GLOBAL RESEARCH ALLIANCE
ON AGRICULTURAL GREENHOUSE GASES

Flagship Project tittle:

Technical guidelines to develop feed additives to reduce enteric methane

Overview of project

Coordinators: David Yáñez-Ruiz (CSIC) & André Bannink (WUR)

Postdoc: Florencia García

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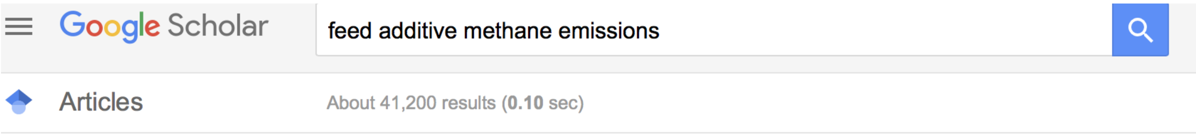
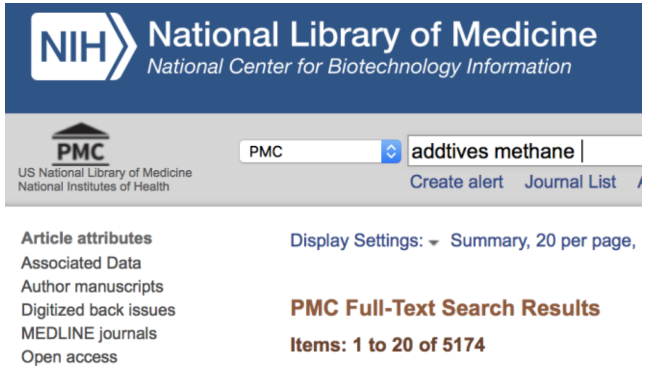
1st September 2022 – 2 years

Overview of project

Background:

- *Increasing interest in developing feed additives to reduce enteric CH_4 emissions worldwide*
- *Feed additives: Extensive research effort over the last decades that has not resulted in many additives in the market (Hegarty et al., 2021)*





Overview of project

Additive	Efficacy: CH_4 reduction potential [1]	Efficacy: No. of academic papers [2]	Efficacy: Confidence in efficacy [3]	Potential animal welfare risks	Potential food safety risks	Potential co-benefits	Production system applicability [4]	Development needs
3-Nitrooxypropanal	Very High	> 20	5	None known	None known	Improved feed efficiency.	TMR systems immediately. Grazing systems in future.	Validation in large-scale TMR systems required. Formulation for grazing systems.
Asparagopsis	Very High	< 10	1	Damage to rumen wall	Bromide & iodine residues in animal tissue/products	Improved feed efficiency.	TMR systems immediately. Grazing systems in future.	Validation in large-scale TMR systems required. Formulation for grazing systems.
Nitrate	High	< 20	4	Toxicity in non-adapted animals	None known	Can reduce need for urea supplementation in animal feed.	TMR systems immediately. Grazing systems in future.	Validation in large-scale TMR systems required. Formulation for grazing systems.
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								ivity
				known	known	Reduced risk of bloat & acidosis.		
Microalgae	Low	< 5	1	None known	None known	PUFA levels in meat improved. Enhanced antioxidants in food products.	TMR & grazing systems (where supplements are administered)	Microalgae supply dependent on use in renewable energy sector.
Biochar	Low	< 5	1	None known	None known	Toxins & heavy metals absorption prevention in animals. Enhanced soil quality when excreta is applied to soils.	TMR & grazing systems (where supplements are administered)	Engineering of an acidified biochar required to achieve adequate efficacy.
Bacterial Direct Fed Microbes	Low	< 15	2	None known	None known	Improved productivity (though inconsistent). Improved calf health. Reduced incidence of E.coli in manure.	TMR & grazing systems (where supplements are administered)	Development of high efficacy bacterial strains.

- **Can we accelerate the development of feed additives to reduce CH4?**
- **How can we monitor and accurately account for the reductions achieved?**

Objectives of the project

GLOBAL RESEARCH ALLIANCE ON AGRICULTURAL GREENHOUSE GASES

Facilitate the development and use of feed additives to reduce enteric methane emissions

Overview of project

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Feed and Nutrition Network (LRG):

Contents lists available at ScienceDirect
Animal Feed Science and Technology
journal homepage: www.elsevier.com/locate/anifeedsci
ELSEVIER

Review article

Design, implementation and interpretation of *in vitro* batch culture experiments to assess enteric methane mitigation in ruminants—a review

Yáñez-Ruiz D.R.[a,*], Bannink A.[b], Dijkstra J.[c], Kebreab E.[d], Morgavi D.P.[e], O'Kiely P.[f], Reynolds C.K.[g], Schwarm A.[h], Shingfield K.J.[i,j], Yu Z.[k], Hristov A.N.[l]

Contents lists available at ScienceDirect
Animal Feed Science and Technology
journal homepage: www.elsevier.com/locate/anifeedsci
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Review article

Review of current *in vivo* measurement techniques for quantifying enteric methane emission from ruminants

K.J. Hammond[a], L.A. Crompton[a], A. Bannink[b], J. Dijkstra[c], D.R. Yáñez-Ruiz[d], P. O'Kiely[e], E. Kebreab[f], M.A. Eugène[g], Z. Yu[h], K.J. Shingfield[i,j], A. Schwarm[k], A.N. Hristov[l], C.K. Reynolds[a,*]

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DOI: 10.1111/gcb.14094
PRIMARY RESEARCH ARTICLE
WILEY Global Change Biology

Prediction of enteric methane production, yield, and intensity in dairy cattle using an intercontinental database

Mutian Niu[1] | Ermias Kebreab[1] | Alexander N. Hristov[2] | Joonpyo Oh[2] | Claudia Arndt[3] | André Bannink[4] | Ali R. Bayat[5] | André F. Brito[6] | Tommy Boland[7] | David Casper[8] | Les A. Crompton[9] | Jan Dijkstra[10] | Maguy A. Eugène[11] | Phil C. Garnsworthy[12] | Md Najmul Haque[13] | Anne L. F. Hellwing[14] | Pekka Huhtanen[15] | Michael Kreuzer[16] | Bjoern Kuhla[17] | Peter Lund[14] | Jørgen Madsen[13] | Cécile Martin[11] | Shelby C. McClelland[18] | Mark McGee[19] | Peter J. Moate[20] | Stefan Muetzel[21] | Camila Muñoz[22] | Padraig O'Kiely[19] | Nico Peiren[23] | Christopher K. Reynolds[9] | Angela Schwarm[16] | Kevin J. Shingfield[24] | Tonje M. Storlien[25] | Martin R. Weisbjerg[14] | David R. Yáñez-Ruiz[26] | Zhongtang Yu[27]

J. Dairy Sci. 101:6655–6674
https://doi.org/10.3168/jds.2017-13536

Symposium review: Uncertainties in enteric methane inventories, measurement techniques, and prediction models[1]

A. N. Hristov,*[2] E. Kebreab,† M. Niu,† J. Oh,* A. Bannink,‡ A. R. Bayat,§ T. M. Boland,# A. F. Brito,‖ D. P. Casper,¶ L. A. Crompton,$ J. Dijkstra,€ M. Eugène,¥ P. C. Garnsworthy,** N. Haque,†† A. L. F. Hellwing,‡‡ P. Huhtanen,§§ M. Kreuzer,## B. Kuhla,‖‖ P. Lund,‡‡ J. Madsen,†† C. Martin,¥ P. J. Moate,¶¶ S. Muetzel,$$ C. Muñoz,€€ N. Peiren,¥¥ J. M. Powell,*** C. K. Reynolds,$ A. Schwarm,## K. J. Shingfield,†††[3] T. M. Storlien,‡‡‡ M. R. Weisbjerg,‡‡ D. R. Yáñez-Ruiz,§§§ and Z. Yu###

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Contents lists available at ScienceDirect
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journal homepage: www.elsevier.com/locate/agee
ELSEVIER

Prediction of enteric methane production, yield and intensity of beef cattle using an intercontinental database

Henk J. van Lingen[a,*], Mutian Niu[a,b], Ermias Kebreab[a], Sebastião C. Valadares Filho[c], John A. Rooke[d], Carol-Anne Duthie[d], Angela Schwarm[e,1], Michael Kreuzer[e], Phil I. Hynd[f], Mariana Caetano[f], Maguy Eugène[g], Cécile Martin[g], Mark McGee[h], Padraig O'Kiely[h], Martin Hünerberg[i,j], Tim A. McAllister[i], Telma T. Berchielli[k], Juliana D. Messana[k], Nico Peiren[l], Alex V. Chaves[m], Ed Charmley[n], N. Andy Cole[o], Kristin E. Hales[p], Sang-Suk Lee[q], Alexandre Berndt[r], Christopher K. Reynolds[s], Les A. Crompton[s], Ali-Reza Bayat[t], David R. Yáñez-Ruiz[u], Zhongtang Yu[v], André Bannink[w], Jan Dijkstra[x], David P. Casper[y], Alexander N. Hristov[z]

Contents lists available at ScienceDirect
Science of the Total Environment
journal homepage: www.elsevier.com/locate/scitotenv
ELSEVIER

Review

Modelling the effect of feeding management on greenhouse gas and nitrogen emissions in cattle farming systems

Latifa Ouatahar[a,b,*], André Bannink[c], Gary Lanigan[d], Barbara Amon[b,e]

Contents lists available at ScienceDirect
Journal of Cleaner Production
journal homepage: www.elsevier.com/locate/jclepro
ELSEVIER

Enteric methane mitigation strategies for ruminant livestock systems in the Latin America and Caribbean region: A meta-analysis

Guilhermo Francklin de Souza Congio[a,b,*], André Bannink[c], Olga Lucía Mayorga Mogollón[a], Latin America Methane Project Collaborators1, Alexander Nikolov Hristov[d,**]

Overview of project

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Brief description of project steps (2 years)

- Define structure and sections of the Technical guidelines → **COP27 – 6-18 Nov., Egypt**
- Allocate contributions for each section to participating partners (not only FNN members)
- Working groups
- Data gathering, processing, discussion & writing
- Deliver technical guidelines and position scientific paper(s) on feed additives

Structure of Guidelines

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- **Block 1: Experimental / Testing**
  - Chapter 1: Identification/screening of candidates
  - Chapter 2: Testing at animal level
  - Chapter 3: Uncovering modes of action
- **Block 2: Modeling/C accounting /Implementation**
  - Chapter 4: Testing at farm level
  - Chapter 5: Registration and accounting

Block 1: Experimental /Testing

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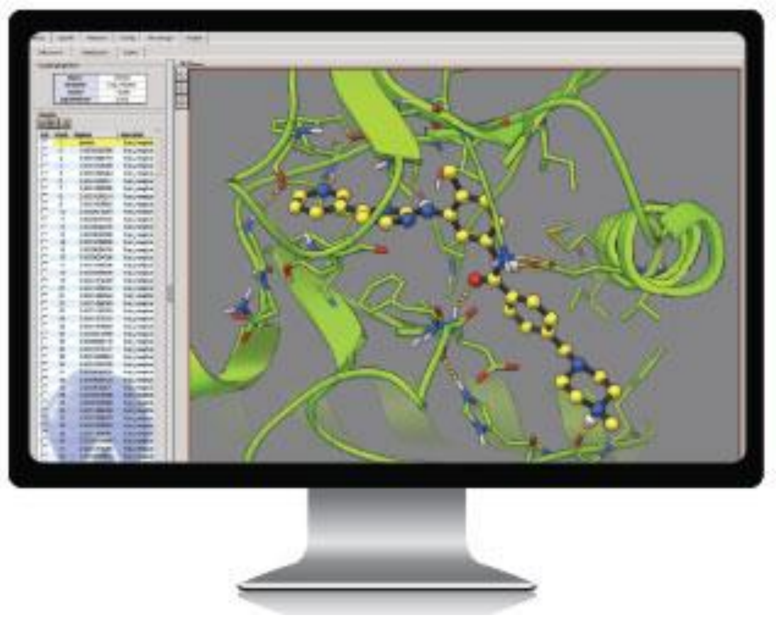
Chapter 1: Identification and screening of new bioactive compounds

In silico screening/chemical modeling

In vitro screening/ Dose selection / Range of substrates

Chemical characterization - Formulation seeking stability



Block 1: Experimental /Testing

Chapter 2: Testing at animal level

Transforming doses at different levels (diet / rumen volume)

Short and long term *in vivo* experiments (Dairy/Beef- Confined/Grazing) // Statistical designs

Early life interventions

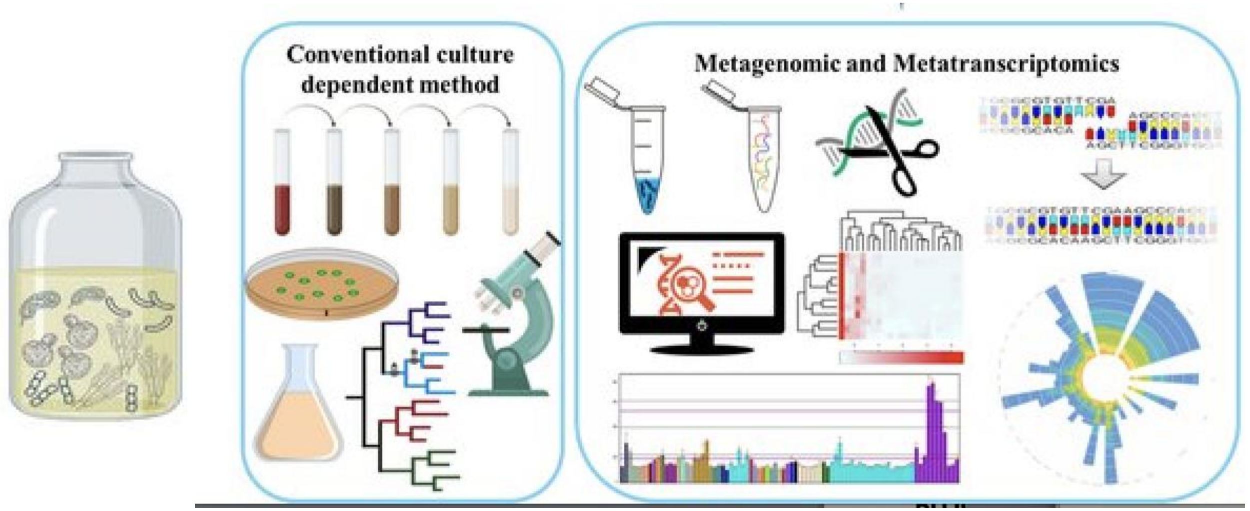
Other aspects: Delivery methods, Persistency/residual effects, animal health

Block 1: Experimental /Testing

Chapter 3: Uncovering their mechanisms of action

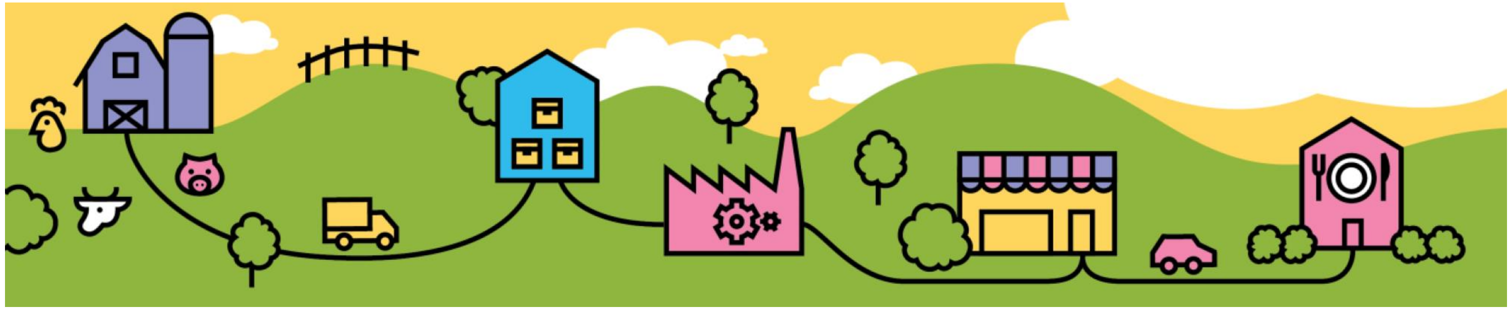
Microbial pure culture assessments/Effect on the rumen microbiome

Mechanisms of methanogenesis inhibition and their biological consequences in other digestive processes



Chapter 4: Testing at farm level

Assessing the impact of mitigation though modeling at farm level (LCA)/Farm level cost assessment



Proposed structure of the Guidelines

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Chapter 5: Registration and accounting

Regulatory contexts around the world

Linking the impact at farm level to their impact at regional and/or national mitigation targets

Adoption barriers for the use of feed additives and strategies to overcome those limitations.

How to scale-up their use?

efsa European Food Safety Authority

FDA U.S. FOOD & DRUG ADMINISTRATION

Ministry for Primary Industries Manatū Ahu Matua

Australian Government Australian Pesticides and Veterinary Medicines Authority

ipcc INTERGOVERNMENTAL PANEL ON climate change

UNITED NATIONS PARIS CLIMATE AGREEMENT ENTRY INTO FORCE — 4 NOVEMBER 2016 —

Conclusions

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Project conceived to help both academy and industry

Ambitious, wide range of expertise

Open for new collaborators

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How can we collaborate and join our efforts?

Thank you!

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