GLOBAL RESEARCH ALLIANCE

ON AGRICULTURAL GREENHOUSE GASES

David Yáñez-Ruiz (CSIC, Spain), André Bannink (WUR, Netherlands), Florencia García (Argentina)

Flagship Project:

Methane Feed Additives

September 2022 – June 2025

Context

GLOBAL RESEARCH ALLIANCE ON AGRICULTURAL GREENHOUSE GASES

- Feed additives are a valuable strategy to reduce methane emissions from ruminants
- Increasing interest in developing feed additives
- Despite the extensive research effort over the last decades:
  - few products can substantially (>20%) reduce methane emissions consistently and
  - only one is available in the market

Flagship Project Goal(s)

GLOBAL RESEARCH ALLIANCE ON AGRICULTURAL GREENHOUSE GASES

- ✔ to facilitate the development of feed additives to reduce methane emissions
- ✔ Provide technical recommendations for
  - ✔ testing *efficacy* and understanding *modes* of action
  - ✔ facilitating *registration* and *accounting* for reductions in GHG

Anticipated Flagship Outcomes/Impacts

GLOBAL RESEARCH ALLIANCE ON AGRICULTURAL GREENHOUSE GASES

Technical guidelines and protocols on good practice on how to develop and test feed additives, as well as for accounting for the effect of using this mitigation strategy

Global network of experts to share knowledge and create detailed guidance to enable the livestock sector to collaboratively harness the potential that feed additives offer

Flagship Project Partners

GLOBAL RESEARCH ALLIANCE
ON AGRICULTURAL GREENHOUSE GASES

60 RESEARCHERS

23 COUNTRIES

46 INSTITUTIONS

GLOBAL DAIRY PLATFORM

Project coordinators


David Yáñez-Ruiz


André Bannink

Coordination assistant


Florencia Garcia

Lead authors


Evert Duin


Zoey Durmic


Alex Hristov


Peter Lund


Jan Dijkstra


Ermias Kebreab


Alejandro Belanche


Emilio Ungerfeld

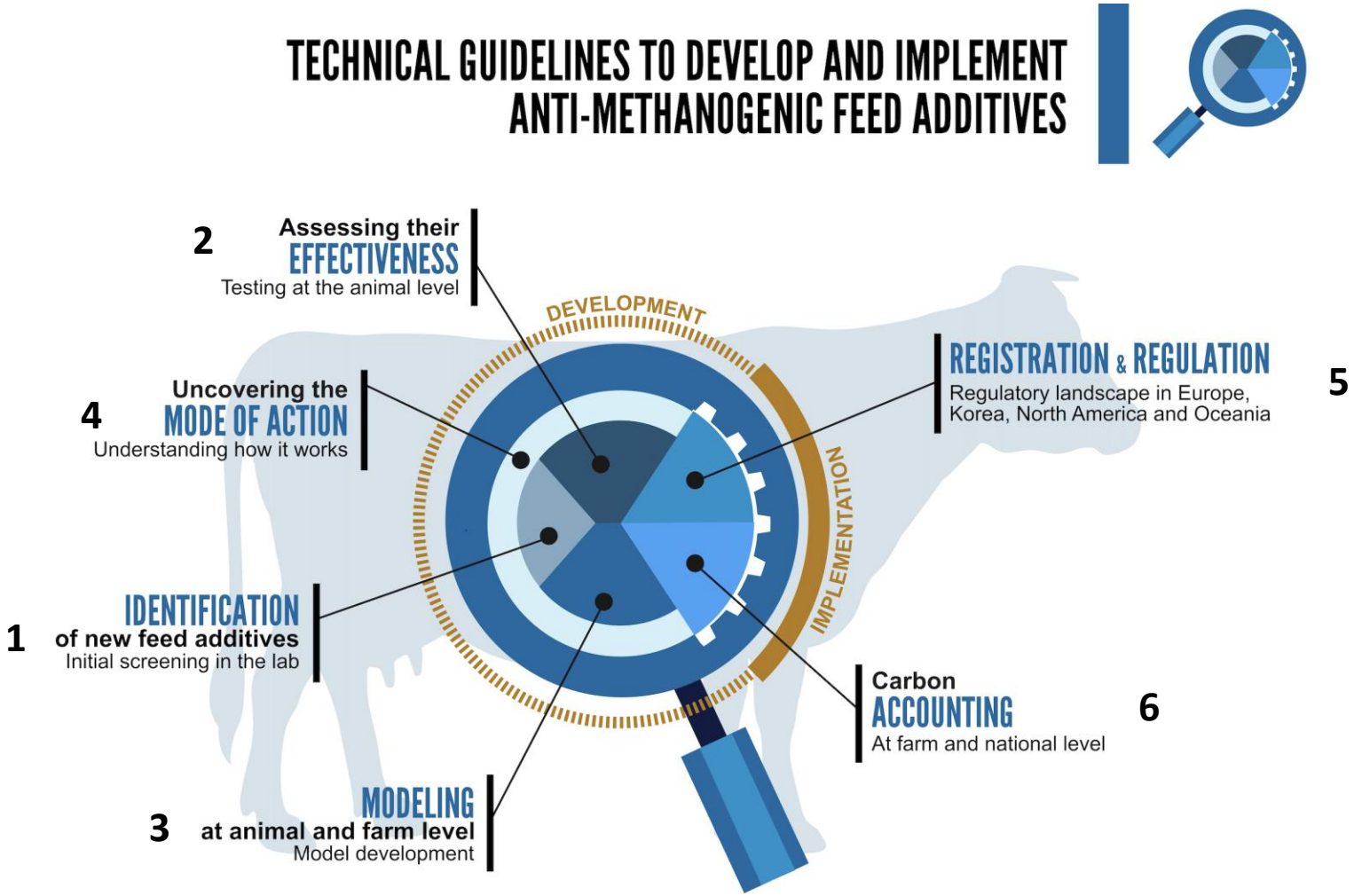

Juan Tricarico


Agustín del Prado


Ronaldo Vibart

Activities: 6 chapters of the guidelines

GLOBAL RESEARCH ALLIANCE
ON AGRICULTURAL GREENHOUSE GASES



Activities/Results To Date

GLOBAL RESEARCH ALLIANCE
ON AGRICULTURAL GREENHOUSE GASES

J. Dairy Sci. 108:302–321
https://doi.org/10.3168/jds.2024-25045

Feed additives for methane mitigation: Recommendations for identification and selection of bioactive compounds to develop antimethanogenic feed additives

Zoey Durmic,[1] Evert C. Duin,[2] André Bannink,[3] Alejandro Belanche,[4] Vincenzo Carbone,[5] M. Dolores Carro,[6] Max Crüsemann,[7] Veerle Fievez,[8] Florencia Garcia,[9*] Alex Hristov,[10] Miroslav Joch,[11] Gonzalo Martinez-Fernandez,[12] Stefan Muetzel,[5] Emilio M. Ungerfeld,[13] Min Wang,[14] and David R. Yáñez-Ruiz[15*]

J. Dairy Sci. TBC:1–35 JDS25050
https://doi.org/10.3168/jds.2024-25050

Special issue: Recommendations for testing enteric methane-mitigating feed additives in ruminant studies

Alexander N. Hristov,[1*] André Bannink,[2] Marco Battelli,[3] Alejandro Belanche,[4] M. Cecilia Cajarville Sanz,[5] Gonzalo Fernandez-Turren,[5,6] Florencia Garcia,[7] Arjan Jonker,[8] David A. Kenny,[9] Vibeke Lind,[10] Sarah J. Meale,[11] David Meo Zilio,[12] Camila Muñoz,[13] David Pacheco,[8] Nico Peiren,[14] Mohammad Ramin,[15] Luca Rapetti,[3] Angela Schwarm,[16] Sokratis Stergiadis,[17] Katerina Theodoridou,[18] Emilio M. Ungerfeld,[19] Sanne van Gastelen,[2] David R. Yáñez-Ruiz,[20] Sinead M. Waters,[21] and Peter Lund[22*]

J. Dairy Sci. 108:356–374
https://doi.org/10.3168/jds.2024-25049

Feed additives for methane mitigation: Modeling the impact of feed additives on enteric methane emission of ruminants—Approaches and recommendations

Jan Dijkstra,[1*] André Bannink,[2] Guilhermo F. S. Congio,[3] Jennifer L. Ellis,[4] Maguy Eugène,[5] Florencia Garcia,[6] Mutian Niu,[7] Ronaldo E. Vibart,[8] David R. Yáñez-Ruiz,[9] and Ermias Kebreab[10*]

J. Dairy Sci. 108:375–394
https://doi.org/10.3168/jds.2024-25046

Feed additives for methane mitigation: A guideline to uncover the mode of action of antimethanogenic feed additives for ruminants

Alejandro Belanche,[1*] André Bannink,[2] Jan Dijkstra,[3] Zoey Durmic,[4] Florencia Garcia,[5] Fernanda G. Santos,[6] Sharon Huws,[6] Jeyamalar Jeyanathan,[7] Peter Lund,[8] Roderick I. Mackie,[9] Tim A. McAllister,[10] Diego P. Morgavi,[11] Stefan Muetzel,[12] Dipti W. Pitta,[13] David R. Yáñez-Ruiz,[14] and Emilio M. Ungerfeld[15*]

J. Dairy Sci. TBC:1–18 JDS25051
https://doi.org/10.3168/jds.2024-25051

pecial Issue: Regulatory frameworks and scientific vidence requirements for the authorization of feed dditives to mitigate ruminant methane emissions

ıan M. Tricarico,[1*] Florencia Garcia,[2] André Bannink,[3] Sang-Suk Lee,[4] Michelle A. Miguel,[4] John R. Newbold,[5] Peri K. Rosenstein,[6] Matthew R. Van der Saag,[7] and David R. Yáñez-Ruiz[8]

J. Dairy Sci. 108:411–429
https://doi.org/10.3168/jds.2024-25044

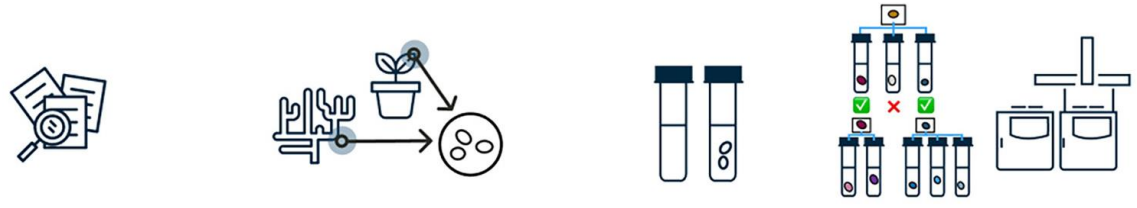
Feed additives for methane mitigation: Assessment of feed additives as a strategy to mitigate enteric methane from ruminants—Accounting; How to quantify the mitigating potential of using antimethanogenic feed additives

Agustin del Prado,[1,2*] Ronaldo E. Vibart,[3*] Franco M. Bilotto,[4] Claudia Faverin,[5,6] Florencia Garcia,[7] Fábio L. Henrique,[8] Fernanda Figueiredo Granja Dorilêo Leite,[5] Andre M. Mazzetto,[9] Bradley G. Ridoutt.[10,11] David R. Yáñez-Ruiz.[12] and André Bannink[13]

Key outcomes: Chapter 1 - Identification

GLOBAL RESEARCH ALLIANCE
ON AGRICULTURAL GREENHOUSE GASES

Empirical From compounds known to be bioactive



Literature search to identify sources of candidates

Search of parent material and extracting compound/s to test

Evaluate antimethanogenic effectiveness in vitro

In vitro testing of multiple rounds of separation

Mechanistic Targeting methanogens unique cellular process

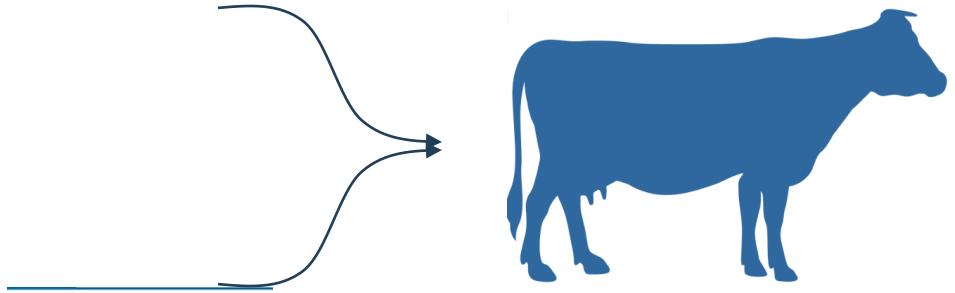
Knowledge on chemistry, and enzymes and cofactors involved in the processes to be targeted

Experimentally derived protein crystal structures or modeled structures to develop the target

In silico docking studies and programming for selecting compounds

Curated bioactive libraries or natural product libraries

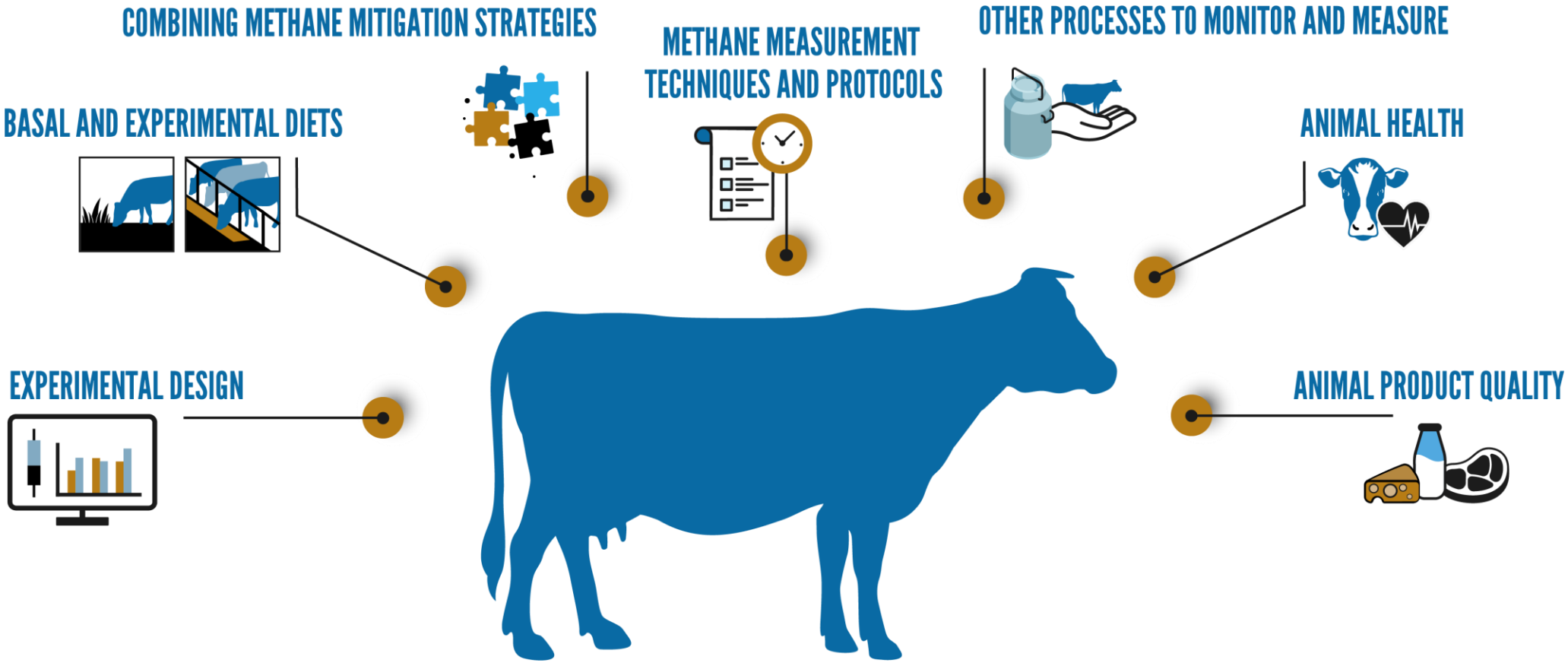
Synthesizing or extracting compound from parent material



Evaluate antimethanogenic effectiveness in vitro

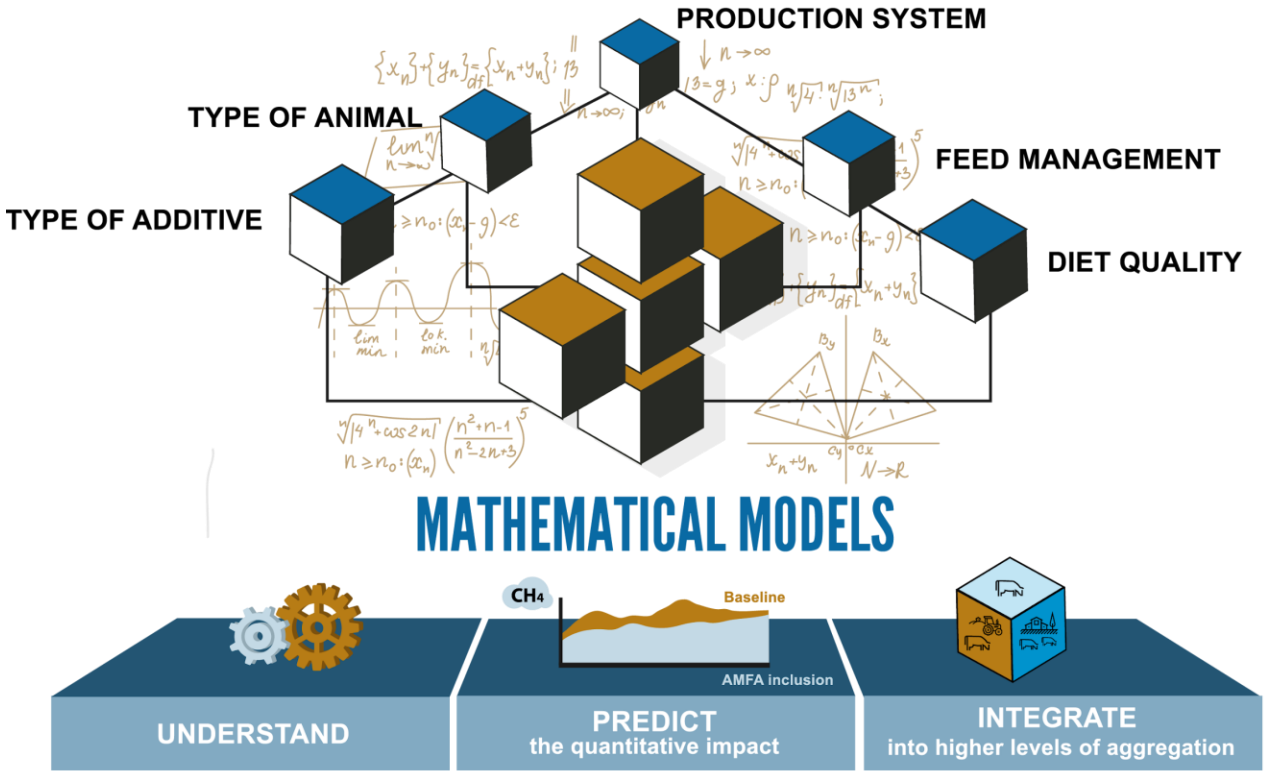
Key outcomes: Chapter 2 – In vivo testing

GLOBAL RESEARCH ALLIANCE
ON AGRICULTURAL GREENHOUSE GASES

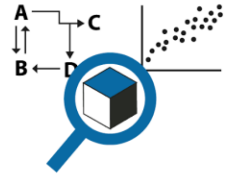


Key outcomes: Chapter 3 – Modelling animal/farm levels

GLOBAL RESEARCH ALLIANCE
ON AGRICULTURAL GREENHOUSE GASES

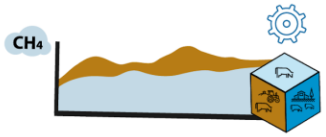


COVERED TOPICS



Type of model

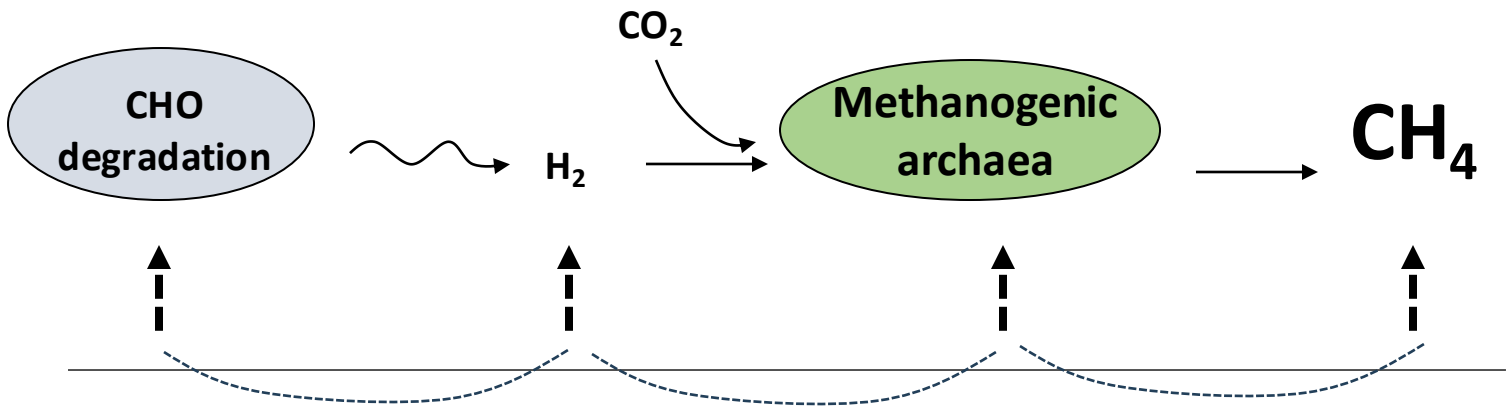
Synergies and trade-offs of combining AMFA

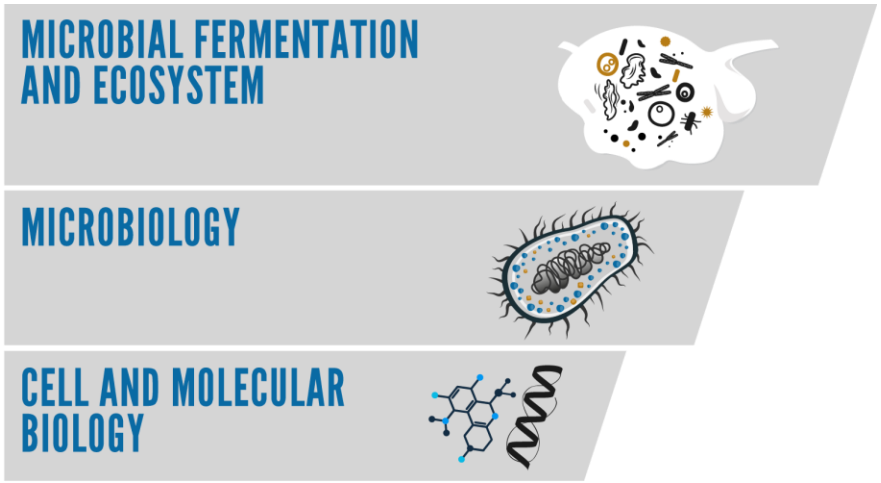


Model application

Key outcomes: Chapter 4 – Mode of action

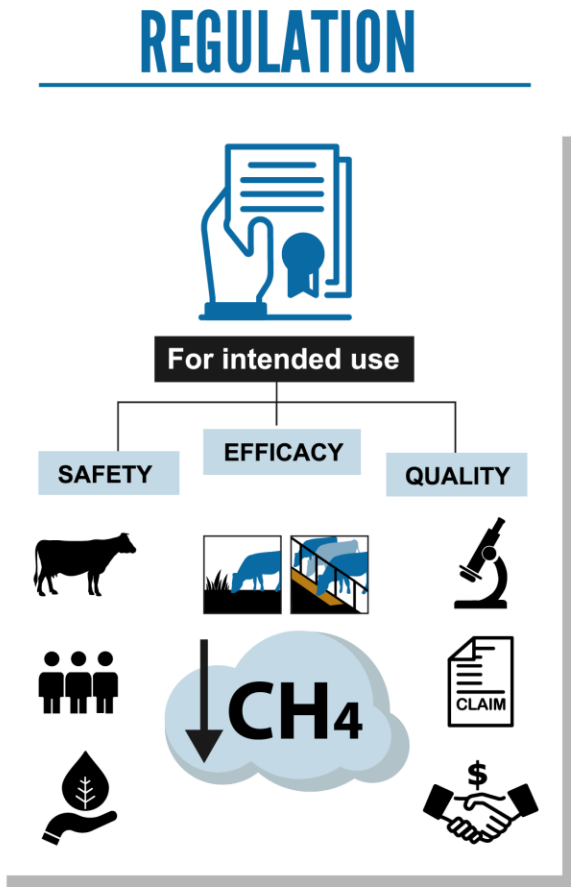
GLOBAL RESEARCH ALLIANCE ON AGRICULTURAL GREENHOUSE GASES

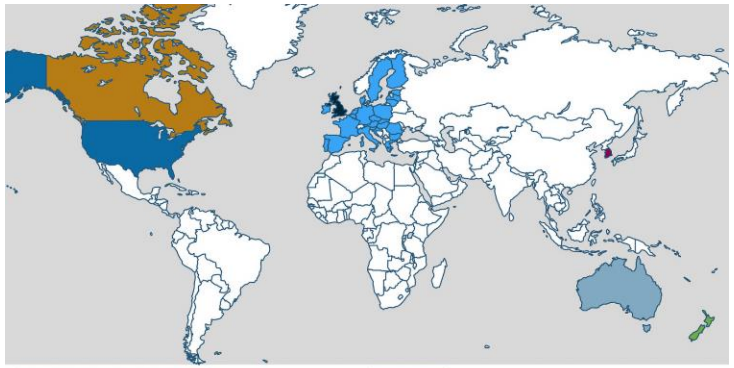




Key outcomes: Chapter 5 – Registration & regulation

GLOBAL RESEARCH ALLIANCE
ON AGRICULTURAL GREENHOUSE GASES





UNITED STATES OF AMERICA

Rule: Federal Food, Drug, and Cosmetic Act (FD&C Act)
Authority: Food and Drug Administration (FDA) Center for Veterinary Medicine (CVM)
Regulatory Status: New animal drugs require a New Animal Drug Application (NADA).

UNITED KINGDOM

Rule: Assimilated Regulation (EC) 1831/2003 and assimilated Commission Regulation (EC) 429/2008
Authority: Food Standards Agency (FSA) and Food Standards Scotland (FSS)
Regulatory Status: Zootechnical additives require review of a technical dossier.

EUROPEAN UNION

Rule: Regulation (EC) 1831/2003 Regulation (EC) 767/2009
Authority: European Commission (EC)
Regulatory Status: Zootechnical additives require review of a technical dossier by the European Food Safety Authority (EFSA).

NEW ZEALAND

Rule: Agricultural Compounds and Veterinary Medicines (ACVM) Act 1997
Authority: Ministry of Primary Industries (MPI)
Regulatory Status: Inhibitors are a type of agricultural compound that require authorization by the MPI.

CANADA

Rule: Feeds Act (1983), Food and Drugs Act (1985)
Authority: Canadian Food Inspection Agency (CFIA). Health Canada Veterinary Drugs Directorate (VDD)
Regulatory Status: Gut modifiers require review and approval by the CFIA.Veterinary Drugs require review and approval by the VDD.

SOUTH KOREA

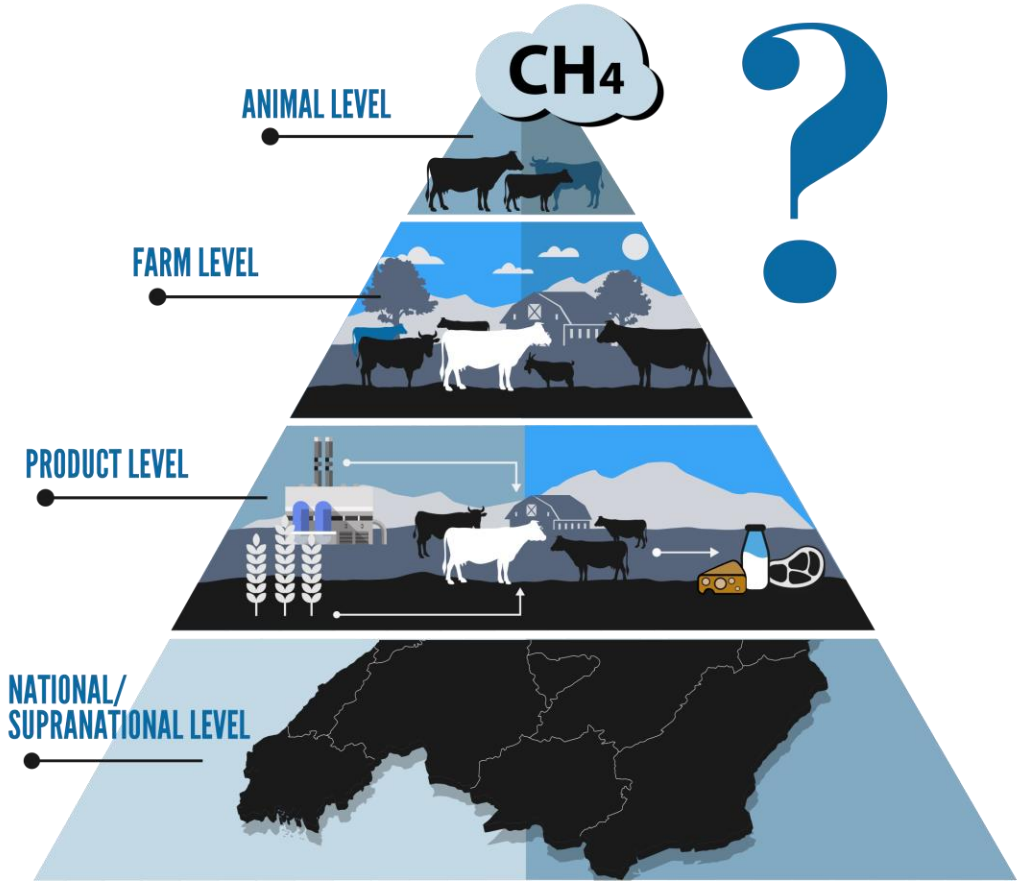
Rule: Standards and specifications of feed, etc. (2023) pursuant to Control of Livestock and Fish Feed Act No. 17091
Authority: Ministry of Agriculture, Food and Rural Affairs (MAFRA) and National Institute of Animal Science (NIAS)
Regulatory Status: Methane-reducing agents require approval by the Feed Process Review Committee and registration with NIAS.

AUSTRALIA

Rule: National Registration Scheme for Agricultural and Veterinary Chemicals (NRS)
Authority: Australian Pesticides and Veterinary Medicines Authority (APVMA)
Regulatory Status: Veterinary chemical products require registration. Excluded nutritional or digestive (END) products are exempt from registration.

Key outcomes: Chapter 6 – C accounting

GLOBAL RESEARCH ALLIANCE
ON AGRICULTURAL GREENHOUSE GASES



Dissemination activities

GLOBAL RESEARCH ALLIANCE ON AGRICULTURAL GREENHOUSE GASES

- **Webinars**
  - Academic – 2 FNN workshops in February 2025 (97 and 167 participants!)
  - Industry / policy – Global Diary Platform – April 2024 in the Netherlands
- **Dissemination material repository** (GRA website)
  - Short video
  - Links to manuscripts
  - Presentations
- **Specific Workshops / Symposia**
  - ADSA June, 2025 - Symposium on Methane Feed additives special issue
  - GGAA October, 2025 – FNN workshop
  - EAAP 2025 August 2025 – Symposium on Methane Feed additives special issue

Conclusions

GLOBAL RESEARCH ALLIANCE ON AGRICULTURAL GREENHOUSE GASES

- **The guidelines contributed to improving capabilities in science, feed industry and policy making to develop methane feed additives**

- **All steps are important:**
  - ***Identification -- in vivo -- mode of action -- regulation -- C accounting***

Future opportunities / next steps

GLOBAL RESEARCH ALLIANCE ON AGRICULTURAL GREENHOUSE GASES

- Long-term effects of effective feed additive
  - Efficacy, safety and productivity
- Develop specific delivery systems for grazing systems

Thank you!

GLOBAL RESEARCH ALLIANCE
ON AGRICULTURAL GREENHOUSE GASES