Sinead Waters

Ruminant Methane Mitigation Conference

Art of the possible by 2030 and beyond

#MethaneBFS23

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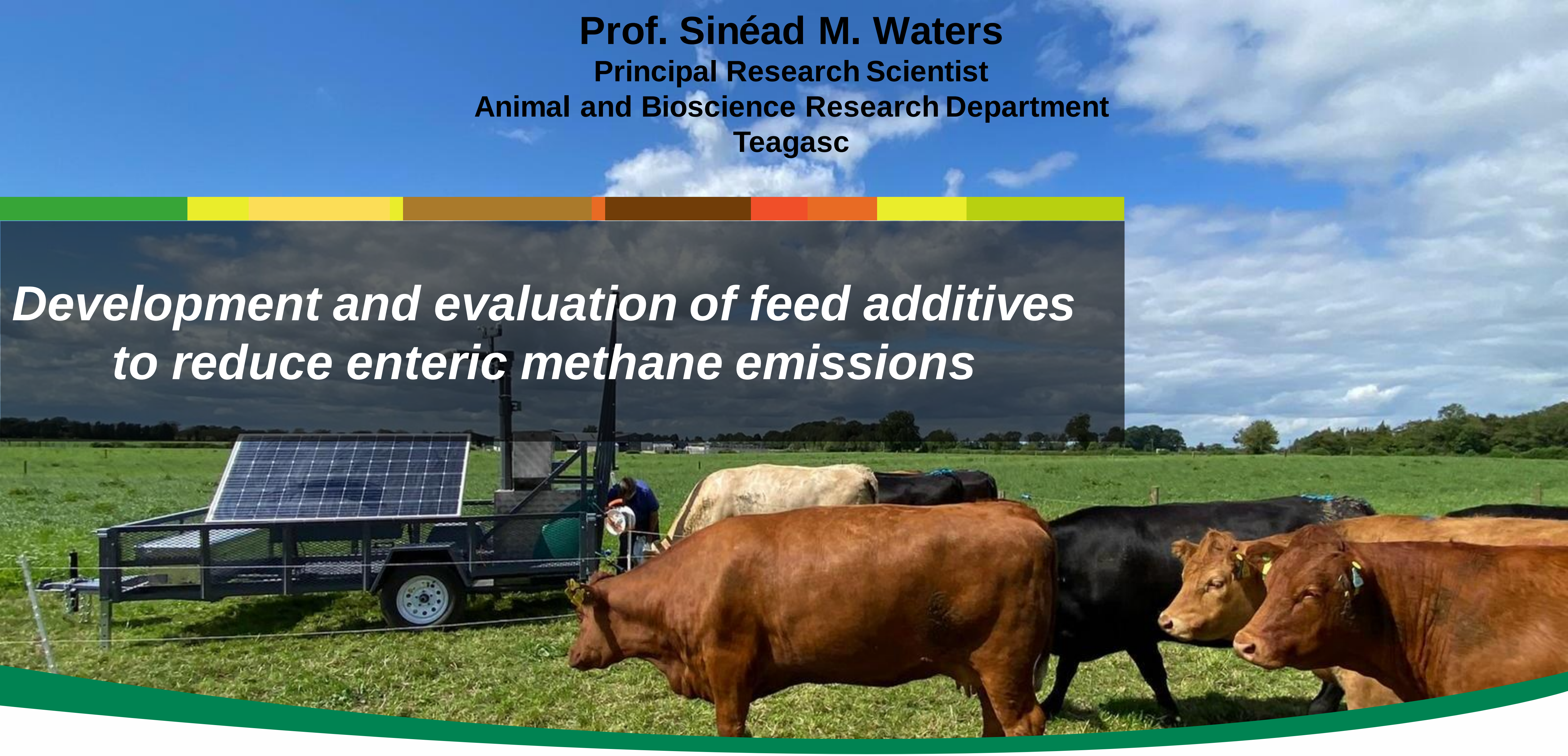
Development and evaluation of feed additives to reduce enteric methane emissions



BSAS Methane Mitigation Conference
27th November, 2023
Queen's University Belfast

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Introduction

- **Agriculture** is responsible for 37% of Ireland's GHG emissions

- **Methane** is a potent greenhouse gas (GHG)

- **Methane** accounts for ~72% of Irish Agri-GHG emissions (EPA, 2023)

- **Ireland: Climate Action and Low Carbon Development Bill 2021**
  - 25% reduction in Agri-emissions by 2030
  - 10% reduction in ruminant derived methane

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How are we going to reduce methane emissions from agriculture?

- Improved management practices – Farm efficiency
- **Teagasc MACC**
  - Reducing age of slaughter
  - Reducing age of first calving

- **Grassland management**
  - Significantly lower methane in pasture based settings

- **Breeding strategies** (Teagasc and ICBF)
  - Enhance feed efficiency and lower methane
  - Longer term strategy

- **Feed additives**

Marginal Abatement Cost Curve 2023

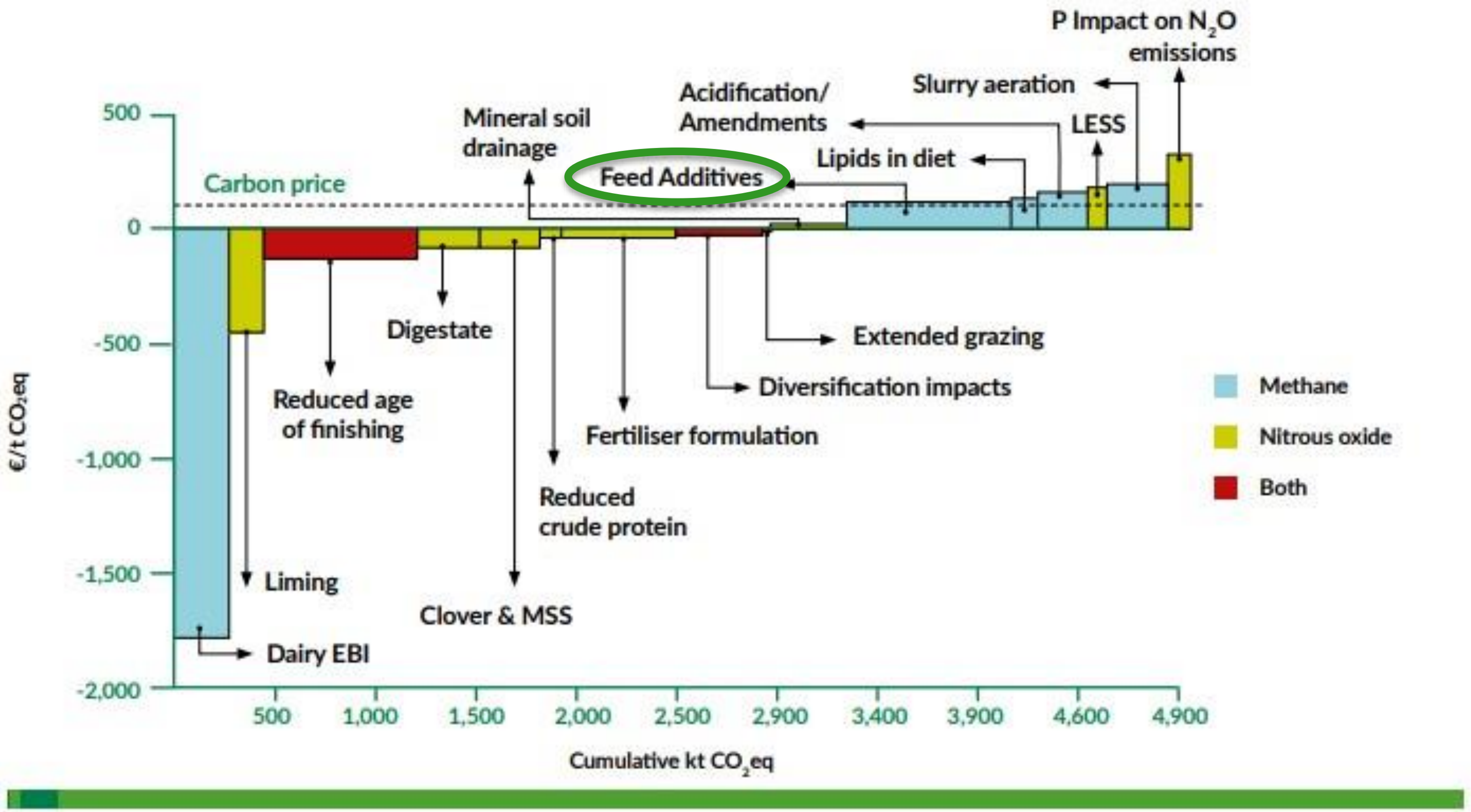

Figure 2: Agricultural MACC for the expected animal numbers (Scenario 1) with a high level of measure adoption (Pathway 2) for methane, nitrous oxide and both gases. The dashed line indicates a Carbon Price of €100 per tonne CO_2eq.

- **Feed additives** can reduce methane emissions by 788kt CO2 eq per year by 2030

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International reports

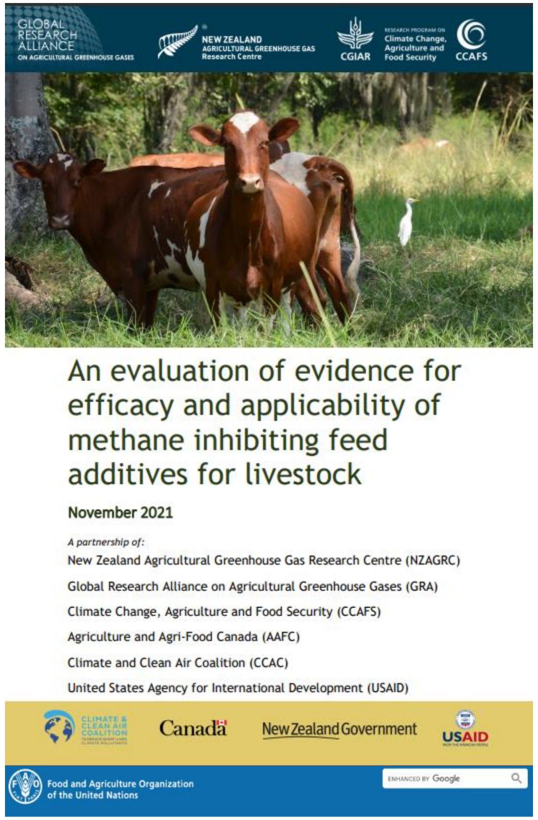
Dr Roger Hegarty NZAGRC

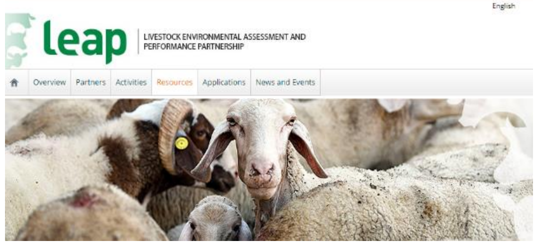
- Only two of the additives evaluated delivered over 20% mitigation
  - ➢ **Bovaer** (3-NOP)
  - ➢ **Asparagopsis** (red algae)
  - ➢ SilvAir - Nitrate (~10% reduction)

- **Constraints with feed additives:**
  - ➢ 'Insufficient evidence of a **co-benefit** of increased production'
  - ➢ Rely **on additives mixed into a total mixed ration** – fed continuously

- **TAG FAO LEAP Partnership 2022**

'more research is needed to develop, adapt, and evaluate anti-methanogenic strategies for grazing systems' (Beauchemin et al., 2022)





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What do we want from a feed additive?

- **Must Have**
  - Consistent methane reduction potential
  - Mechanism of delivery to the animal
  - Capable of counting in the national inventory
  - No food safety/residue implications
  - No negative performance effects and palatability
- **Desirable**
  - Low cost
  - Increased performance benefits
  - Natural origin
  - Potential for combination with other solutions

‘METH-ABATE’: Development of novel farm ready technologies to reduce methane emissions from pasture based Irish agricultural systems

- **Feed additives** to mitigate methane emissions
    - Bovaer (3-NOP)
    - Seaweeds and seaweed extracts
    - Lipids (e.g., linseed oil, olive feed)
    - Novel oxidising methane inhibitors (RumenGlas)
    - Commercial products

- Monitoring their effects on animal productivity
- Formulations for **slow release** options at pasture
- **Nutritional and toxicological** composition of meat and milk - **no residues**
- **Life Cycle** Analysis (LCA) and **farm level cost effectiveness**

Queen's University Belfast | National University of Ireland, Galway / Ollscoil na hÉireann, Gaillimh | afbi Agri-Food & Biosciences Institute | An Roinn Talmhaíochta, Bia agus Mara / Department of Agriculture, Food and the Marine | Teagasc Agriculture and Food Development Authority

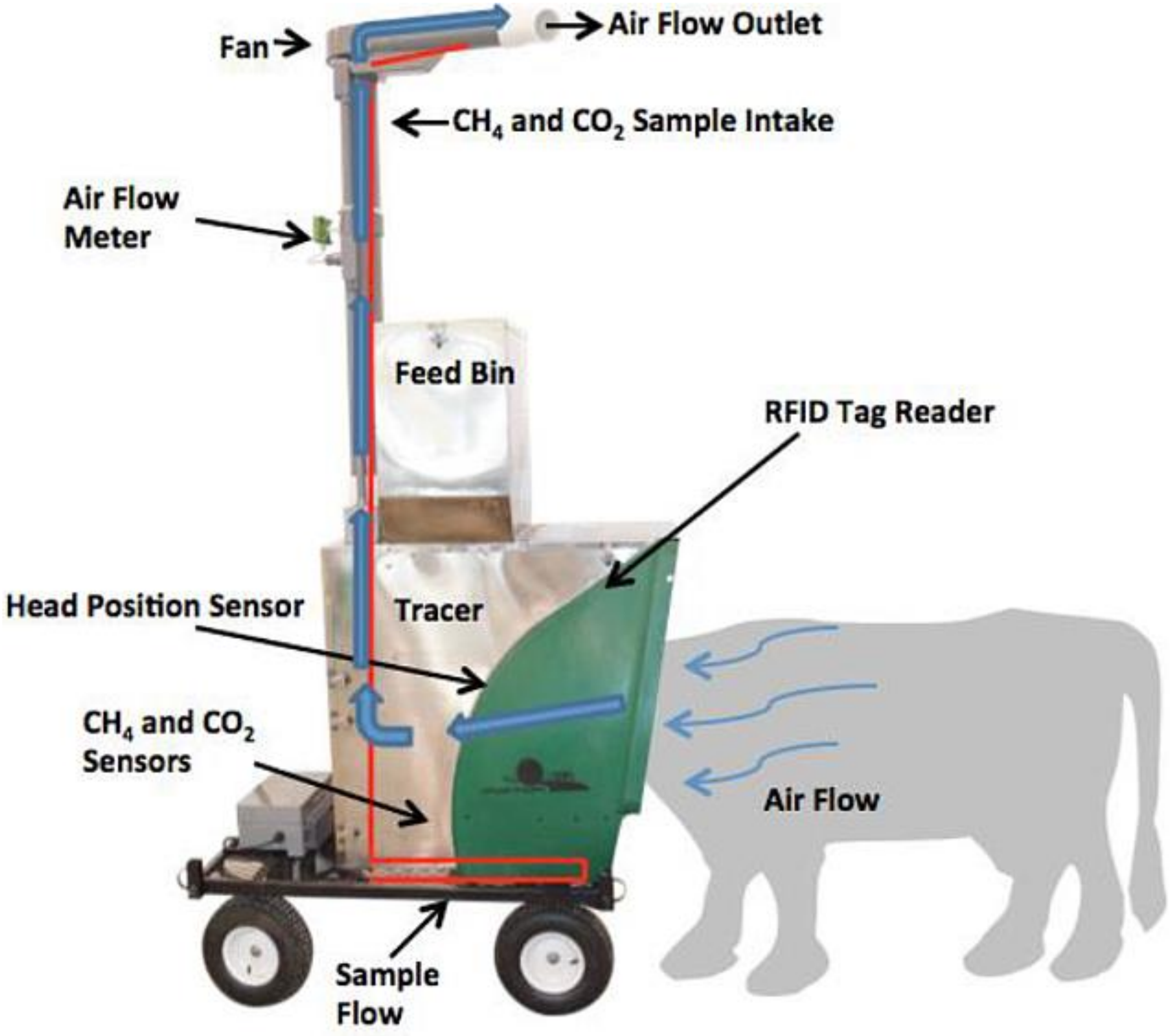
Screening candidates for methane mitigation

Feed additive	Change in methane emissions (%)
Oxidising methane inhibitors	-67%
Asparagopsis taxiformis	-68%
Ascophyllum nodosum	-36%
Brown seaweed extract	-15%
Olive feed extract	-26%

In vitro **RUSITEC system**

Roskam *et al*., 2022; O'Donnell *et al*.,2023

GreenFeed technology to measure methane



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Bovaer (3-nitrooxypropanol; 3NOP)

- Synthetic non-toxic compound, **3-nitrooxypropanol**
- Mean reduction of **30%** in methane
- **Mode of action** – limits the last step of the methanogenesis cycle
- Immediate reduction to CH_4 once fed
  - Emissions will increase once feeding stopped
- Challenge to incorporate into a **pasture based diet**
- **EFSA approved** in EU for feeding to dairy cattle
- **Cost**
  - €25.55 annually for beef cattle
  - €60.59 annually for dairy cows

DSM

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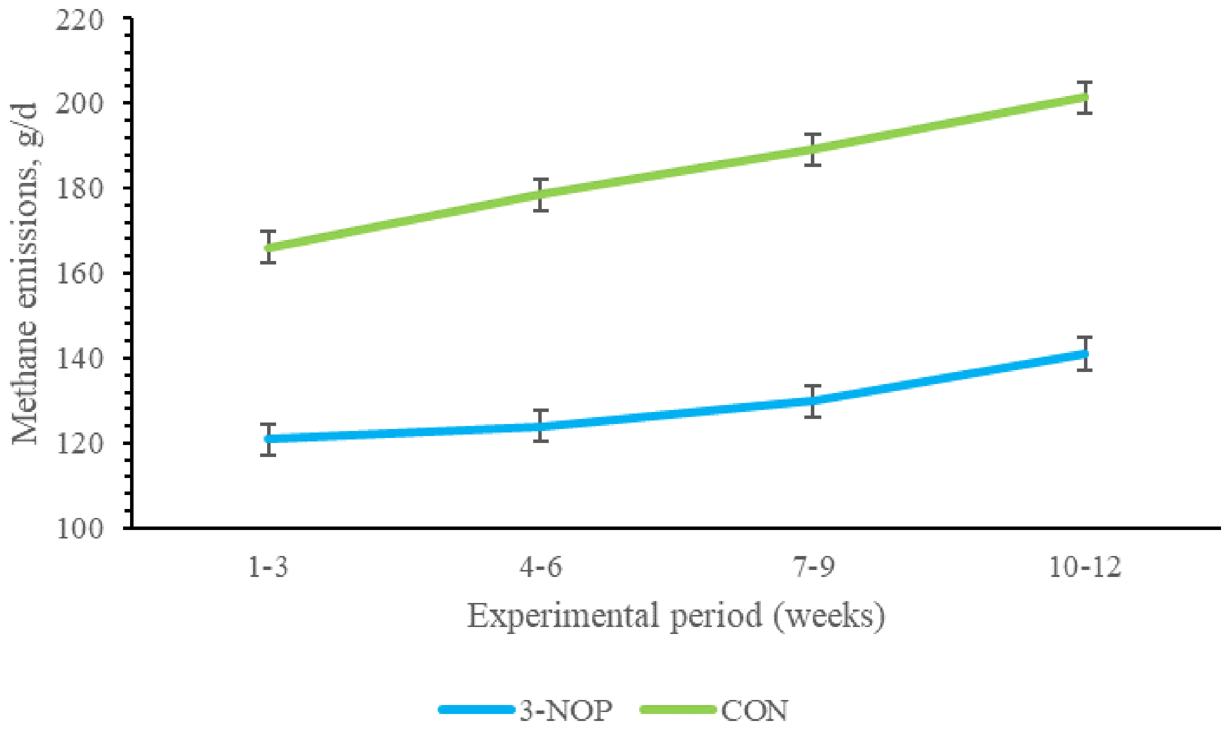
Bovaer (3-NOP) supplementation in young beef cattle

- Efficacy of 3-NOP in **growing beef cattle**
- DMI, daily methane output, daily live-weight gain



- No effect on DMI, ADG, feed efficiency
- Methane emissions ⇩30%

Kirwan *et al.*, 2023 JAS

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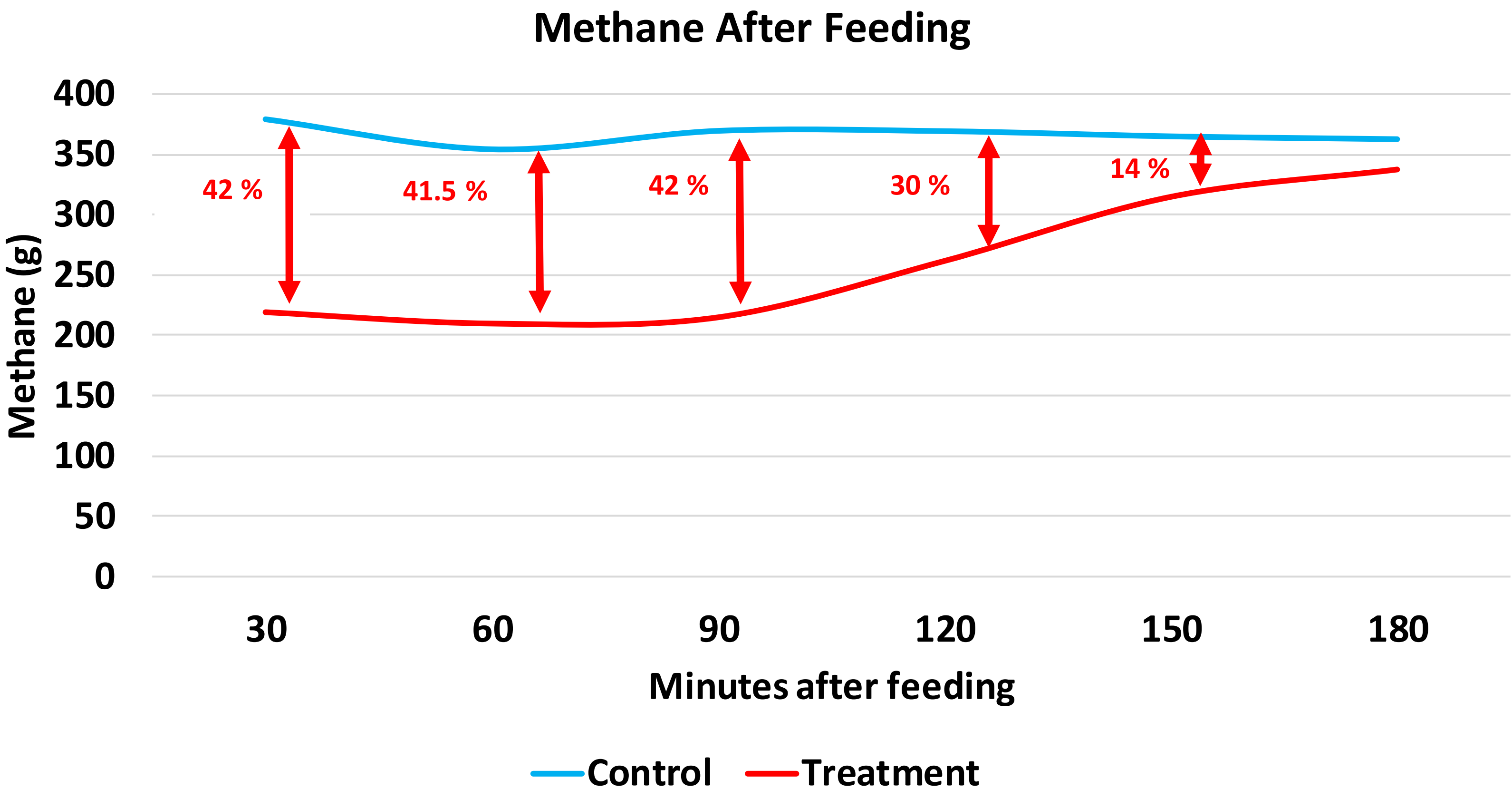
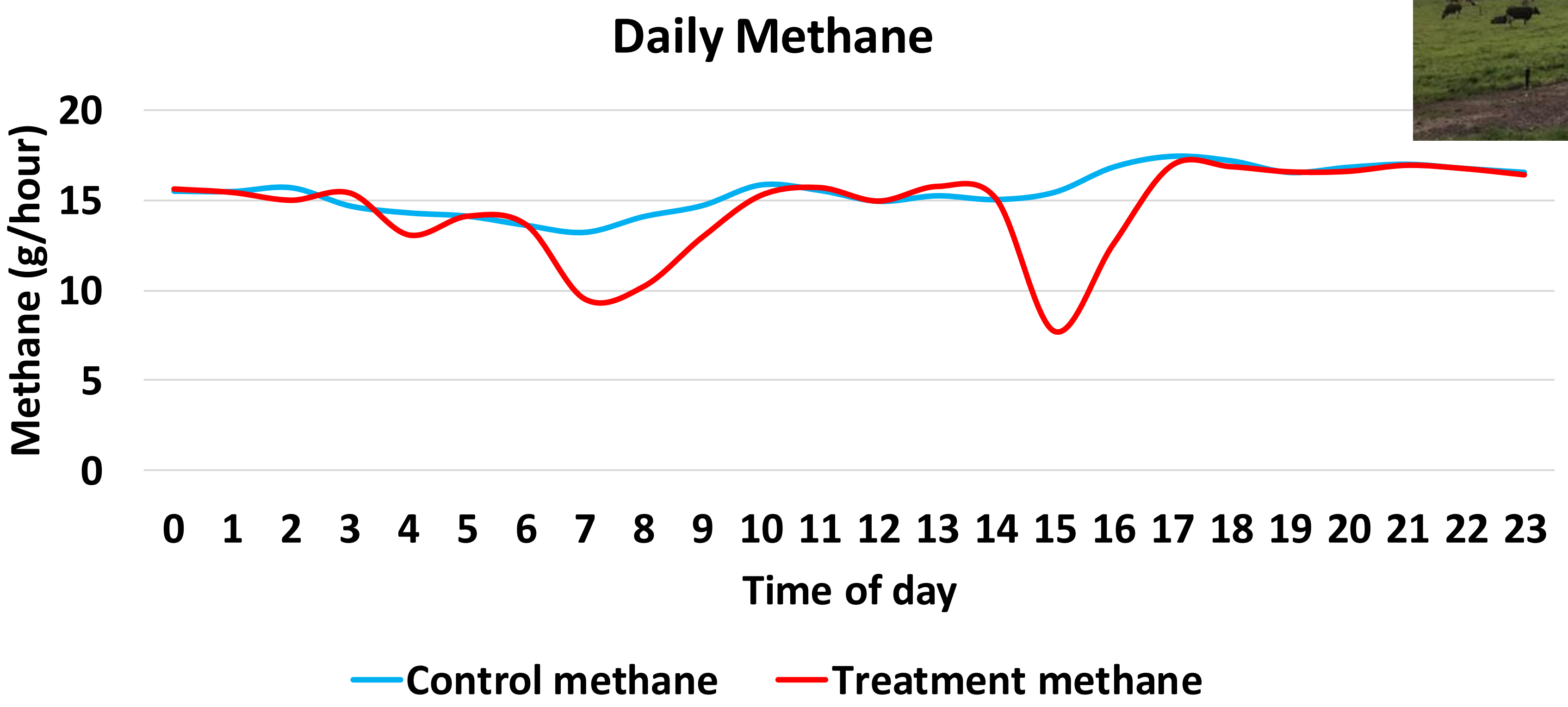
Bovaer supplementation in grazing dairy cows

~30% reduction in methane for 2.5 hours after feeding



Costigan *et al. In prep*

Bovaer supplementation in grazing dairy cows



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- Twice a day supplementation
- Overall **7% reduction** in methane emissions

Costigan ***et al. In Prep***

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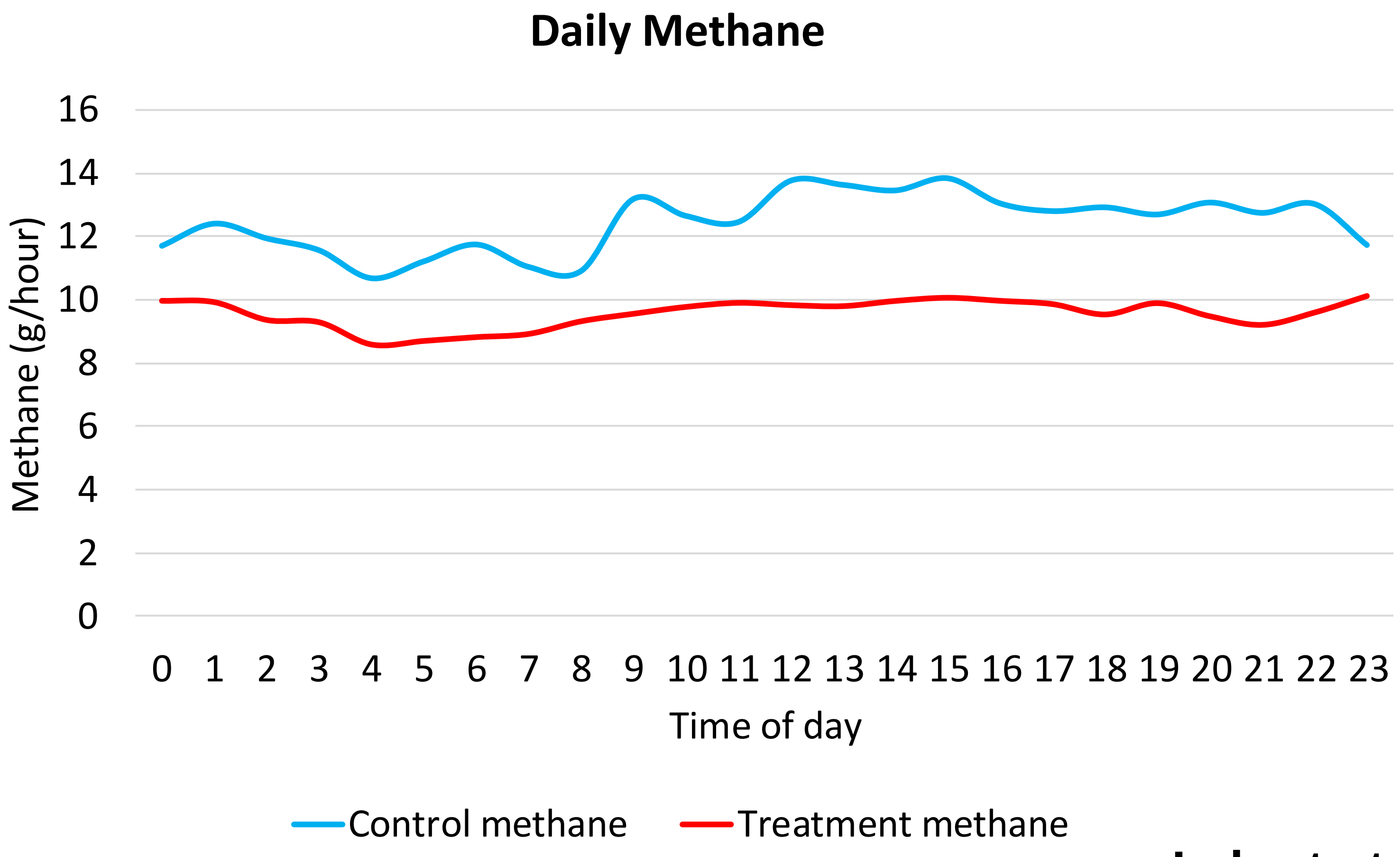
Bovaer supplementation in dairy cows during the dry period

- Mixed throughout feed using a **diet feeder**
- **22% reduction** in methane
- No significant effect on performance



VistaMilk

Lahart et al., In Prep.

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Supplementation with lipids

- Dietary supplementation of dairy cross beef bulls with **linseed oil** (4%) reduced methane emissions by 18%
  - **DMI (↓ 5%)** tended to be reduced

- Dietary supplementation of Charolais heifers with:
  - Rapeseed cake (14.5%) reduced CH_4 by **7.87%**
  - Rapeseed oil (2.5%) reduced CH_4 by **8.05%**
  - No reduction in intake or diet digestibility

- Costly to add to the diet
  - 1t rapeseed oil ~€450 → €60/head/year
  - 1t linseed oil ~€2,500 → €325/head/year

Folliard *et al*. In Preparation

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Supplementation with seaweeds

- Global seaweed production - 30.4 m t FW
  - Impractical for transport
  - Requirement to identify and extract bioactive component for reduction in methanogenesis

- **Red seaweeds** - *Asparagopsis spp.*
  - ***A. taxiformis****:* ↓ CH_4 by >80% *in vitro*, in sheep and in beef

Issues:

- ***Tropical species***: not native to Ireland, lack of consistency and high cost
- ***Bromoform***: Bioactive in *A. taxiformis* is a known carcinogen
- Environmental concerns – ozone depletion

Supplementation with seaweeds

- **Brown seaweeds**
  - Indigenous, plentiful, inexpensive
  - Main bioactive – phlorotannin
  - High protein
  - Inconsistent anti-methanogenic results

- *Ascophyllum nodosum (2%)*
  - No effect on CH_4 in sheep
  - Reduced methane by 4% in beef cattle

- *A. nodosum* extract (2%)
  - 9% reduction in CH_4 in sheep
  - 7% reduction in CH_4 in beef

SEASOLUTIONS

Roskam *et al*. In Prep

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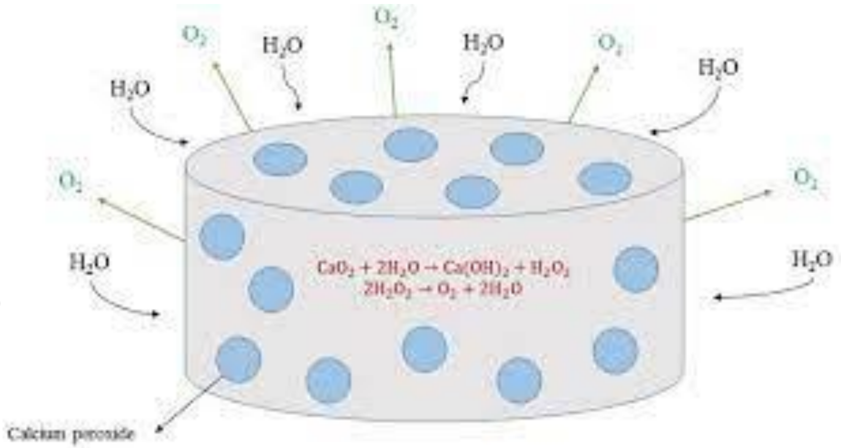
Oxidising methane inhibitors



- **What are they?**
  - ***Peroxide based compounds*** routinely used in human food
    - Calcium peroxide (CaO_2) - **RumenGlas**
  - Based on the control of rumen oxidation-reduction potential (ORP)

- **Mechanism of action?**
  - 1. Inhibit methanogens
    - » ↑ **ORP** to favourably alter rumen fermentation pathways and suppress methanogenesis
  - 2. Divert electrons from H_2 → trap energy in biomass

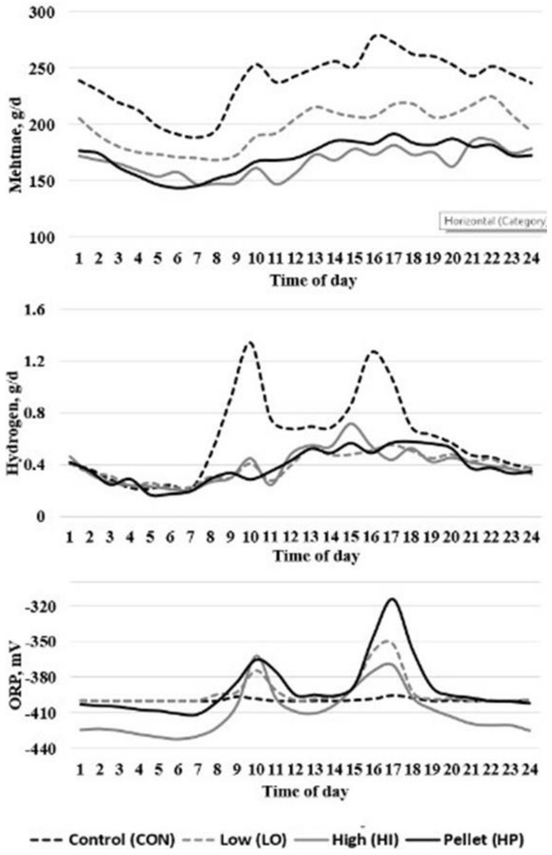
- **Cost?**
  - €0.09-0.13 per head per day

RumenGlas supplementation in beef cattle

Reduction in methane by 17% (low dose) and 28% (High dose) vs CON

- **H_2** ↓ by 32-36%
- **ORP** ↑ for 2 h post feeding
- No effect on feed intake or ADG (1.3-1.4 kg/d)

Ease of delivery 2x/d feeding in a pellet



GlasPort Bio

Roskam *et al*. In Review JAS

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Take home messages

- **Most promising feed additives evaluated**:
  - Bovaer (3-NOP)
  - RumenGlas
  - Oils (rapeseed oil) offer some reductions but expensive

- **Seaweeds**: Limited effectiveness of brown seaweeds and issues with *Asporogopsis taxiformis*

Future priorities:

- Potential for synergy - combining feed additives as different mechanisms of action
- **Challenges at grazing**: Slow release and bolus technology for application during grazing
- EFSA approval required
- Exploring opportunities to combine with other strategies such as breeding

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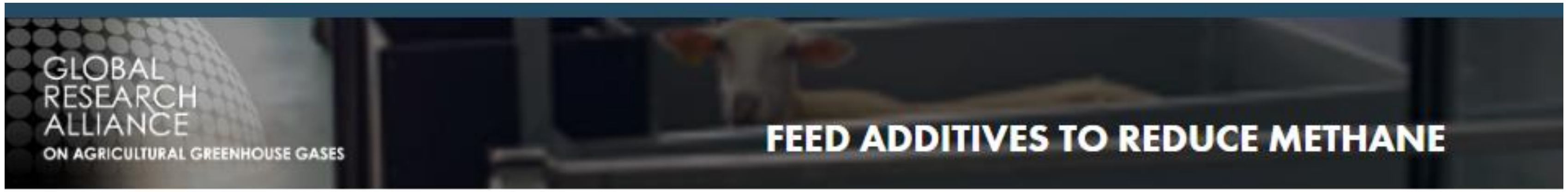
GRA Flagship on feed additives



- **Ireland is a partner**
- **GRA Flagship PhD student**
- **Development of feed additives for grazing systems**
- **International review paper**

Technical guidelines to develop feed additives to reduce enteric methane

Flagship Goal: To accelerate the development and use of feed additives to reduce global enteric methane emissions from livestock.

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