atf animal task force
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# 12th ATF Seminar
# 17 November 2022

## *Evaluation and development of feed additives to reduce methane emissions from ruminants*

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**Teagasc**

Animal and Grassland Research and Innovation Centre

**Ireland**

# Introduction

- **Methane** is a potent greenhouse gas (GHG)
- **Agriculture** is responsible for 37% of Ireland's GHG emissions
- **Methane** accounts for ~70% of Irish Agri-GHG emissions (EPA, 2022)
  - Enteric fermentation (feed digestion) **62%**
  - Stored slurries and manures **8%**
- **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 in Ireland?*

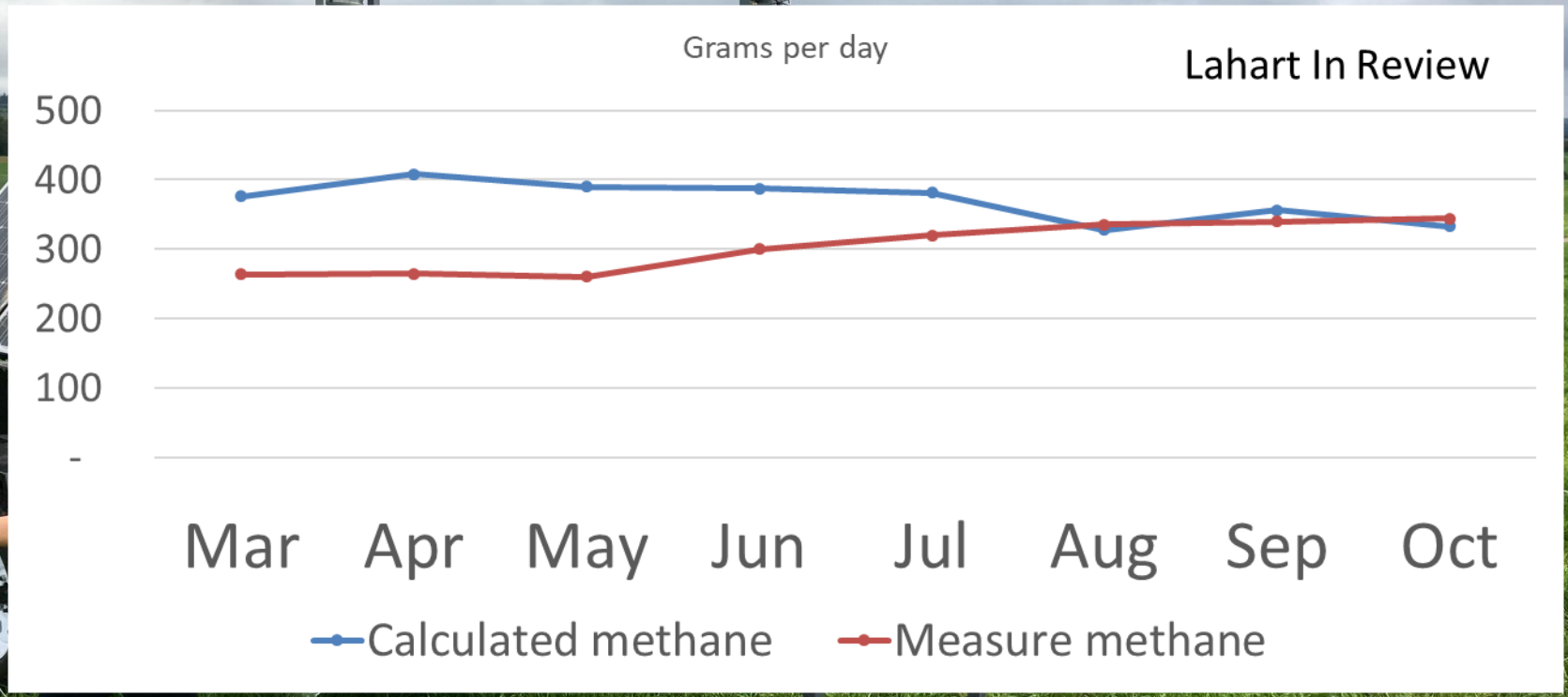
- Improved management practices – Farm efficiency
- **Teagasc MACC**
    - **Reducing age of slaughter**

- **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**
    - Can they be delivered during grazing?

# Methane measurement at pasture



# International reports on feed additives

**Dr Roger Hegarty** NZAGRC

- Only two of the additives evaluated delivered over 20% mitigation
  - **Bovaer** (3-NOP)
  - **Asparagopsis** (red algae)
  - 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
- Extensive or grazing systems?

**TAG FAO LEAP Partnership 2022**

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

# 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 – monitoring their effects on animal productivity
  - Bovaer (3-NOP)
  - Seaweeds and seaweed extracts
  - Lipids (e.g., linseed oil, olive feed)
  - Novel oxidising methane inhibitors (RumenGlas)
  - Commercial products (e.g., Agolin, Mootral)

- Formulations for **slow release** options at pasture
- Additives to reduce methane from **stored manure/slurry**
- **Nutritional and toxicological** composition of meat and milk - to confirm **consumer safety – no residues**
- **Life Cycle** (LC) Analysis and **farm level cost effectiveness**

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# Effect of feed additives on methane emissions *in vitro* using RUSITEC

| | Mmol $CH_4$/day | *P*-Value |
|---|---|---|
| **Oxidising inhibitors** | | |
| 1X UHP | -60% | <.0001 |
| 0.5X UHP | -67% | <.0001 |
| **Seaweeds/extracts** | | |
| *Asparagopsis taxiformis*[1a] | -41% | 0.0078 |
| *Asparagopsis taxiformis*[1b] | -68% | <.0001 |
| *Ascophyllum nodosum*[1] | -7% | 0.9789 |
| *Ascophyllum nodosum*[2] | -36% | 0.0044 |
| Brown seaweed extract[2] | -15% | 0.0217 |
| **Feed compound** | | |
| Olive feed extract[3] | -26% | 0.0317 |

1 – 1% inclusion rate
2 – 4% inclusion rate
3- 25% inclusion rate

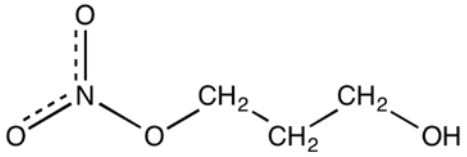
a. harvested in Summer; bromoform = 4.35 mg/g DM
b. harvested in Autumn; bromoform 6.84 mg/g DM



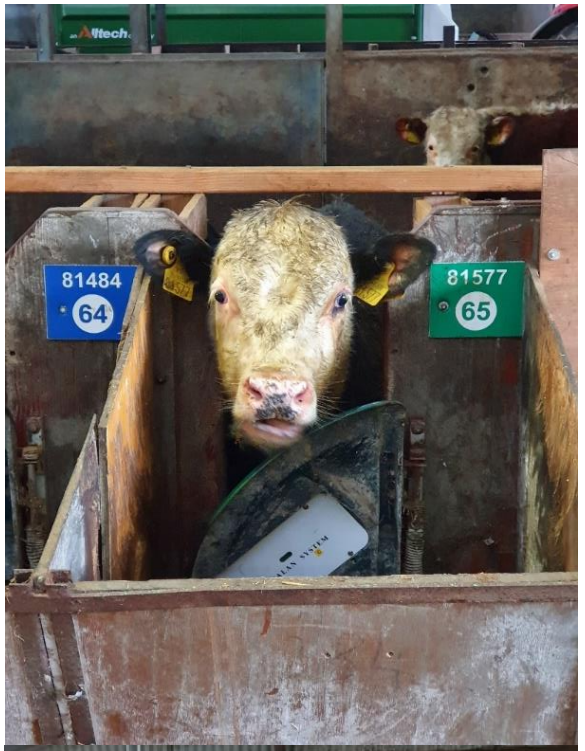
***Roskam et al., 2022 In review; O'Donnell et al. In Preparation***

# Bovaer (3-NOP) Beef Trial

- Synthetic non-toxic compound, 3-nitrooxypropanol




- Efficacy of 3-NOP in **growing beef cattle**
- Teagasc Grange (Sept 2021- Jan 2022)
- 3-NOP vs control n=34
- Acclimatisation period (4 weeks) +12 wk supplementation, TMR diet
  - 30% forage (silage)
- Dairy/beef cross animals
  - ≤ 6 months of age at the start of experiment
- DMI, daily methane output, daily live-weight gain




***Kirwan et al., 2022 In Preparation***

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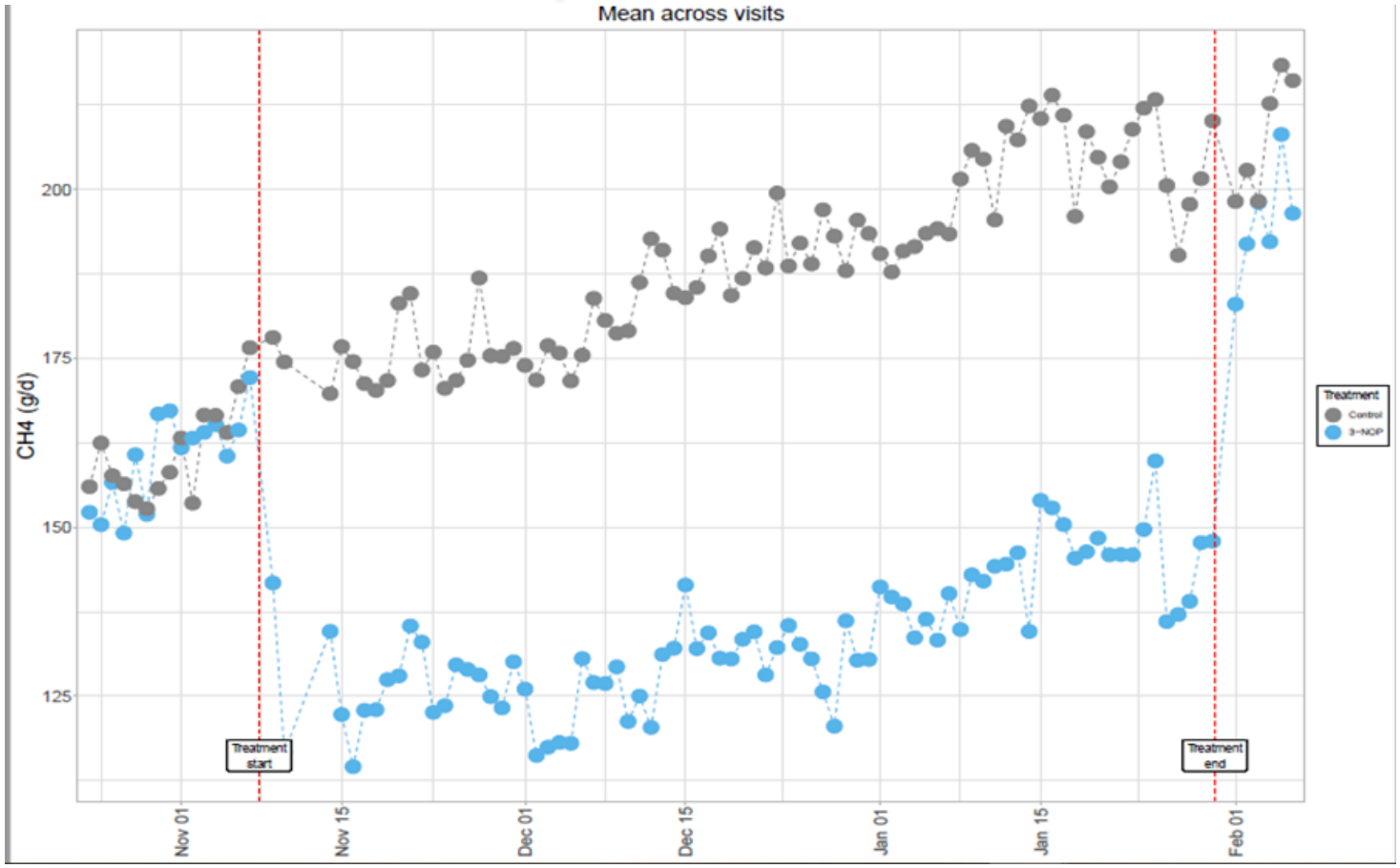
# Effect of Bovaer supplementation on methane emissions in growing cattle

- No effect on DMI, ADG, feed efficiency
- Methane data ⬇ 25-30%




***Kirwan et al., 2022 In Preparation***

# Effect of feed additves on methane emissions in beef cattle

- **72 dairy beef X bulls**
  - » ~4 dietary treatments (n=18)
- **Timeline:**
  - » Acclimatisation to the Calan Gates and GreenFeeds
  - » 7 day covariate period
  - » 70 days experimental period
  - » 7-day residual effect

**Diet:**

- 60:40 forage:concentrate
- Barley-based coarse ration with additive
  - **Fed 2x/d (AM + PM)**

***Roskam et al., In Preparation***

**Experiment 2**

- Control (no additive)
- **Linseed oil** (4%)
- ***Ascophyllum nodosum*** (2%)
- ***Ascophyllum nodosum* extract** (2%)

**Experiment 3**

- Control
- **RG** Low (1.35%)
- **RG** High (2.25%)
- **RG** High pellet (2.25%)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# Effect of feed additives on methane emissions in beef cattle

- Compared to unsupplemented control diet:
  - **Brown Seaweed** supplementation tended to ↓ $CH_4$ g/d (↓**4%**)
  - **Seaweed extract** ↓ $CH_4$ g/d (↓**7%**), no effect on $CH_4$ yield or intensity
  - **Linseed oil supplementation:** ↓$CH_4$ g/d (↓**18**%), $CH_4$ yield (↓**14%**)
  - **DMI (↓ 5%)** and **ADG (↓17%) reduced** by linseed oil supplementation
  - Residual effects

*Roskam et al., In Preparation*

# Effect of *RumenGlas* on methane emissions and performance in beef cattle

## *Preliminary results:*

- Compared to unsupplemented control diet:
- **RG (High)** reduced methane (g/d) ↓**30%**
  **Feed intake** reduced by 14% - possible formulation or palatability issues
- **RG (Low)** reduced methane (g/d) by ↓**18%**
  **18%** increase in weight gain (ADG)
- **RG PELLET:** reduced methane (g/d) ↓**28%**
  No negative effect on intake and improved weight gain (**18%)**

**Advantages : Ease of delivery** 2x/d feeding in a pellet

***Roskam et al., In Preparation***

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# Current and Future work

- **Dairy grazing feed additive studies – lack of persistency**
  - Effective only for 3 hours
- **Development of new formulations** for extensive/grazing application
- Mechanism of action – VFA and rumen microbiome studies
- Sensory and residue analysis (meat and milk)
- Cost effectiveness (affordability) and life cycle analyses
- Delivery on farm – uptake by farmers will require industry and state incentives
- Incorporation into national inventories (EPA)

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# Development of additives to reduce methane from stored manure/slurry

**'GasAbate'** – methane reduction from slurry and manure


**Application types:**

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

**Advantages:**

- No start-up/implementation costs
- 29% reduced fertiliser purchase
- 38% increased energy output from AD
- Reduced agitation time

**Pilot study: 75-80% reduction in $CH_4$ emissions over 23 days**

- **1 hour to dose shed (600 tonnes)**
- **Cows could remain indoors**



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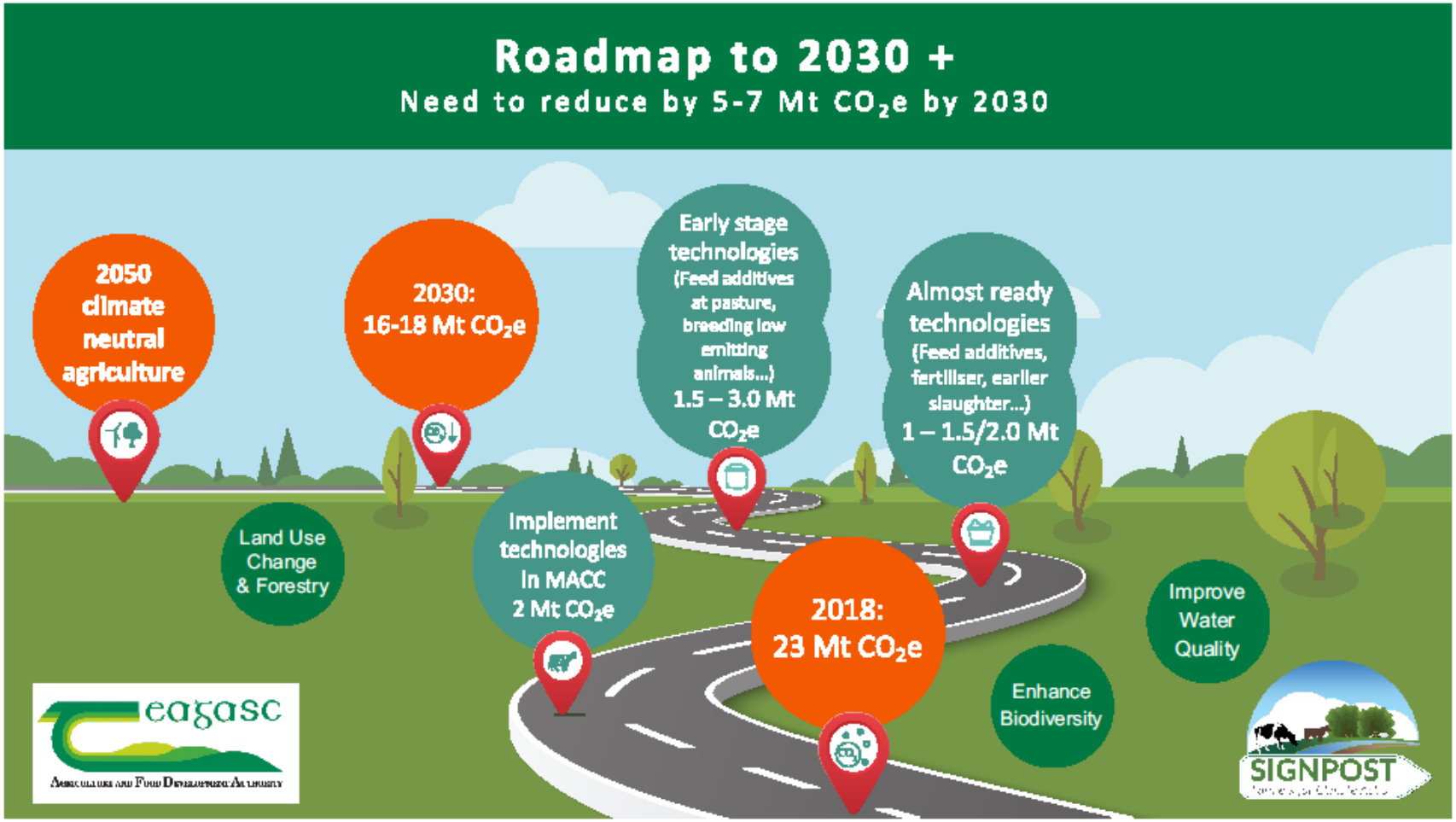
# Road map to meeting our GHG targets





**The Signpost Programme** - *Promoting climate action by farmers.*
*A multi-annual campaign to prompt climate action by all Irish farmers*

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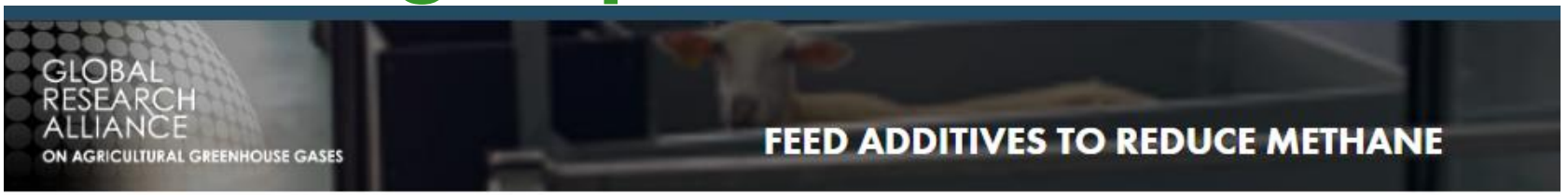
# Take home messages

- **Methane** is a potent agricultural GHG
- National and international commitments to significantly reduce biogenic methane
- Promising **feed additives**:
  - 3-NOP
  - Novel oxidising methane inhibitors which can be delivered in a pellet format
  - Limited effectiveness of brown seaweeds
- **Slow release** feed additives essential for application at grazing
- Effective additive (‘GasAbate’) developed for stored manure and slurry

# GRA Flagship on Feed Additives




**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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# Acknowledgements


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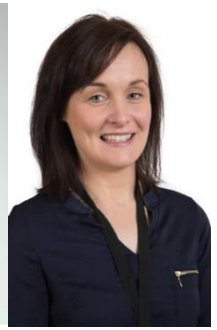
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