Development of novel technologies to reduce methane emissions from Irish agricultural systems

Prof. Sinéad M. Waters
Teagasc, Animal and Bioscience Research Department Animal Teagasc, Grange
Teagasc Research Insights
14th July, 2021
Overview

- Methane emissions
- Strategies to reduce methane emissions
- Feed additives - ‘Meth-Abate’ Project
- Early life intervention
Methane emissions

- **Agriculture** is responsible for 32.7% of Ireland's Greenhouse Gas (GHG) emissions

- Sources of methane from **Irish agriculture**:
  - Enteric fermentation (feed digestion) - 56.2%
  - Stored slurries & manures - 9.6%

**Reducing methane will be key to meeting targets on climate change**
How is enteric methane produced?

- Methanogenesis in the rumen during feed digestion

\[
\text{CO}_2 + 4\text{H}_2 \rightarrow \text{CH}_4 + 2\text{H}_2\text{O}
\]

**Inefficiency:** 2–12% loss of feed energy for the animal
Measuring Enteric Methane Output

Respiration chamber  SF$_6$ tracer  GreenFeed system
So how are we going to reduce methane emissions from agriculture in Ireland?
Improved management practices

Teagasc Marginal Abatement Cost Curve (2021-2030)

- Improved farm management – methane abatement estimated to be 1.85 Mt CO2e per year
- Cost negative strategies ~ 10% reduction in total GHG emissions
  - Extending length of grazing season
  - Increasing dairy cow genetic merit via the Economic Breeding Index
  - Optimising age at first calving
  - Increasing the daily live weight gain
  - Optimising the calving and lambing rate
  - Lower age at which an animal is slaughtered
  - Improved waste management
‘METH-ABATE’
DAFM-RSF 2019R479

Development and validation of novel technologies to reduce methane emissions from Irish pasture based beef, dairy and lamb production systems
METH-ABATE - Development of novel farm ready technologies to reduce methane emissions from Irish pasture based beef, dairy and lamb production systems

- **Feed additives** to mitigate methane emissions – monitoring their effects on animal productivity (cattle and sheep)
  - 3-NOP (Bovaer), seaweeds, oils, halides, yucca extracts, olive feed

- Encapsulation for **slow release** options at pasture

- **Nutritional and toxicological** composition of meat and milk - to confirm consumer safety – no residues

- **Farm level cost effectiveness** will be evaluated - national farm survey
Additives evaluated *in vitro*

**Rumen Simulation Technique**

- Plant/oil extracts
- Olive by-products
- Short-lived reactive oxygen halide species

**Seaweeds**
- *Alaria esculenta* (B)
- *Himanthalia elongate* (B)
- *Fucus vesiculosus* (B)
- *Fucus serratus* (B)
- *Bifurcaria bifurcate* (B)
- *Ascophyllum nodosum* (B)
- *Pelvetia canaliculata* (B)
- *Asparagopsis taxiformis* (R)
- *Palmaria palmata* (R)
- *Chondrus crispus* (R)
- *Ulva intestinalis* (G)

**Seaweed extracts**
3-NOP (Bovaer)

Synthetic non-toxic compound, 3-nitrooxypropanol (3-NOP) is a promising methane inhibitor.

- Consistent methane yield decreases of ~30% in many trials.
- Binding to methyl-coenzyme M reductase in methanogens.
- Positive effects of 3-NOP in vitro, in vivo in sheep, dairy cows and beef cattle mainly in indoor systems.
- Productive performance not compromised.
- 3-NOP beef trial cattle for EFSA approval.

Issues: Pasture based systems and consumer acceptability.

• Development of a slow release prototype.
Irish animal trials

- **Sheep**: commenced May 2021
  - Agolin, Mootral, oils, halides, seaweed, seaweed extract

- **Beef**: commencing 2022
  - *Ad lib* grass silage + concentrates
  - Treatments: Control, 3-NOP, plus most promising additives from sheep study

- **Dairy**: commencing 2022
  - Grazed swards (Grass + clover)
  - Treatments: Control, slow-release 3-NOP and most promising additive from sheep study
Early life – the window of opportunity?

RESEARCH ARTICLE

Investigating temporal microbial dynamics in the rumen of beef calves raised on two farms during early life

Eóin O’Hara¹,², David A. Kenny¹,³, Emily McGovern¹,³,‡, Colin J. Byrne¹,³,‡, Matthew S. McCabe¹, Le Luo Guan² and Sinéad M. Waters¹,⁴,*

¹Animal and Poultry Department, Animal and Grassland Research and Innovation Centre, Teagasc

FEMS Microbiology Ecology, 96, 2020, fiz203

doi: 10.1093/femsec/fiz203
Advance Access Publication Date: 9 January 2020
Research Article
Early life intervention

- **First month of life** presents a time-frame during which the rumen microbiome becomes established.

- Lasting effects on rumen functionality including methanogenesis, which can extend into later life.

- **Meale et al. (2021)** - Early-life administration (oral dose) of dairy calves with 3-NOP from birth-to-14 weeks of life.

- Reduction in methane emissions, which persisted to 12 months of age.

- Cumulative reduction of circa 150 kg of CO2eq per head in these cattle during the first year of life.
Take home message

- Methane is a potent agricultural GHG

- Promising feed additives being assessed under a systematic approach, for methane mitigation potential

- Potential for early life intervention
Thank you for your attention