GlasPort Bio

# *Reducing the carbon footprint of cattle and pig manure*

*Dr. Stephen Nolan & Mr. Shaun Connolly*

*8th April 2022*

www.glasportbio.com

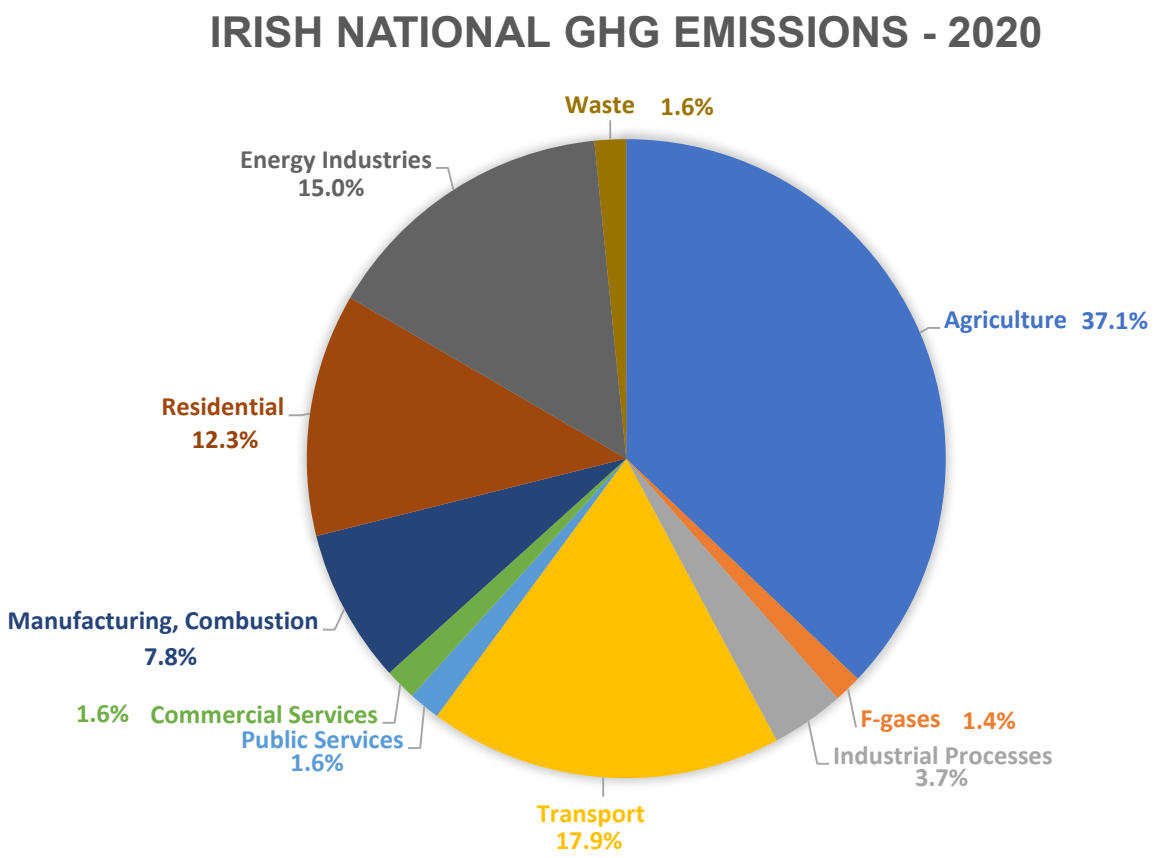
# Overview

- **Introduction (Dr. Stephen Nolan):**
  - Climate Change & Agriculture
  - GlasPort Bio and its lead product: GasAbate

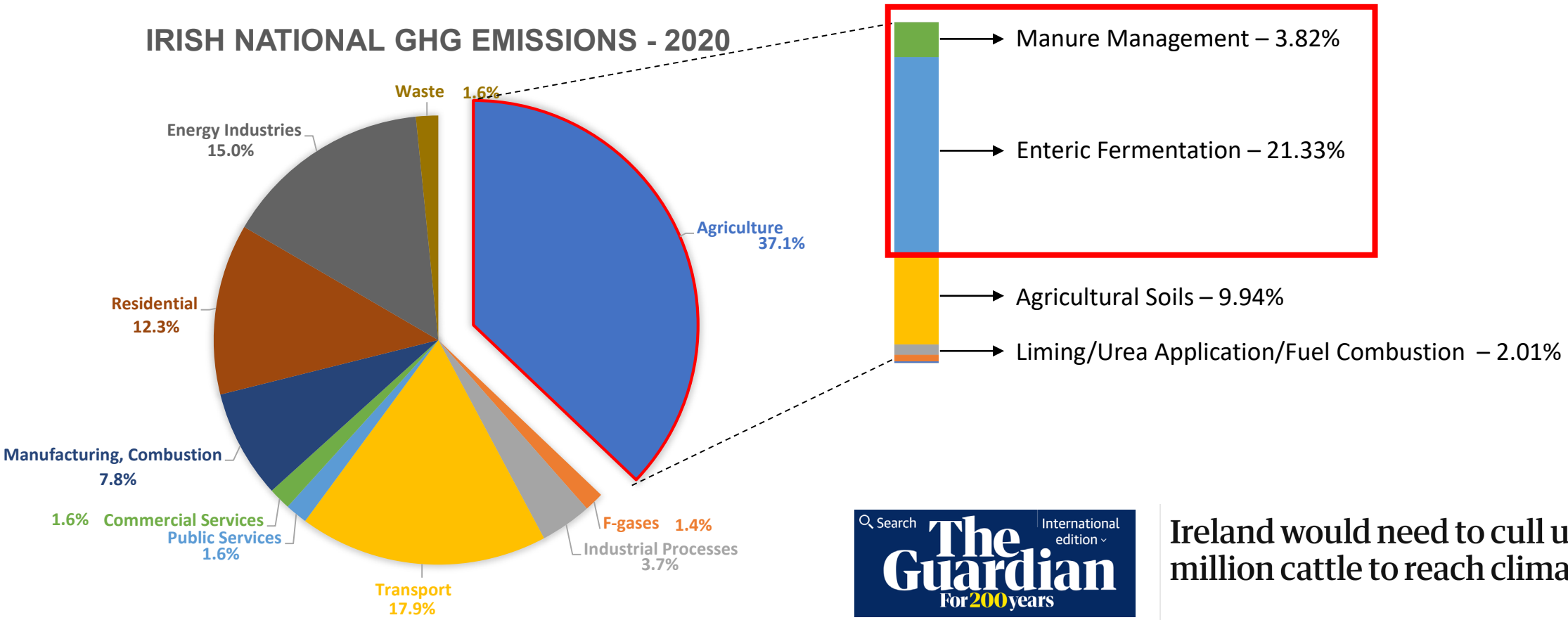
- ***GEBTech project***, SEAI RD&D 2018-2022
  - **Green Energy Boosting Technology (GEBTech):** a novel treatment for farm slurries to reduce greenhouse gas emissions and to generate energy.

- ***PIGergy project***, ERA Net SES funded by SEAI 2019-2022
  - **PIGergy:** A novel means of unleashing the energy potential of pig waste

# Climate Change & Agriculture



# Climate Change & Agriculture

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## Ireland would need to cull up to 1.3 million cattle to reach climate targets

**With more than a third of the country's greenhouse gases coming from farming, Dublin faces huge pressure over reduction aims**

# Problem – gaseous emissions during manure storage

## Storage

Gas Emitted (e.g. ammonia, methane)
Loss of Nitrogen; Loss of Carbon
Toxic $H_2S$ (~10% on-farm EU fatalities)

- Mineral fertiliser purchase
- Poor energy output from AD
- Health and Safety risks
- GHG emissions (~1.5% global total)

## Current Treatments


- High Capital and implementation costs
- Largely ineffective
- Do not prevent both Carbon & Nitrogen losses
- May require onward slurry processing

**No net savings to customer**
**(net costs: up to €4.99/tonne slurry treated)**

# Our Solution: GasAbate

**GasAbate application types:**

- Slow-release block
- Automatic dosing pump
- Hand-applied pump

Specific targeting of methanogens
Inhibition of microbial gas production

Up to 95% reduction in GHG emissions

- No start-up/implementation costs
- 29% reduced fertiliser purchase
- 38% increased energy output from AD
- Reduced agitation time
- Net savings to customer (fertiliser savings/increased AD output)
- Carbon tax future-proofing

- **Reduction of supply chain carbon footprint**
  - Corporate reduced footprint
  - Reduced produce footprint

- **Generation of tradable carbon credits**


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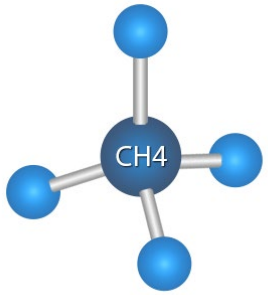
# Mode of action: GasAbate

… treats **liquid manures or slurries** in storage tanks, lagoons or liquid slurry ponds.

… is the product from a reaction of **2 active ingredients** which together produce an **inhibitory agent**

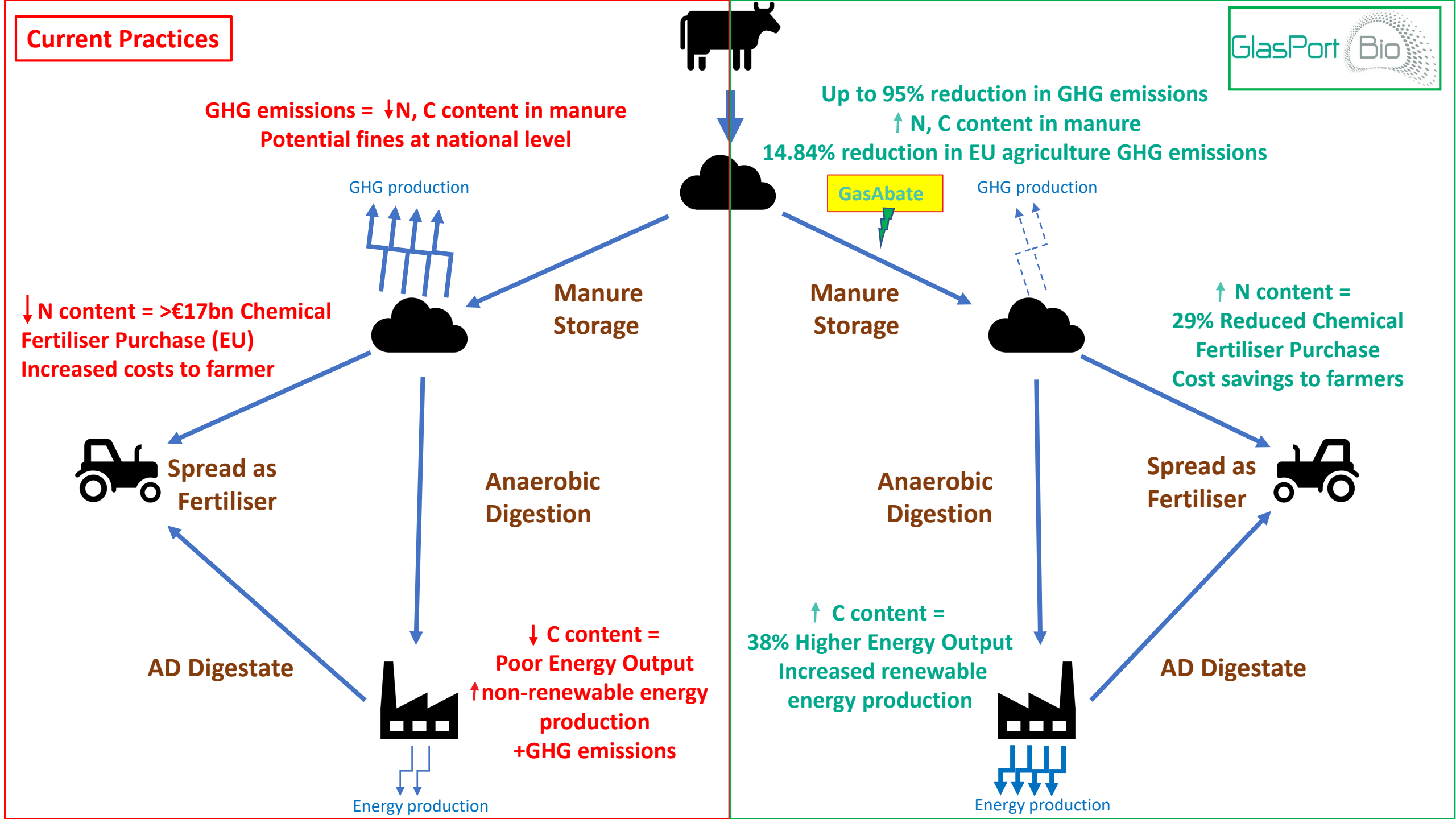
… creates an environment which is not conducive to methanogens and causes them to shutdown for a period of time, thereby **preventing the production and release of methane to the atmosphere.**



# Benefits of GasAbate

- **Greenhouse gas (methane) reduction** opportunities in the agricultural sector
- **Improved biogas yield*** (anaerobic digestion) for situations where manure is stored pre-digester

  **under certain storage conditions*
- **Nutrient enhancement** and **reduction of synthetic fertiliser** usage
- **Animal welfare/odour reductions** – reduction of hydrogen sulphide ($H_2S$) emissions

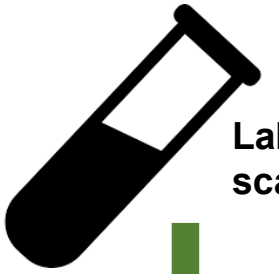

Current Practices
GHG emissions = ↓N, C content in manure
Potential fines at national level
GHG production
↓N content = >€17bn Chemical Fertiliser Purchase (EU)
Increased costs to farmer
Manure Storage
Spread as Fertiliser
Anaerobic Digestion
AD Digestate
↓ C content =
Poor Energy Output
↑non-renewable energy production
+GHG emissions
Energy production
GlasPort Bio
Up to 95% reduction in GHG emissions
↑ N, C content in manure
14.84% reduction in EU agriculture GHG emissions
GasAbate
GHG production
Manure Storage
↑ N content =
29% Reduced Chemical Fertiliser Purchase
Cost savings to farmers
Spread as Fertiliser
Anaerobic Digestion
↑ C content =
38% Higher Energy Output
Increased renewable energy production
AD Digestate
Energy production

# Green Energy Boosting Technology (GEBTech): a novel treatment for farm slurries to reduce greenhouse gas emissions and to generate energy


**987 million cattle** worldwide;

**Largest livestock group emitting greenhouse gases**

**SEAI RD&D Grant: awarded 2018**



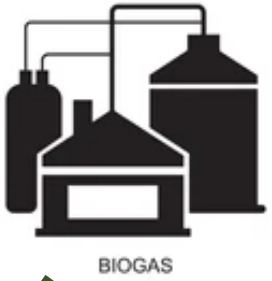
Laboratory-scale trials

Medium-scale trials

Larger-scale trials

Carbon-enhanced manure feedstock

Anaerobic digestion





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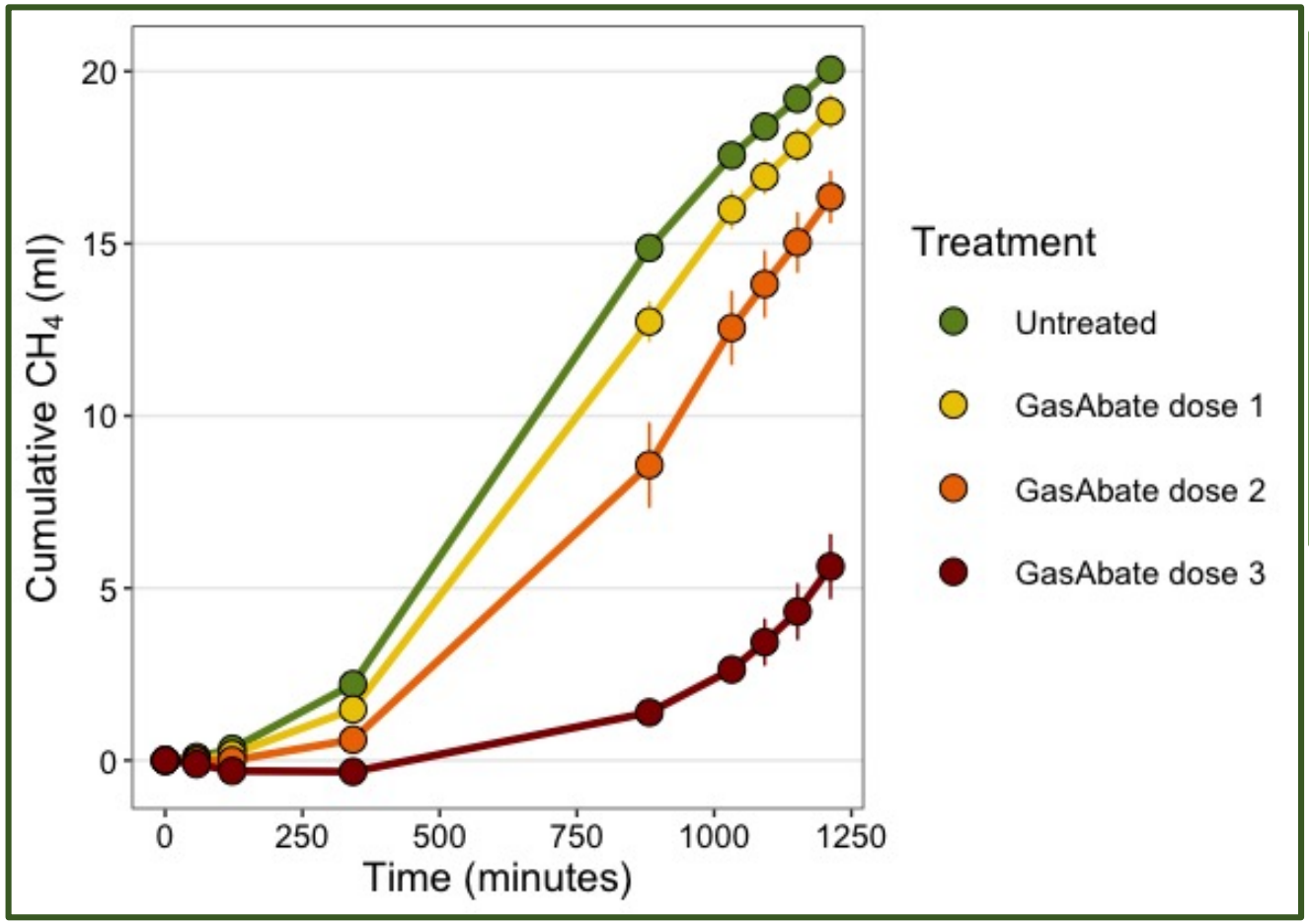
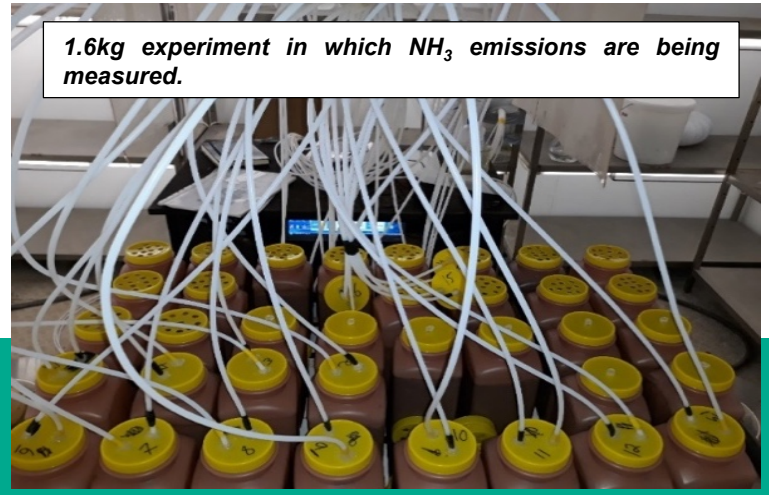
# Laboratory-scale trials overview

- Small-scale trials (10g - 2 kg)
- Varying concentrations of product used.
- Gaseous emissions of treated vs. untreated manure monitored.
- Data set compiled based on effect of:
  - … concentration
  - … frequency
  - … different reagent sources




- Dose requirements of GasAbate N+ trialled with cumulative methane production monitored to **optimise additive formulation**.
- Marked reduction in methane production rates, incubated in small microcosms.
- Effect was dose-dependent, with significant inhibition observed at higher concentrations, with higher dose used for scaled-up trials.



*1.6kg experiment in which $NH_3$ emissions are being measured.*

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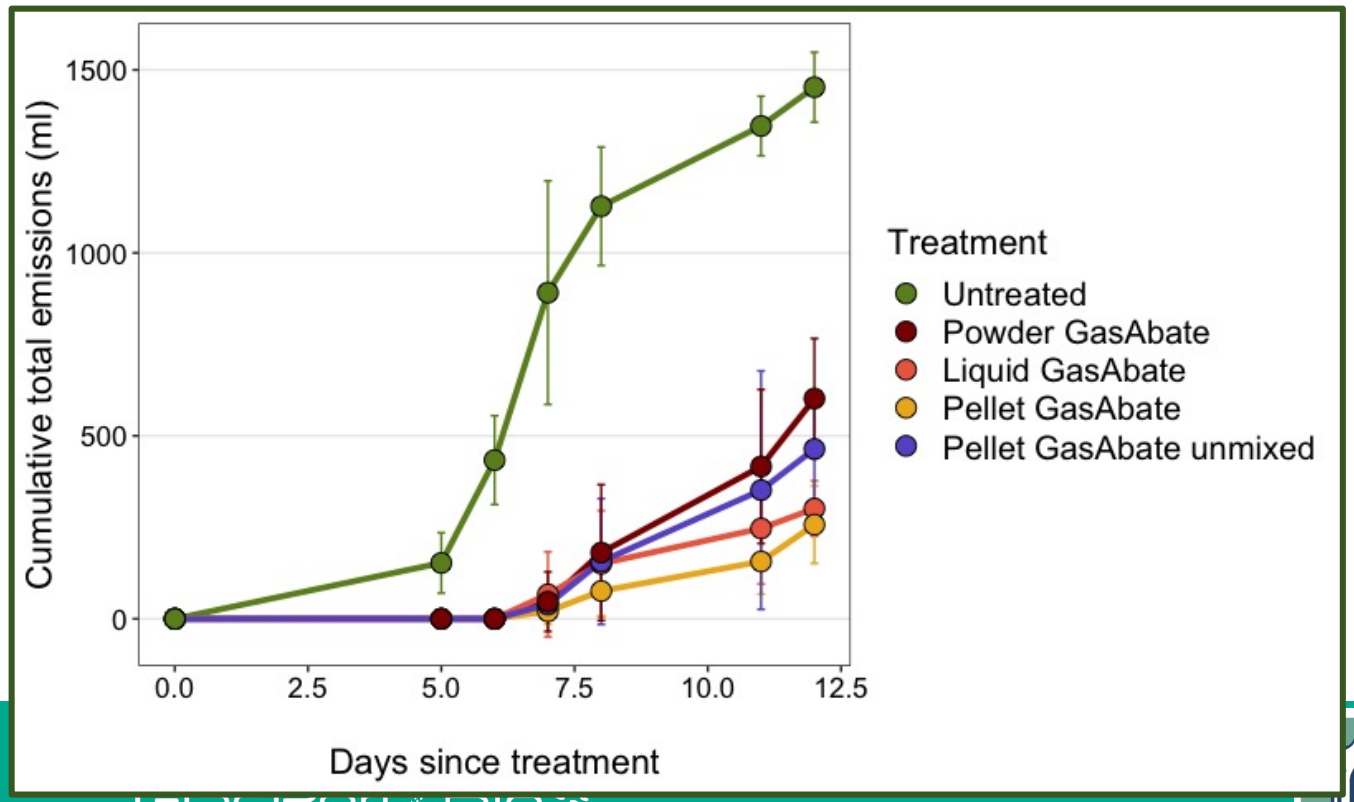
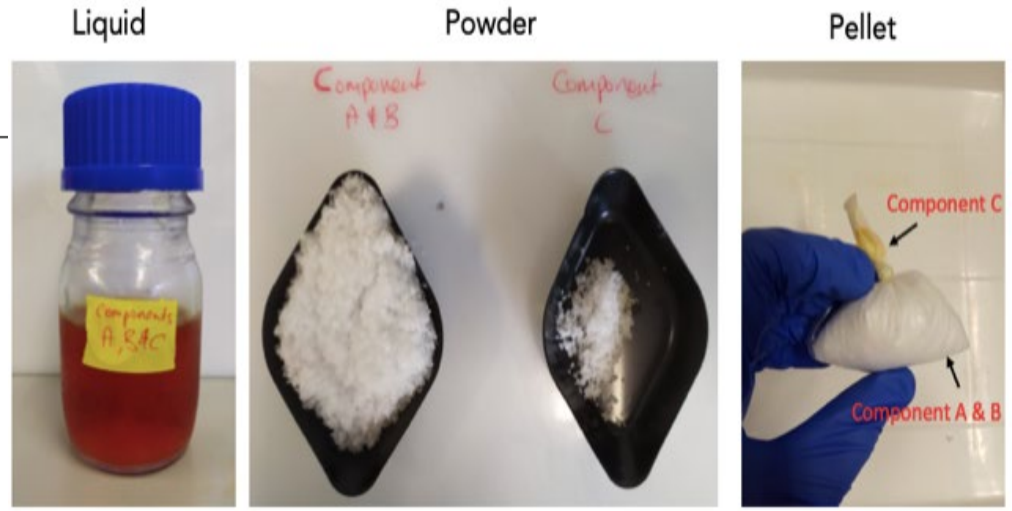
# Cocktail optimisation

(a) To determine **the best delivery method**, 25L mesocosms filled with 15kg slurry with biogas collected, **liquid, powder and pellet variants** tested.

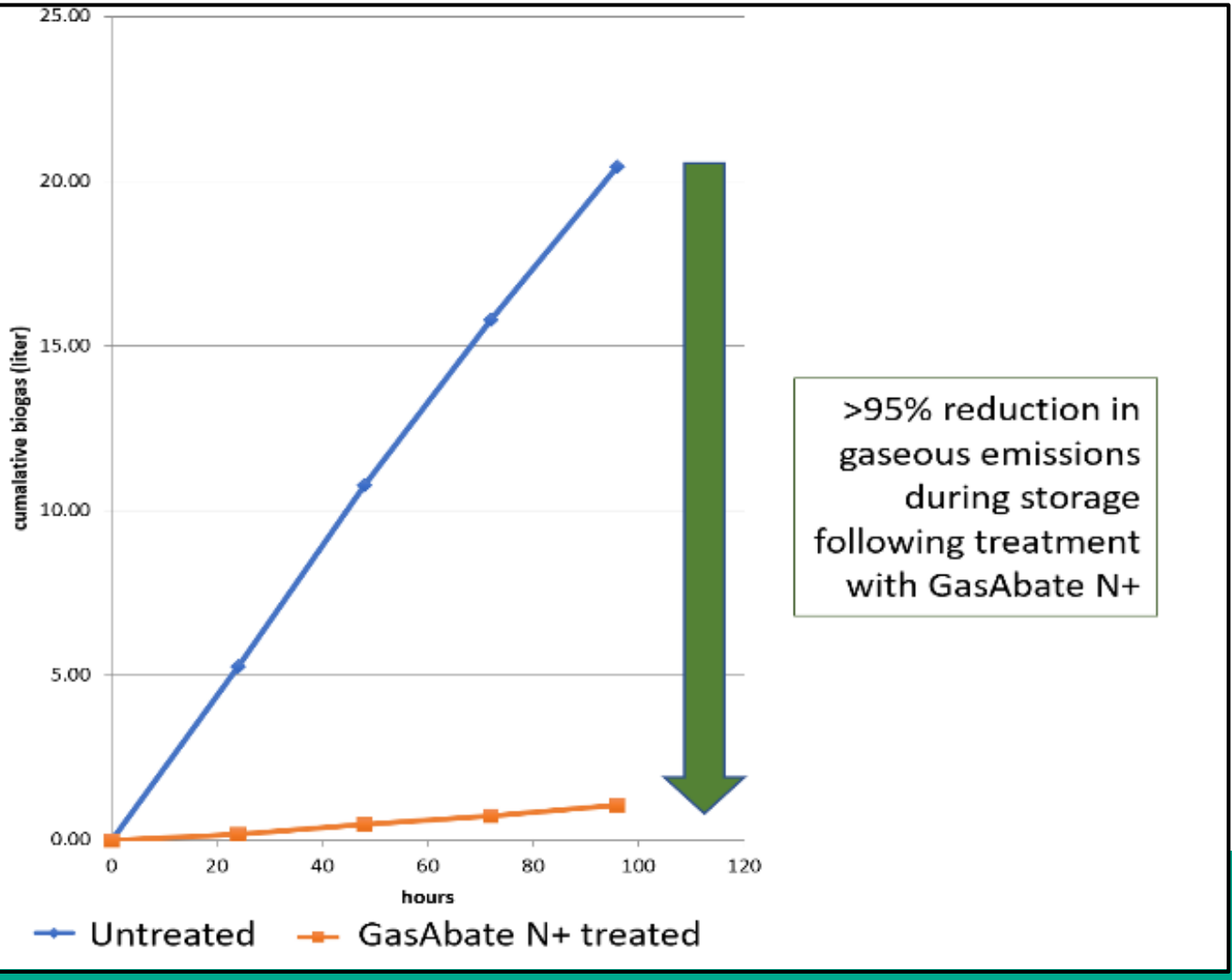
(b) **No appreciable difference** was observed between the three variants.




# Independent trials: Uni. of Kaiserslautern, Germany

- Performance of GasAbate additive formulations assessed in cattle slurry.
- **Temperature:** 25°C storage tanks
- **Testing:** biogas production from untreated vs. treated slurry.
- **Results:**
  - ✓ Biogas: >95%
- **AD** of resultant enhanced carbon feedstock also trialled.




>95% reduction in gaseous emissions during storage following treatment with GasAbate N+

# Medium-scale trials overview

- Small-scale trials replicated at approx. 15kg/25L slurry scale
- 10-week/68-day period.
- Near cessation of gaseous production observed in treated vs. untreated slurry.

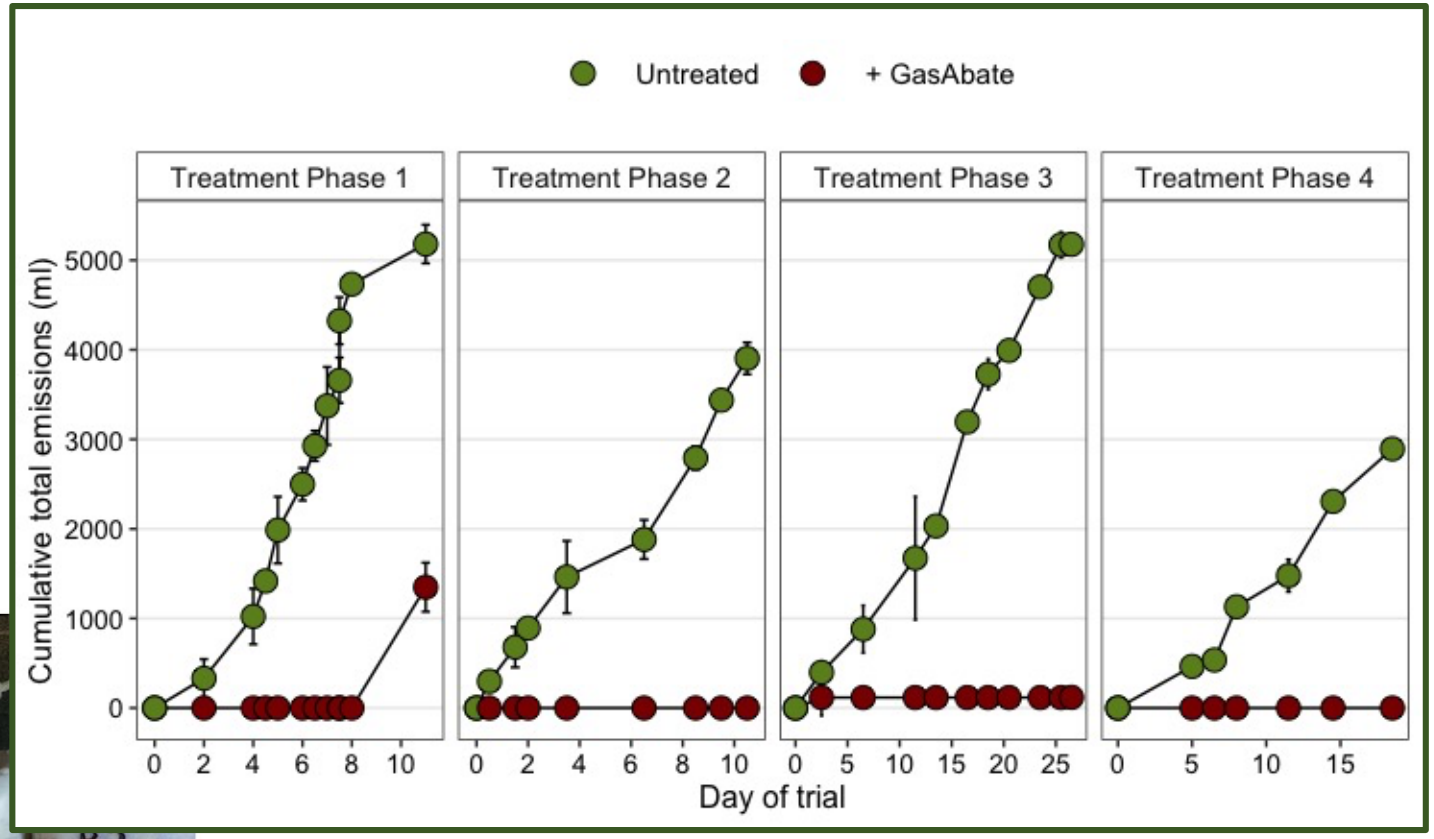




**Figure 2:** Medium-scale storage experiment

- **Temperature:** 15°C
- **Manure solids content:** 14%
- Four-treatment phases over 68-days.
- **Testing:** greenhouse gas (GHG) and ammonia ($NH_3$) emissions; slurry characteristics (pH, redox potential, dissolved oxygen, total ammoniacal nitrogen, dry matter.
- **Results (emission reductions):**
  - ✓ **Total biogas:** untreated slurry (17.2 L) vs. treated (1.5 L): **92%**
  - ✓ **Methane ($CH_4$)… 88.6%**

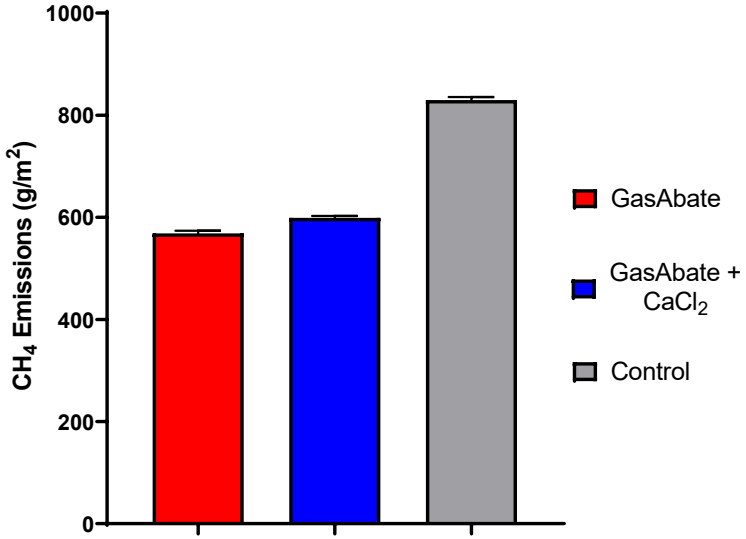
# Larger-scale trial: Teagasc, Johnstown Castle

- June – September 2021
- 6 x 1m$^3$ units with 660L/792kg cattle slurry
- 13-week trial

Teagasc slurry storage facility during tank filling

Mesocosm filled with cattle slurry prior to beginning of experiment

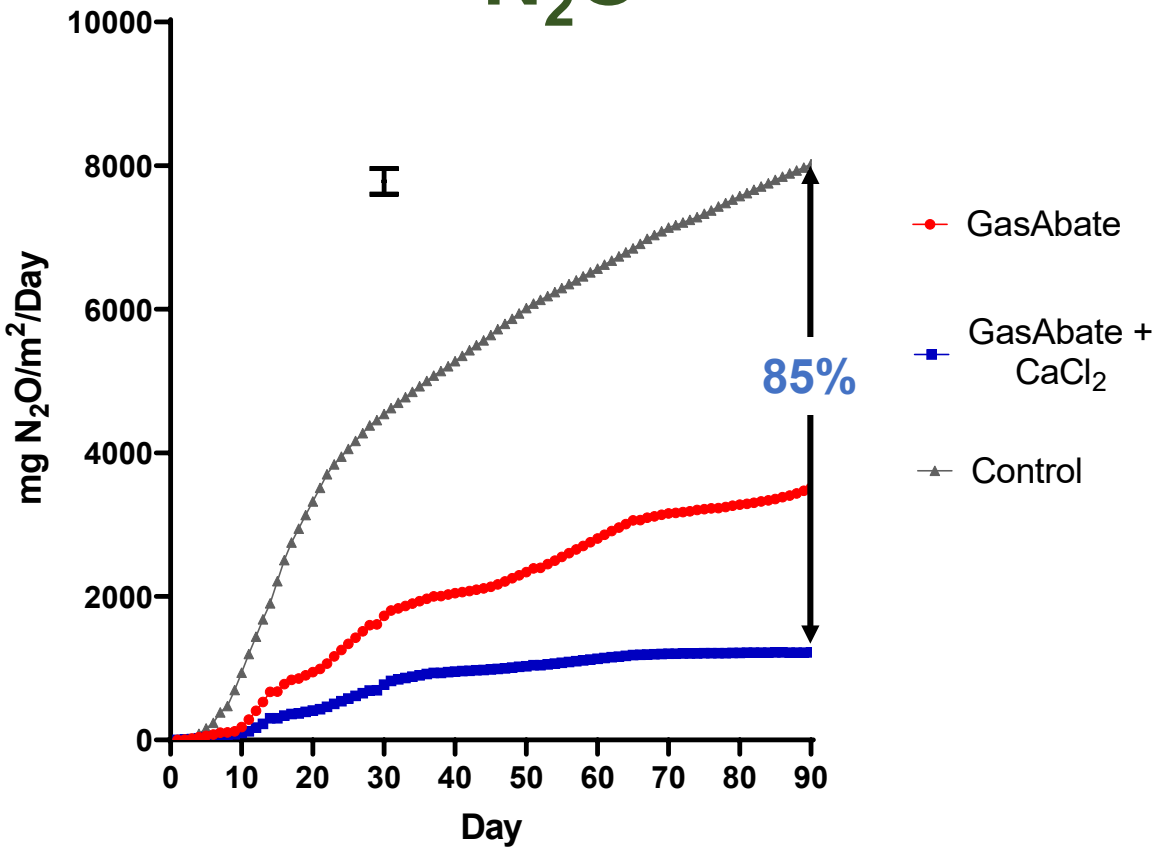
- **Testing:** greenhouse gas (GHG), ammonia ($NH_3$) hydrogen sulphide ($H_2S$) emissions; slurry characteristics (pH, redox potential, dissolved oxygen, total ammoniacal nitrogen, dry matter).
- **Results (<u>emission reductions vs. control</u>):**
  - ✓ **Hydrogen sulphide ($H_2S$) … 80%**
  - ✓ **Ammonia ($NH_3$) … 50%**
  - ✓ **Nitrous oxide ($N_2O$) … 85%**
  - ✓ **Methane ($CH_4$) … 40%**



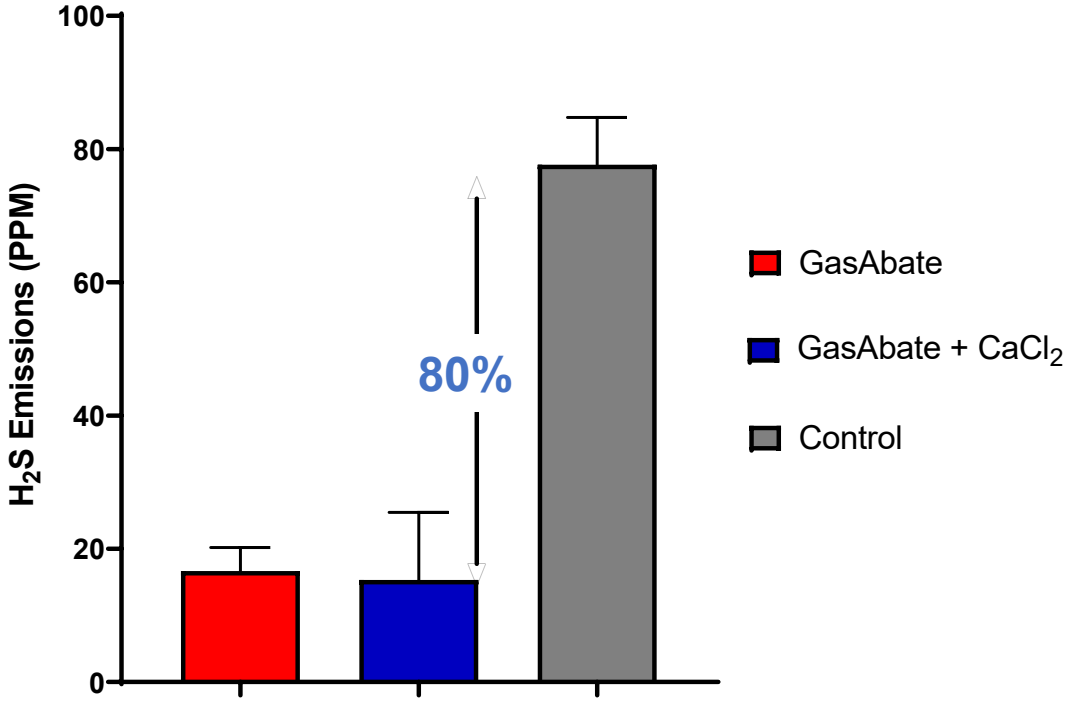

**(a) Hanna Multiparameter which is placed into the cattle slurry during treatment in order to measure real-time pH, redox potential, temperature and dissolved oxygen; (b) Mesocosm lid for testing GHG and ammonia; (c) Acid bubblers for scrubbing ammonia from sampled air for further analyses during dynamic chamber testing**

# Larger-scale trial: Teagasc, Johnstown Castle, Ireland

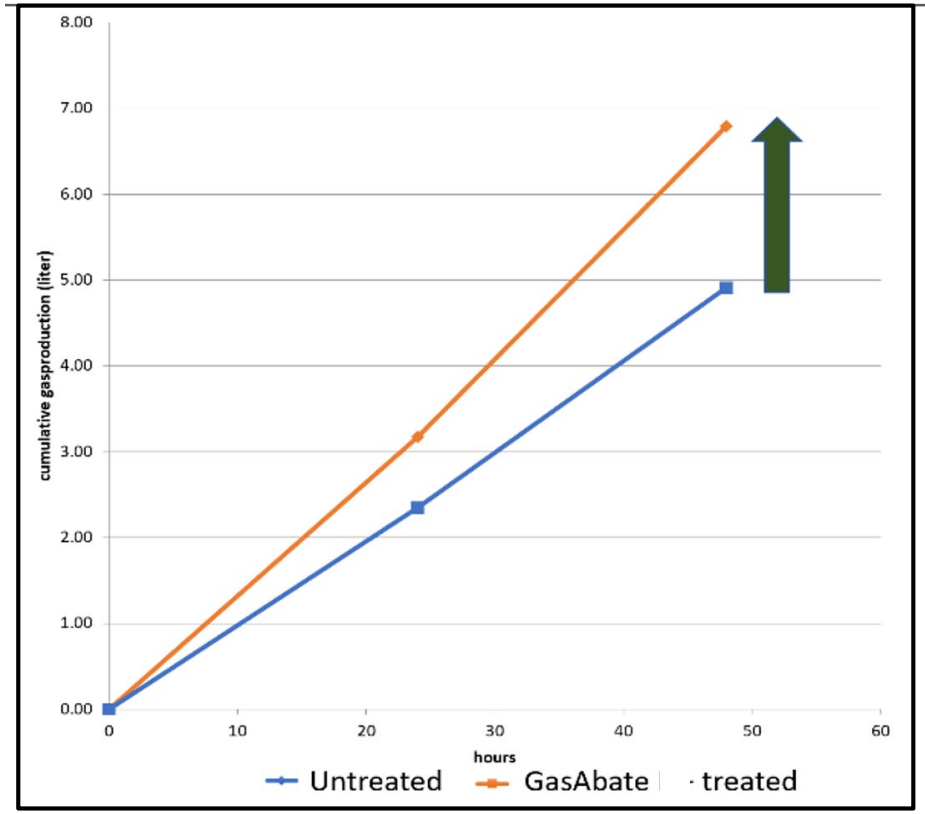
## $N_2O$




## $H_2S$



# Increased biogas output




- Independently verified AD trial on treated vs untreated cattle slurry.
- **38% increase in biogas output** compared to untreated (Technische Universitaet Kaiserslautern)

- Triplicate 10 L bioreactors (continuous AD)
- Co-fed cattle slurry and food production waste (grease trap)
- *Average daily $CH_4$ produced from co-digested cattle slurry over 150 days:*
  - ✓ **Untreated slurry: 122 ml vs. treated slurry: 143 ml methane/day**
  - ✓ **Average methane increase: 14% → 18% in final 40 days of trial**

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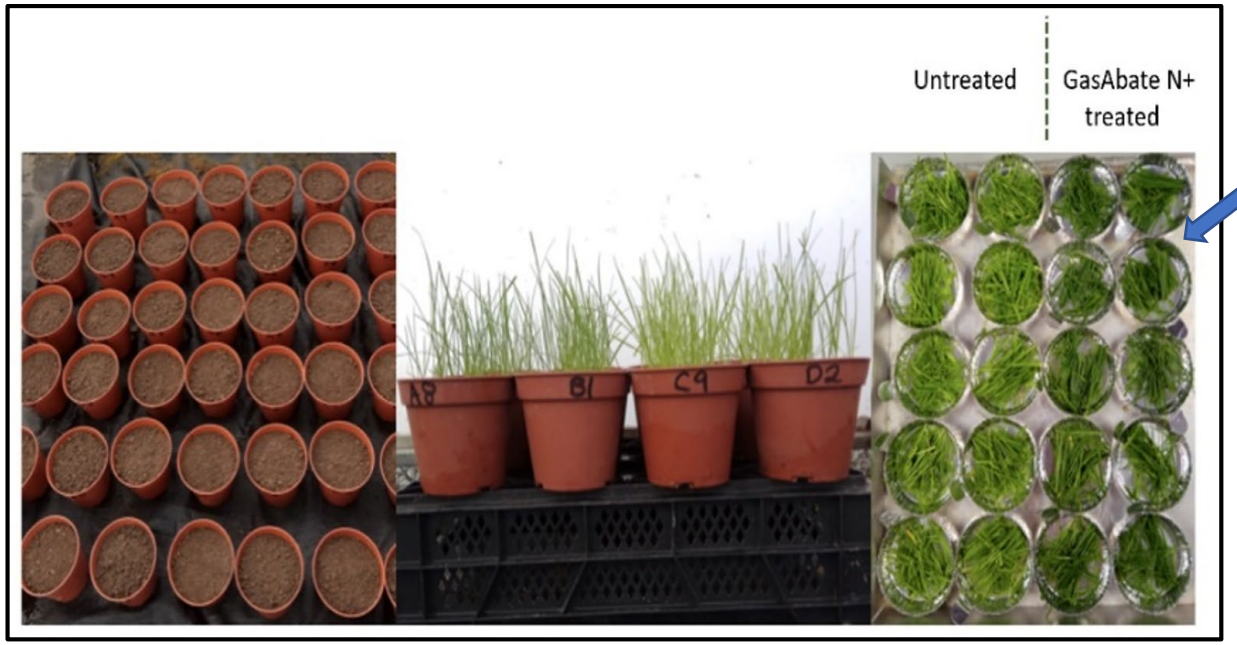
# Fertiliser potential of treated manure/digestate

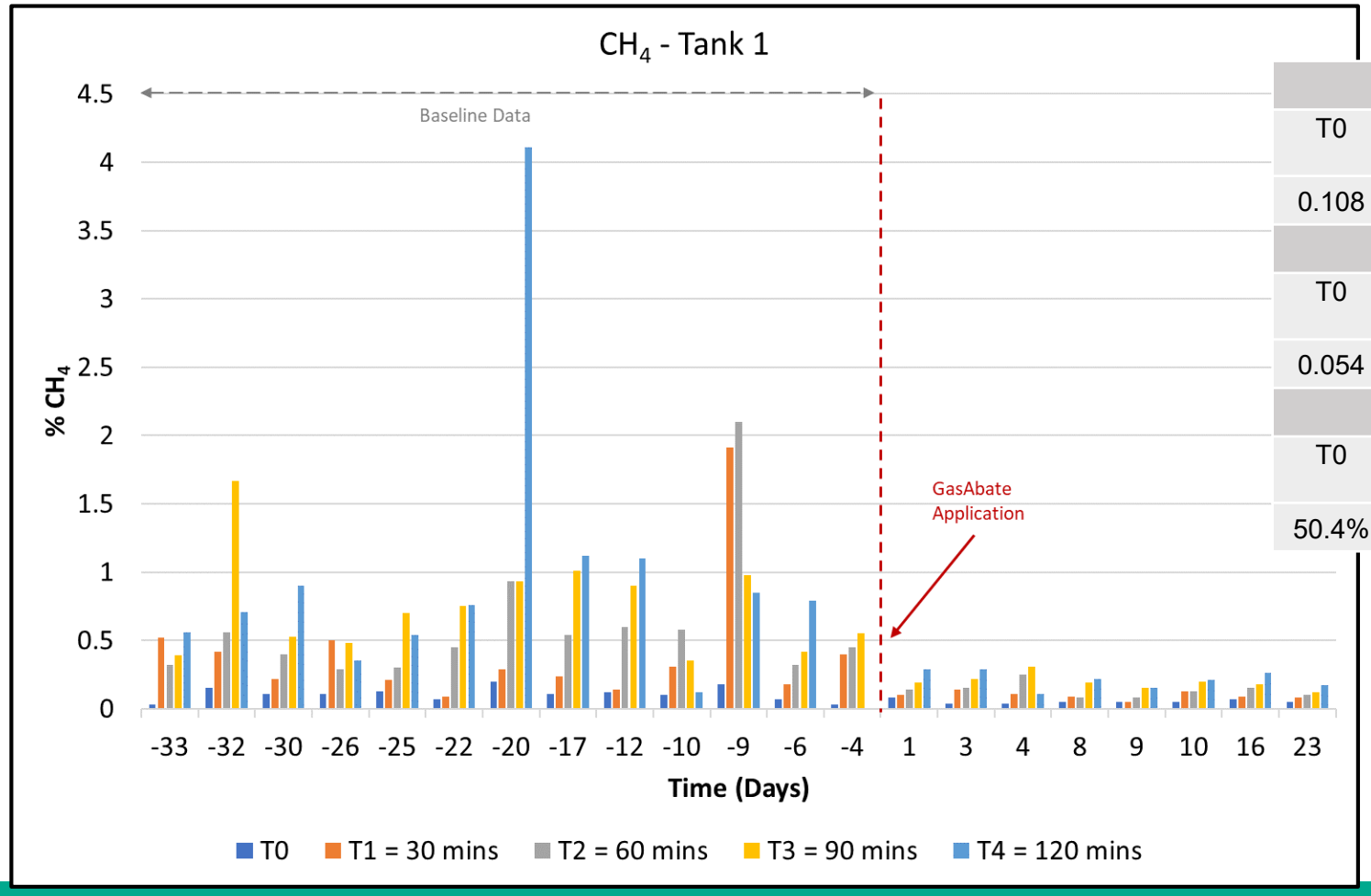



Enhanced Sulphur concentration in treated slurry leads to deeper green samples.

- **Small-scale agronomic pot trials** – perennial ryegrass treated with untreated or GasAbate treated manure.
- Treated grass **~15% increase in dry matter**
- Grass harvested at week 3 – **enhanced sulphur concentration in treated slurry (right)**.
- **Reference (Teagasc – improved N utilisation from S supplementation):** Aspel, C et al, J.PlantNutr.SoilSci.2022;1–12

# Demonstration-scale trial: Commercial Dairy Farm, Ireland

- 220 cows
- 3 tanks
- 485 – 590 $m^3$ slurry in total




| $CH_4$ Average pre-treatment | | | | |
|---|---|---|---|---|
| T0 | T1 = 30 mins | T2 = 60 mins | T3 = 90 mins | T4 = 120 mins |
| 0.108 | 0.418 | 0.603 | 0.743 | 0.993 |

| $CH_4$ Average post-treatment | | | | |
|---|---|---|---|---|
| T0 | T1 = 30 mins | T2 = 60 mins | T3 = 90 mins | T4 = 120 mins |
| 0.054 | 0.099 | 0.135 | 0.195 | 0.213 |

| $CH_4$ Average % reduction | | | | |
|---|---|---|---|---|
| T0 | T1 = 30 mins | T2 = 60 mins | T3 = 90 mins | T4 = 120 mins |
| 50.4% | 76.4% | 77.6% | 73.8% | 78.6% |

# Climate Impact Forecast: 2,000 cow intensive farm in Germany

**Model:** 2,000 intensive cattle German farm with an AD onsite for electricity (100% used on-site) and heat (50% used on-site) production. The farm has a use for the digestate from AD for use as a fertiliser.

**Climate Impact includes:**

+ GasAbate production
+ Transport of GasAbate components
- Fertiliser transport
- Emissions from slurry management
+ Emissions from GasAbate pumps
+ Biogas output from AD of GasAbate-treated manure
+ Ammonium-content of digestate following AD of GasAbate-treated manure

**3,700 potentially tradable carbon credits**

# PIGergy …*A novel means of unleashing the energy potential of pig waste*

**GlasPort Bio** wanted to expand our additive reach to an animal other than **cattle**

**677 million pigs** worldwide;

**2nd largest livestock group emitting greenhouse gases**

**ERA-Net Smart Energy Systems: awarded 2019**

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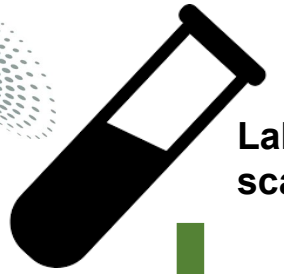
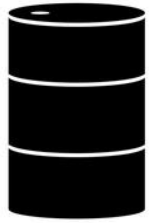
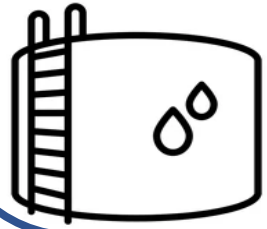


**Laboratory-scale trials**

**Medium-scale trials**



**Larger-scale, on-site trials**



**Carbon-enhanced manure feedstock**


**Biogas/BMP**

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Smart Energy Systems ERA-Net

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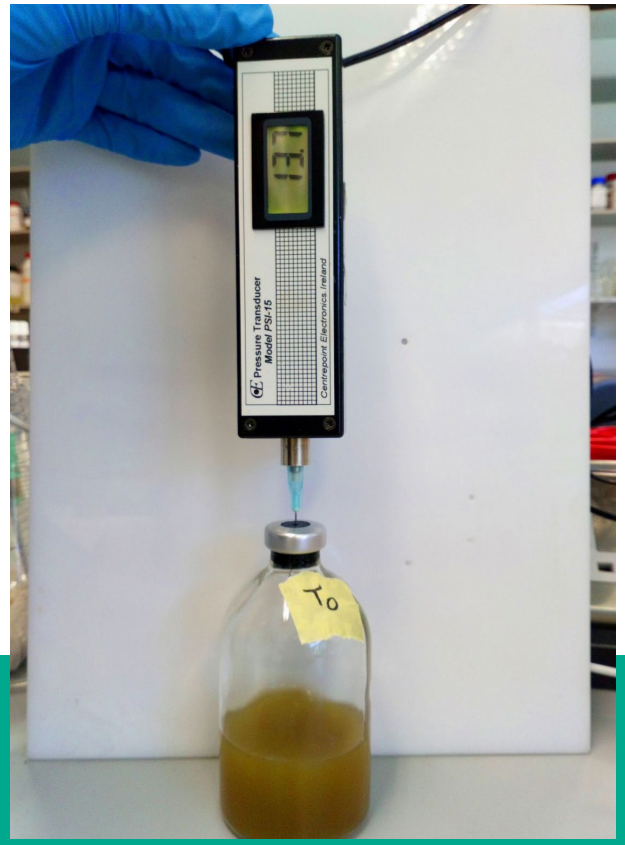
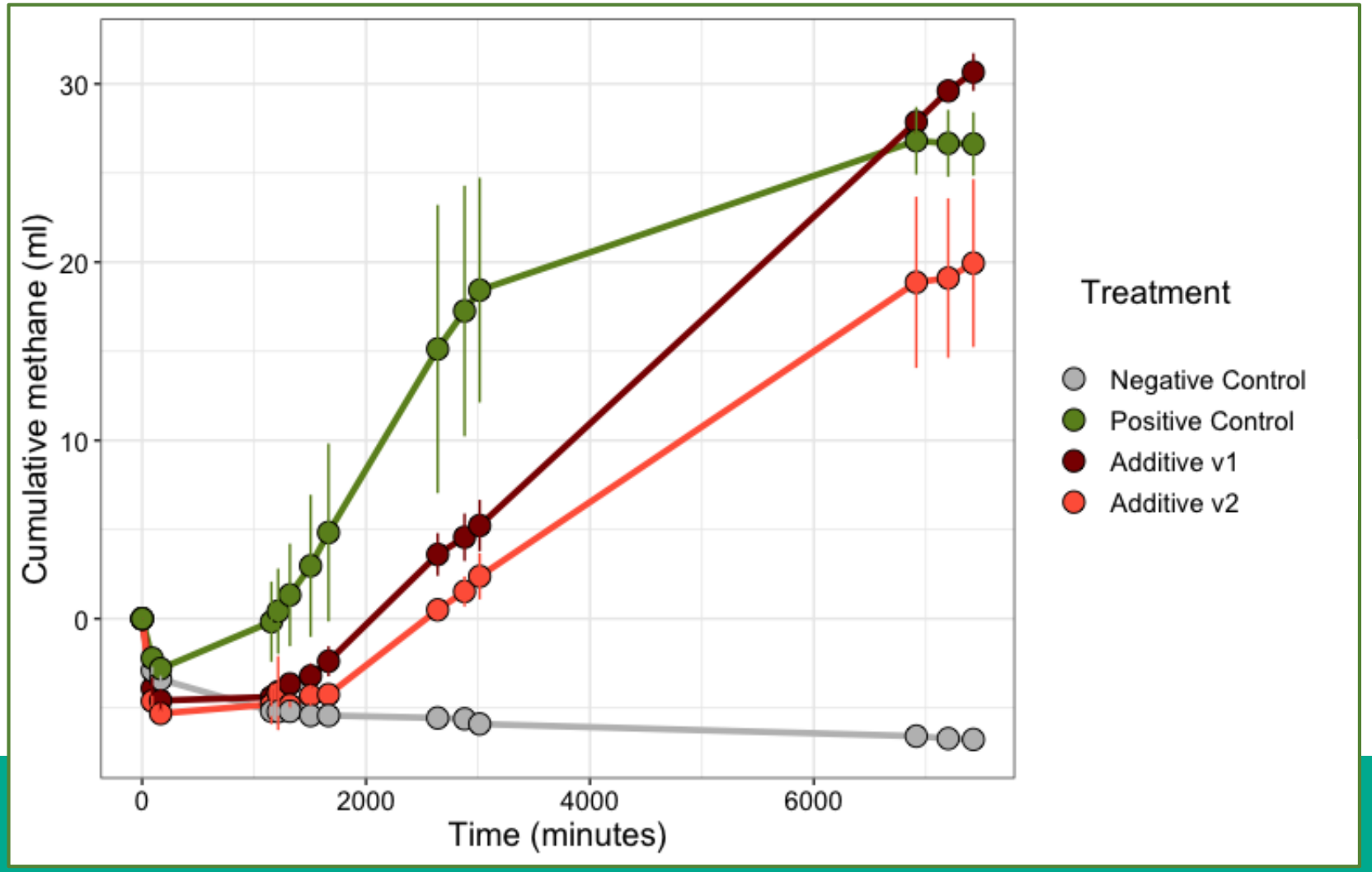
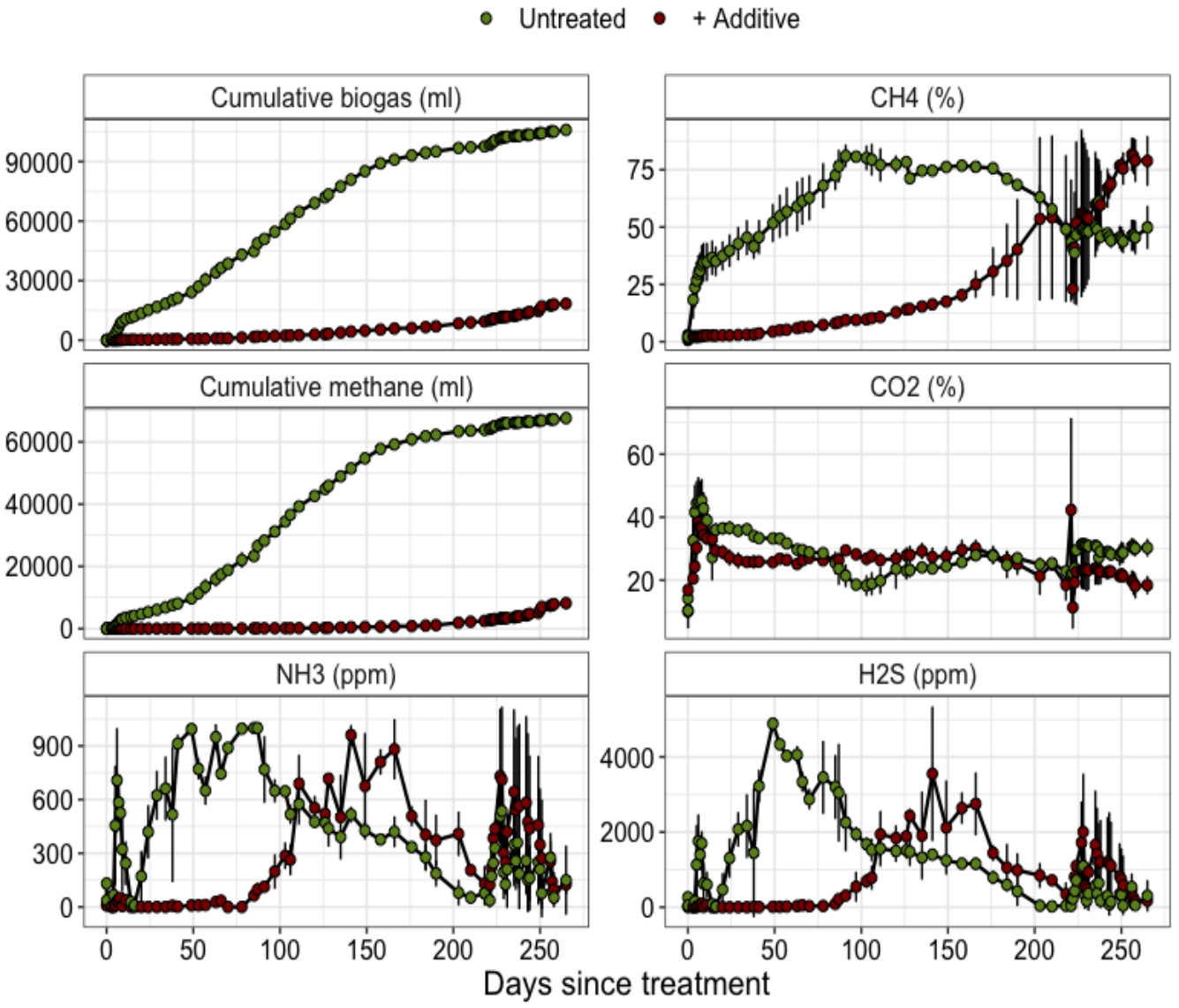
# Laboratory-scale trials

- Small-scale trials (10g - 1kg)
- Varying concentrations of product used.
- Methanogenic activity assessed.



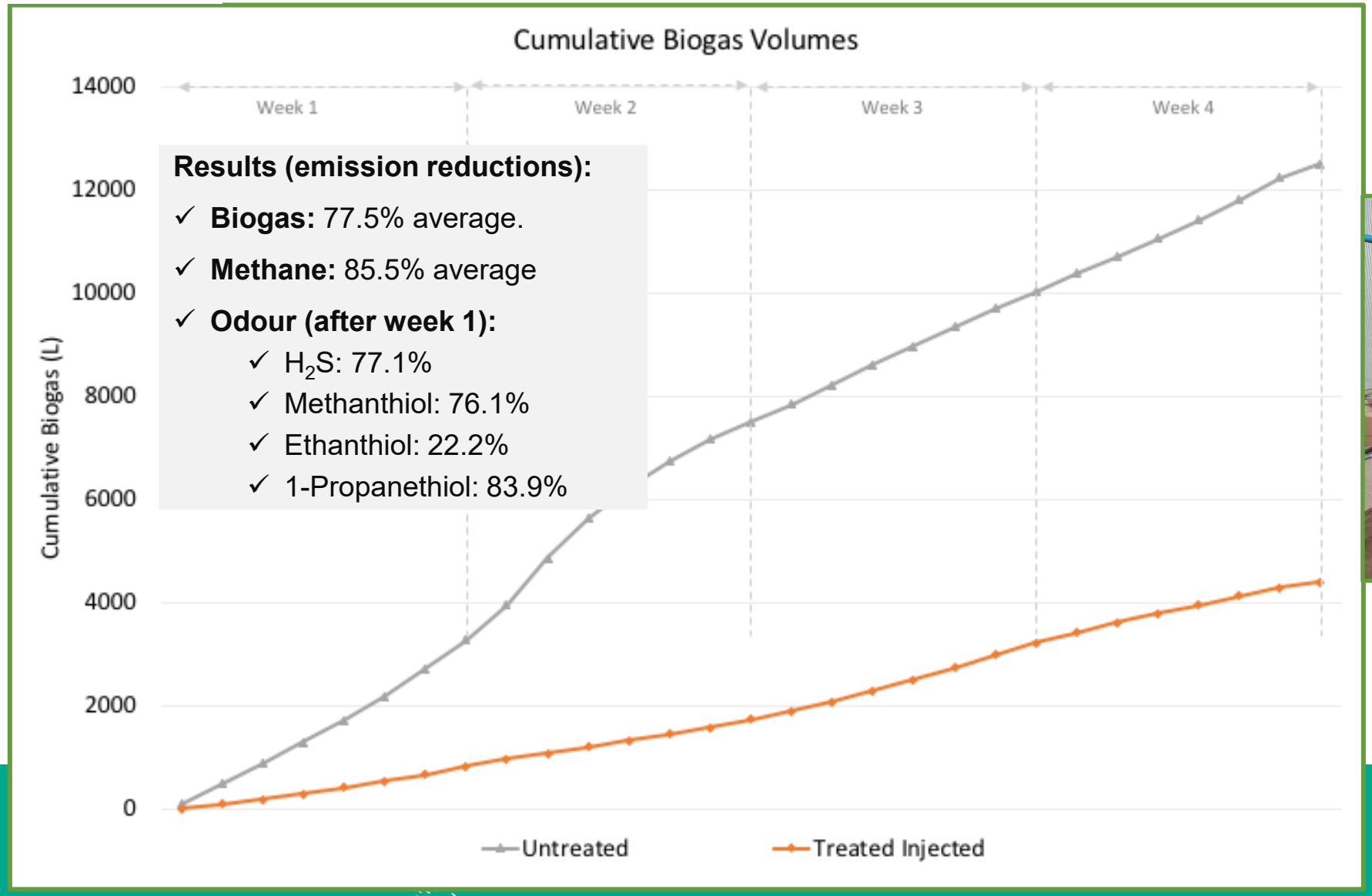
# Medium-scale trials




- 16kg slurry scale
- 250-day period.
- Near cessation of gaseous production observed in treated vs. untreated slurry.

- **Testing:** greenhouse gas (GHG) and ammonia ($NH_3$) emissions; slurry characteristics (pH, redox potential, dissolved oxygen, total ammoniacal nitrogen, dry matter.
- **Results (emission reductions):**
  - ✓ **Biogas… 90%**
  - ✓ **Methane ($CH_4$)… 96%**
  - ✓ **Ammonia ($NH_3$)… 43%**
  - ✓ **Hydrogen sulphide ($H_2S$)… 60%**

# Larger-scale trials




**Results (emission reductions):**

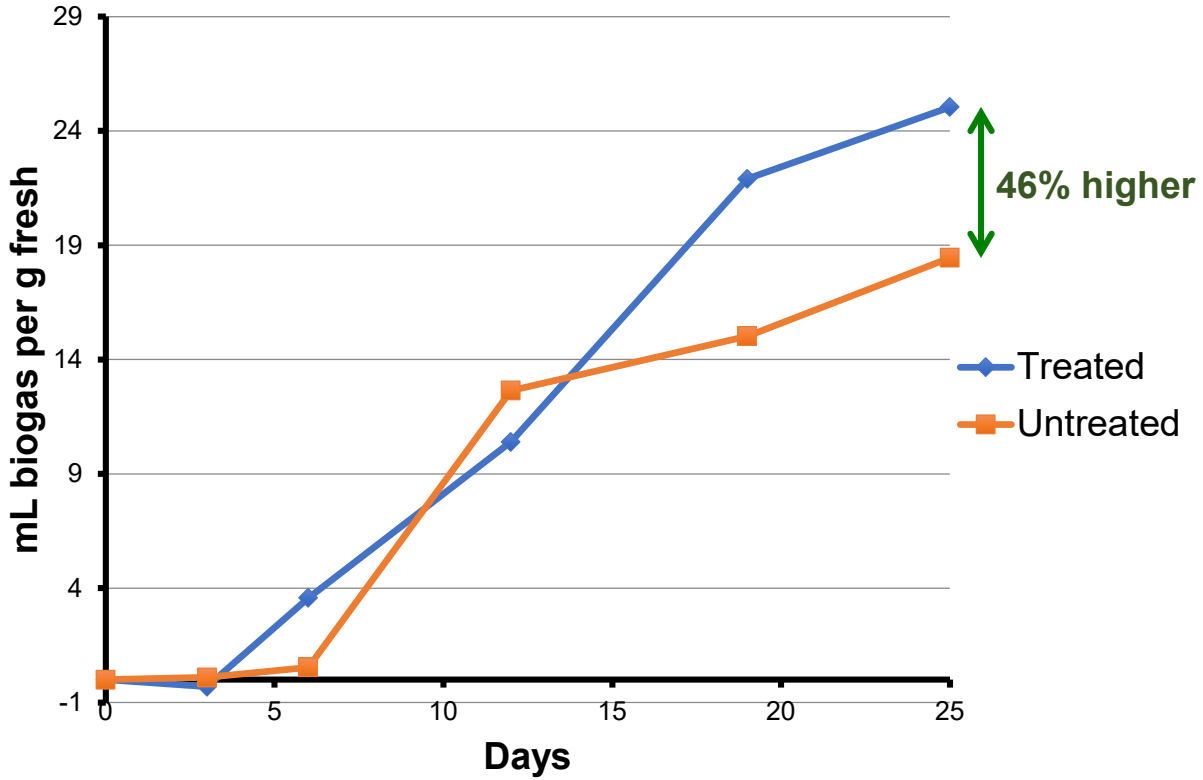
- ✓ **Biogas:** 77.5% average.
- ✓ **Methane:** 85.5% average
- ✓ **Odour (after week 1):**
  - ✓ $H_2S$: 77.1%
  - ✓ Methanthiol: 76.1%
  - ✓ Ethanthiol: 22.2%
  - ✓ 1-Propanethiol: 83.9%

- 6 x 1m$^3$ units with 770 kg pig slurry
- 13-week trial

green generation

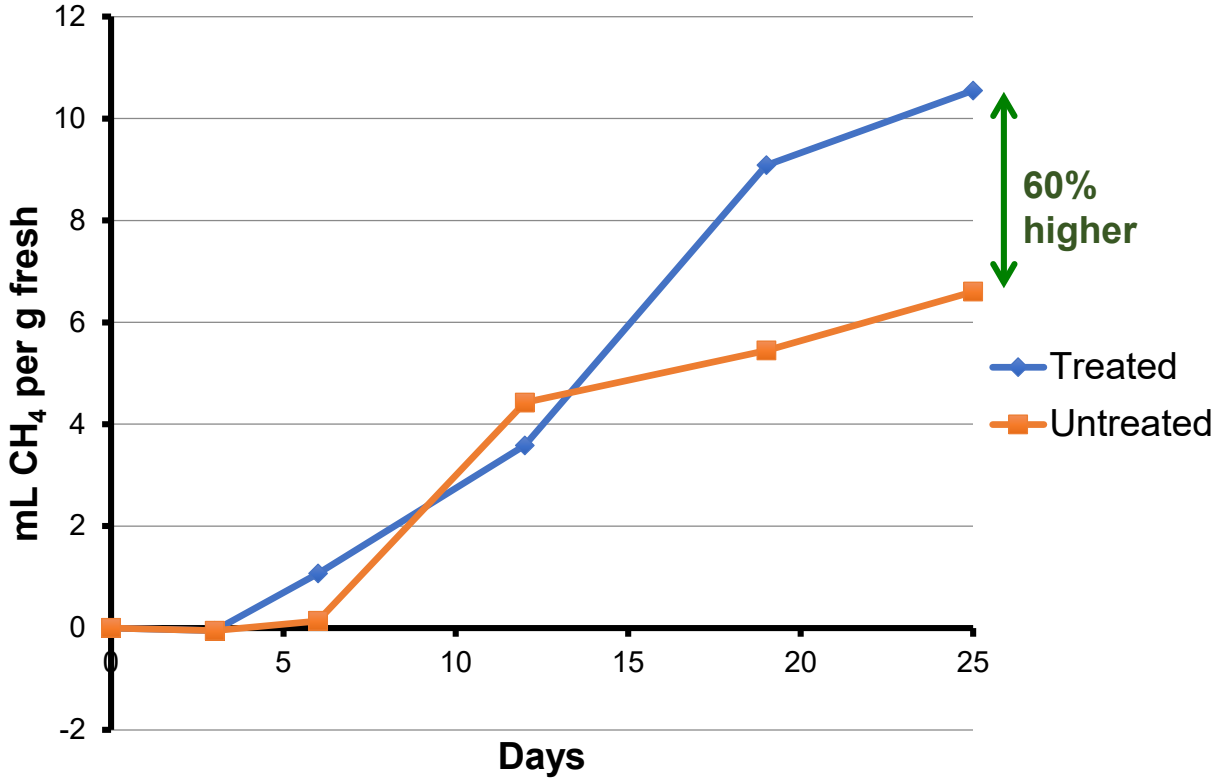
# Biogas/BMP per gram fresh weight

## Cumulative biogas per g fresh




**Treated v Untreated: 46% higher**
**Minus number because blank produced more than trial in first few days**

## Cumulative $CH_4$ per g fresh




**Treated v Untreated: 60% higher**
**Minus number because blank produced more than trial in first few days**

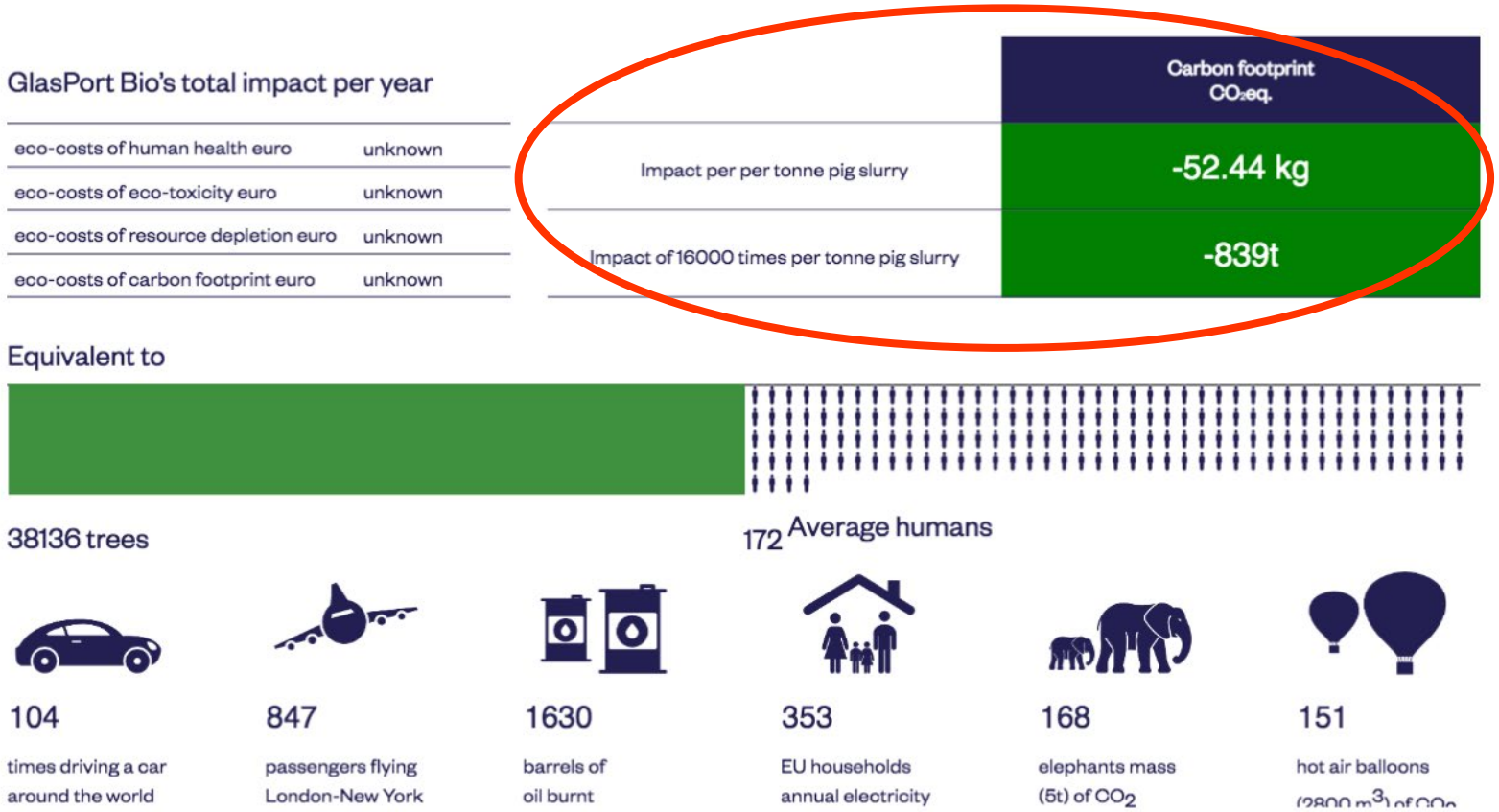
# Climate Impact Forecast: 3,200 pigs on an Irish farm

**Model:** 3,200 pig Irish farm generating biomethane on-site. The farm has a use for the digestate from AD for use as a fertiliser.

**Climate Impact includes:**

+ GasAbate production
+ Transport of GasAbate components
- Fertiliser transport
- Emissions from slurry management
+ Emissions from GasAbate pumps
+ Biomethane using GasAbate slurry
+ Ammonium-content of digestate following AD of GasAbate-treated manure

**839 tonnes potentially tradable carbon credits**



# GlasPort Bio research

- **GEBTech Plus - SEAI RD&D 2022-2025: pig treatment to large-scale**.
  - ✓ Industry-academic partnership to advance GasAbate Swine to market launch in 2024.
  - ✓ Commercial-scale operation on-site at Ashleigh Farm's pig farm and AD plant in Waterford.

- **GasAbate N+ - EIC project (2020-2023): cattle treatment to market**
  - ✓ Completion of remaining pre-commercial and technology validation work
  - ✓ Large-scale trials in Ireland and abroad
  - ✓ Market launch in 2024.

Horizon 2020
This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101010197

# Thank you all!