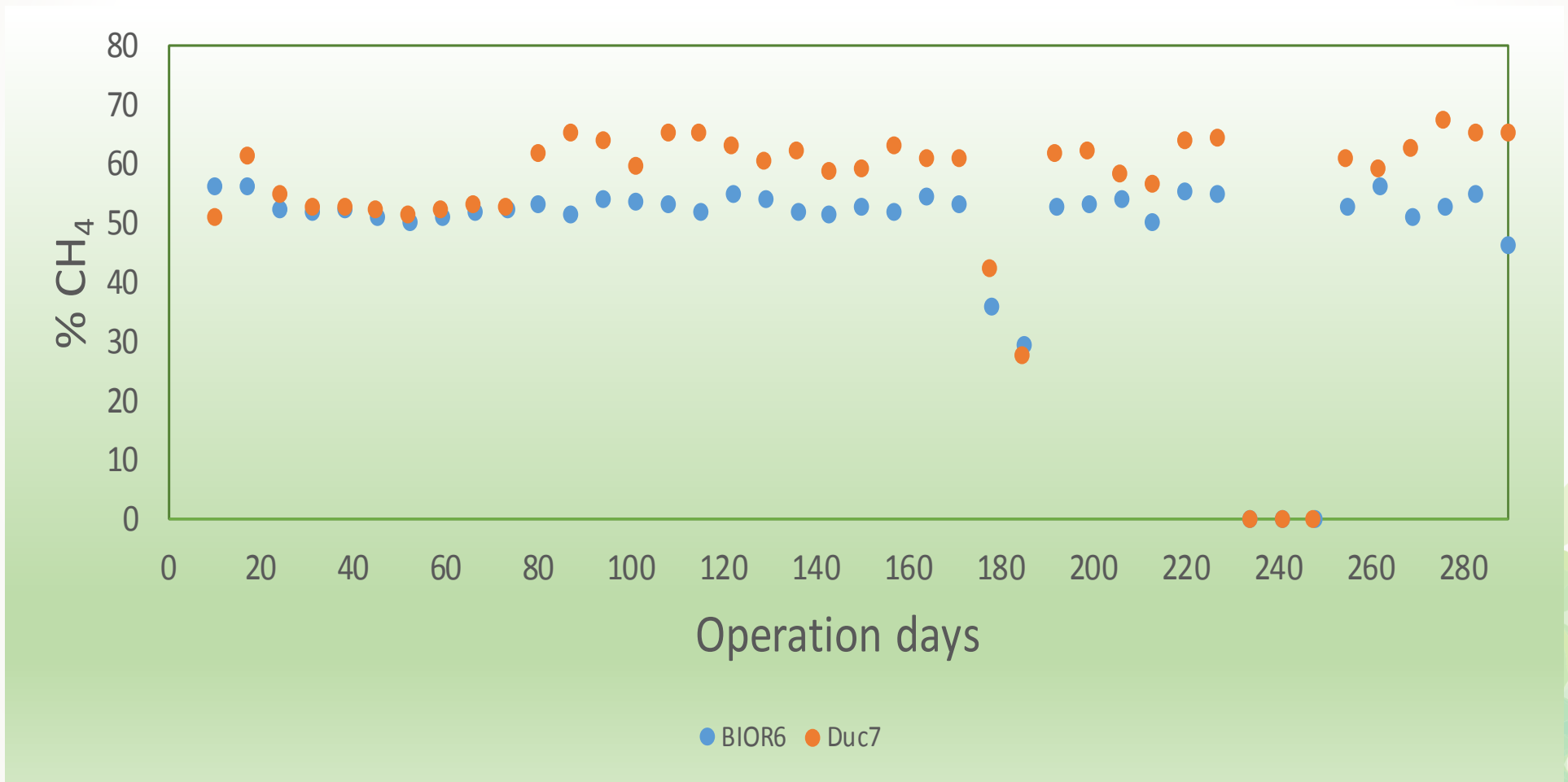
Ammonia in biogas reactors



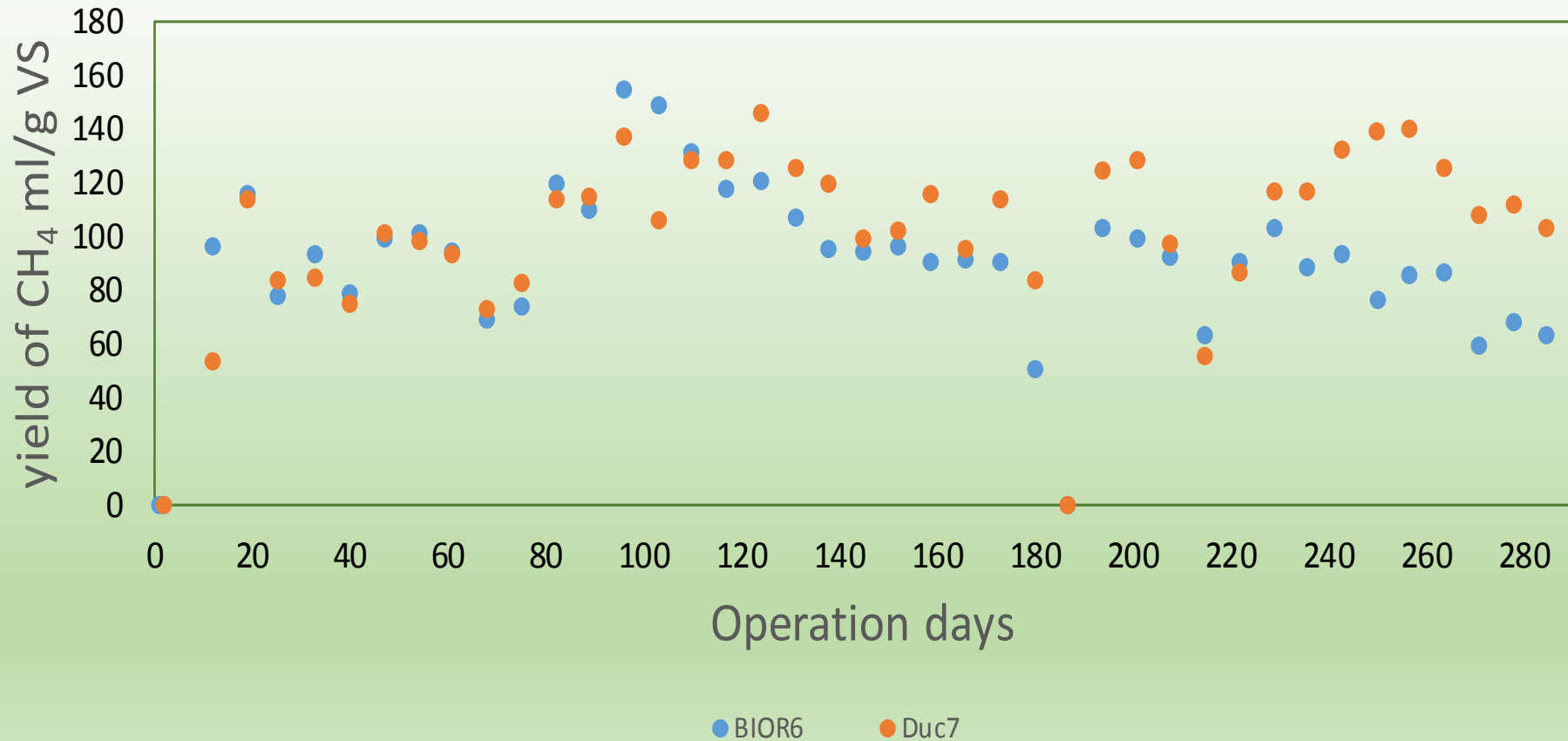
Cumulative CH₄ production



Methane content



Methane yield



Feedstock

As Ductor fermentation will convert nitrogen into ammonium all high nitrogen containing organic material like:

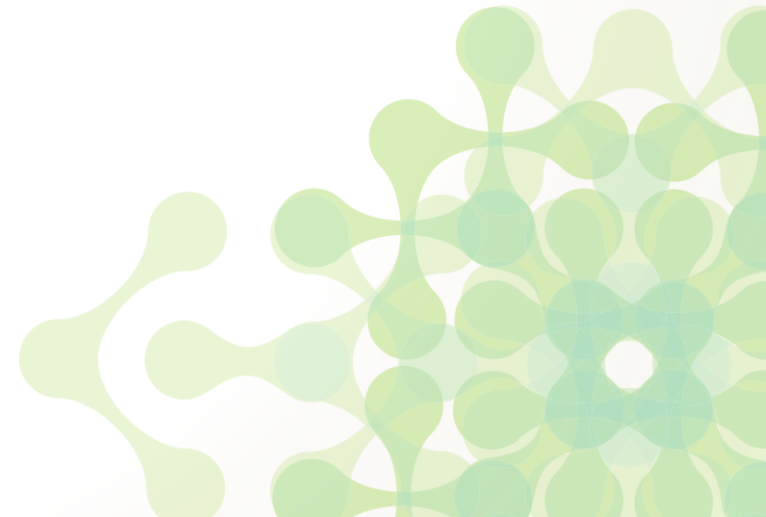
Chicken manure
Pig manure
Cow manure
Slaughter house waste
Fishery waste
Food waste
Feathers
Dead animals
.....

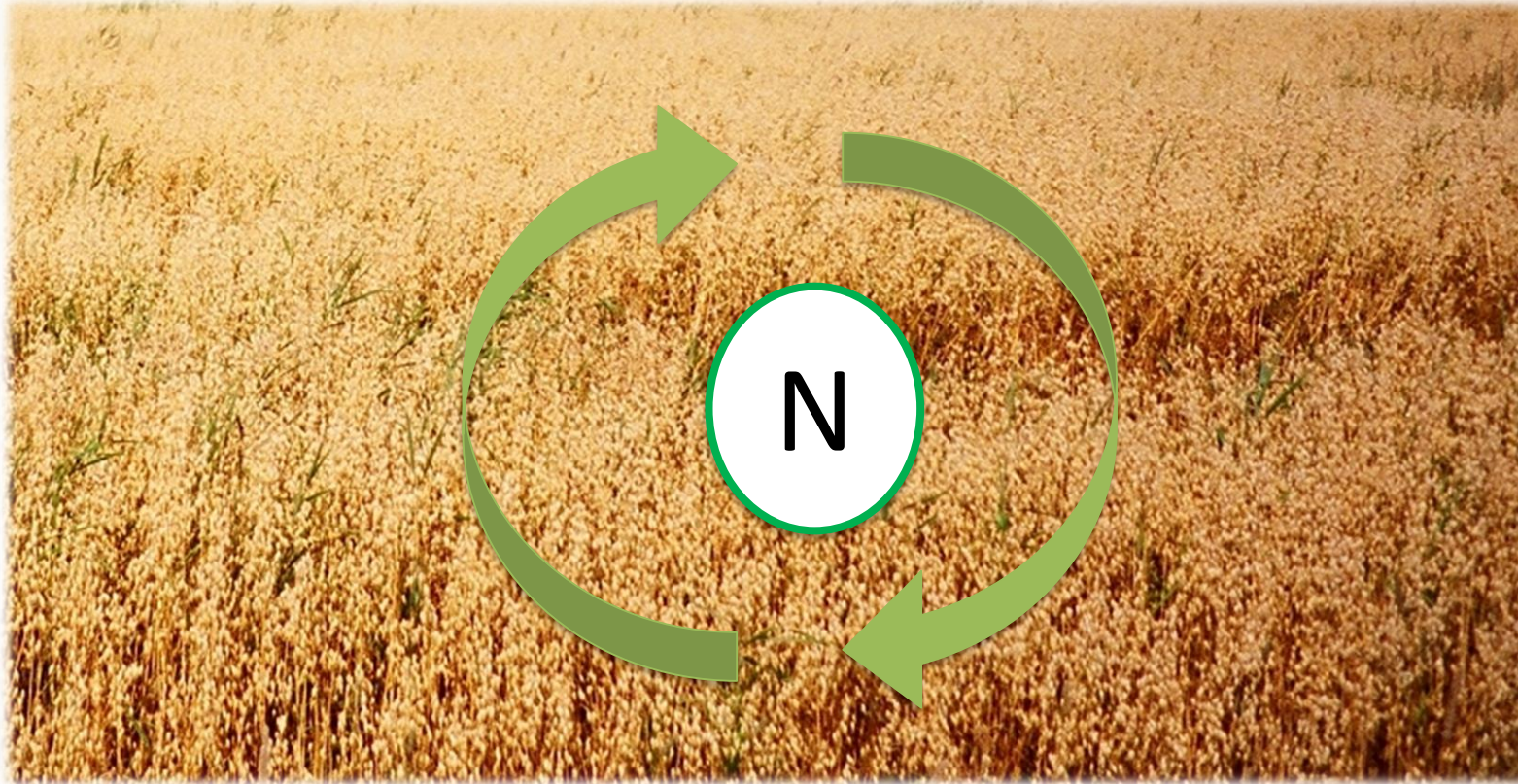
can be used for biogas production.



Conclusions

- It is possible to run a biogas plant with 100 % chicken litter
- Nitrogen was converted into a fertilizer
- The ammonia level will stay low using “ductored” feed
- In the process very little of the methane potential is lost





Can be done !

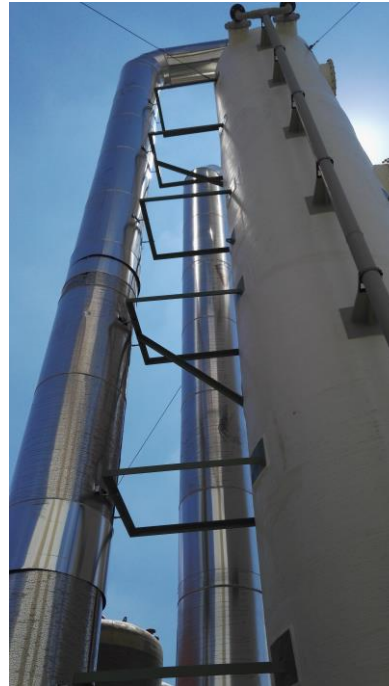




DUCTOR INNOVATIONS CHANGE THE WORLD

www.ductor.com

Project Green Energy, Haren, Germany



Main equipment:

- 1 Fermenter 800 m³
- 1 Solids separator 4 m³/h
- 1 Stripping unit 3 m³/h
- 1 Sand separator
- 3 Chemical tanks

Feedstock:

- Chicken manure 7 400 tn/a
- Corn silage 820 tn/a

Parameters for Ductor fermentation:

- 5 days fermentation
- 24/7

Advantages:

- Substrate savings
- New revenue streams

Up & running 2017 !

Biogas Case Example

INPUT

- 30 000 tn of chicken litter

OUTPUT

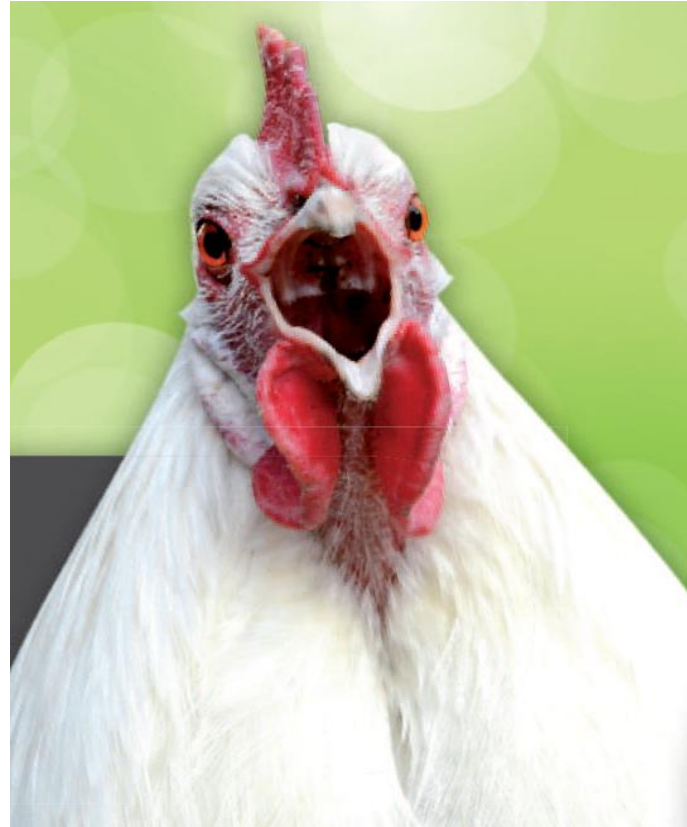
- 1.5 MW electrical power
- 13 150 000 kWh electricity
- 18 120 000 kWh heat
- 2 600 tn ammonium sulfate
- 14 000 tn solid fertilizer

INVESTMENT

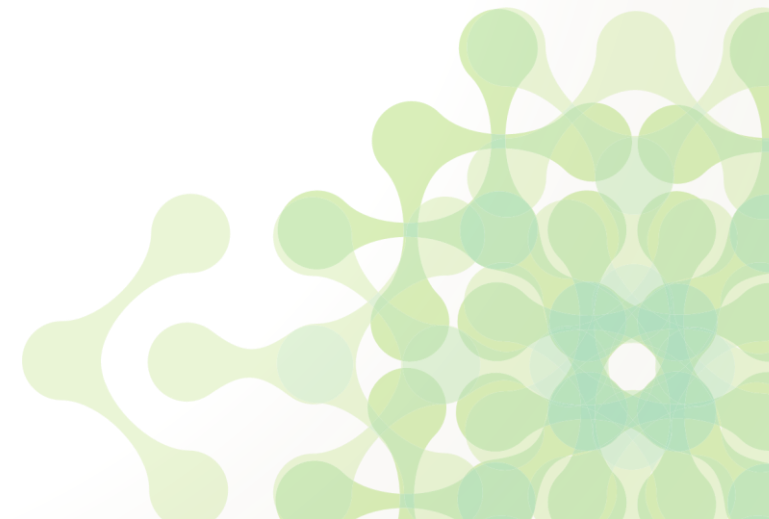
- 5.5 M\$
- Payback time 5 years



Thank you !



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A solid foundation for growth



INVESTMENTS BY 2017 TOTALS OVER 7 M€

- Founders and management
- Finnish & European innovation funding
- Private shareholders

R&D INVESTMENTS YIELD STRONG PROTECTION

- 7 patents
- Several other patents in the pipeline

International recognitions 2013-2015



MAX-PLANCK-GESELLSCHAFT

