

GLOBAL
RESEARCH
ALLIANCE

ON AGRICULTURAL GREENHOUSE GASES

Feed and Nutrition Network (FNN)

David Yanez-Ruiz & André Bannink

2025 Livestock Research Group Meeting, Nairobi, Kenya

Objectives

1. Summarise and evaluate the available data on mitigating GHG emissions of ruminants by nutritional means
2. Develop sound recommendations on methane mitigation by nutritional means for stakeholders
3. Identify gaps in knowledge and focus research on priority issues - PROJECTS

FNN Activities/outcomes

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Contents lists available at [ScienceDirect](#)

Animal Feed Science and Technology

journal homepage: www.elsevier.com/locate/anifeedsci



Review article

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



J. Dairy Sci. 101:6655–6674

<https://doi.org/10.3168/jds.2017-13536>

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Symposium review: Uncertainties in enteric methane inventories, measurement techniques, and prediction models¹

A. N. Hristov,^{x2} E. Kebreab,[†] M. Niu,[†] J. Oh,^{*} A. Bannink,[‡] A. R. Bayat,^{\$} T. M. Boland,[#] A. F. E. 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. I. P. J. Moate,^{¶¶} S. Muetzel,^{\$\$} C. Muñoz,^{€€} N. Peiren,^{¥¥} J. M. Powell,^{***} C. K. Reynolds,^{\$} A. K. J. Shingfield,^{†††} T. M. Storlien,^{‡‡‡} M. R. Weisbjerg,^{‡‡} D. R. Yáñez-Ruiz,^{§§§} and Z. Yu[‡]

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Invited review: Nitrogen in ruminant nutrition: A review of measurement techniques

A. N. Hristov,^{1*} A. Bannink,² L. A. Crompton,³ P. Huhtanen,⁴ M. Kreuzer,⁵ M. Mc C. K. Reynolds,³ A. R. Bayat,⁸ D. R. Yáñez-Ruiz,⁹ J. Dijkstra,¹⁰ E. Kebreab,¹¹ A. K. J. Shingfield,^{8,12,‡} and Z. Yu¹³



Contents lists available at [ScienceDirect](#)

Animal Feed Science and Technology

journal homepage: www.elsevier.com/locate/anifeedsci



Review article

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



Contents lists available at [ScienceDirect](#)

Science of the Total Environment

journal homepage: www.elsevier.com/locate/scitotenv



Review

Challenges and opportunities to capture dietary effects in on-farm greenhouse gas emissions models of ruminant systems



Contents lists available at [ScienceDirect](#)

Science of the Total Environment

journal homepage: www.elsevier.com/locate/scitotenv



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}



PNAS

RESEARCH ARTICLE

SUSTAINABILITY SCIENCE

OPEN ACCESS



Full adoption of the most effective strategies to mitigate methane emissions by ruminants can help meet the 1.5 °C target by 2030 but not 2050

Claudia Arndt^{a,1}, Alexander N. Hristov^b, William J. Price^c, Shelby C. McClelland^d, Amalia M. Pelaez^{b,e}, Sergio F. Cueva^b, Joonpyo Oh^b, Jan Dijkstra^e, André Bannink^e, Ali R. Bayat^f, Les A. Crompton^g, Maguy A. Eugène^h, Dolapo Enahoro^a, Ermias Kebreabⁱ, Michael Kreuzer^j, Mark McGee^k, Cécile Martin^h, Charles J. Newbold^l, Christopher K. Reynolds^g, Angela Schwarm^m, Kevin J. Shingfield^{f,2},

Journal of Cleaner Production 384 (2023) 135523

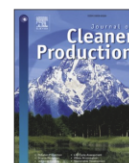


ELSEVIER

Contents lists available at ScienceDirect

Journal of Cleaner Production

journal homepage: www.elsevier.com/locate/jclepro



Prediction of enteric methane emissions by sheep using an intercontinental database

Alejandro Belanche^{a,b,*}, Alexander N. Hristov^c, Henk J. van Lingen^d, Stuart E. Denman^e, Ermias Kebreab^f, Angela Schwarm^g, Michael Kreuzer^h, Mutian Niu^h, Maguy Eugèneⁱ, Vincent Niderkorn^j, Cécile Martin^j, Harry Archimède^j, Mark McGee^k, Christopher K. Reynolds^l, Les A. Crompton^l, Ali Reza Bayat^m, Zhongtang Yuⁿ, André Bannink^o, Jan Dijkstra^p, Alex V. Chaves^q, Harry Clark^r, Stefan Muetzel^s, Vibeke Lind^t, Jon M. Moorby^u, John A. Rooke^v, Aurélie Aubry^w, Walter Antezana^x, Min Wang^y, Roger Hegarty^z, V. Hutton Oddy^{aa}, Julian Hill^{ab}, Philip E. Vercoe^{ac,ad}, Jean Víctor Savian^{ae}, Adibe Luiz Abdalla^{af}, Yosra A. Soltan^{ag}, Alda Lúcia Gomes Monteiro^{ah}, Juan Carlos Ku-Vera^{ai}, Gustavo Jaurena^{aj}, Carlos A. Gómez-Bravo^{ak}, Olga L. Mayorga^{al}, Guilherme F.S. Congio^{am}, David R. Yáñez-Ruiz^{a,**}

Latin America methane Project Collaborators¹, Alexander N. Hristov^{d,**}



ELSEVIER

Science of The Total Environment

Volume 825, 15 June 2022, 153982

Prediction of enteric methane production and yield in dairy cattle using a Latin America and Caribbean database

Guilherme F.S. Congio^a, André Bannink^b, Olga L. Mayorga^c, João P.P. Rodrigues^d, Adeline Bougouin^e, Ermias Kebreab^e, Ricardo R. Silva^f, Rogério M. Maurício^g, Sila C. da Silva^a, Patrícia P.A. Oliveira^h, Camila Muñozⁱ, Luiz G.R. Pereira^j, Carlos Gómez^k, Claudia Ariza-Nieto^c, Henrique M.N. Ribeiro-Filho^l, Octavio A. Castelán-Ortega^m, Jaime R. Rosero-Nogueraⁿ, Maria P. Tieri^o, ... Alexander N. Hristov^u



ScienceDirect

Production

www.elsevier.com/locate/jclepro



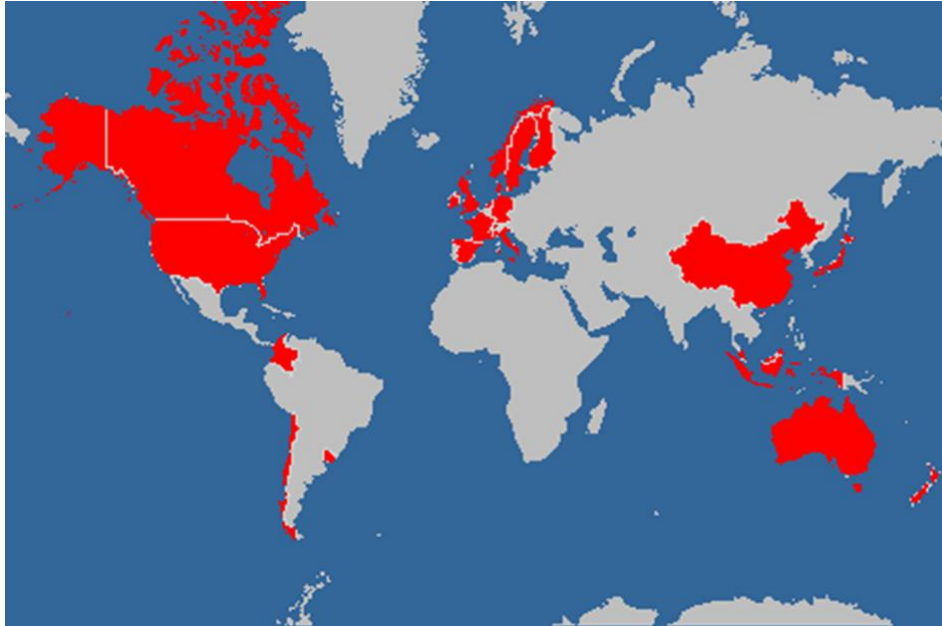
livestock systems in the
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za Lucía Mayorga Mogollón^a,

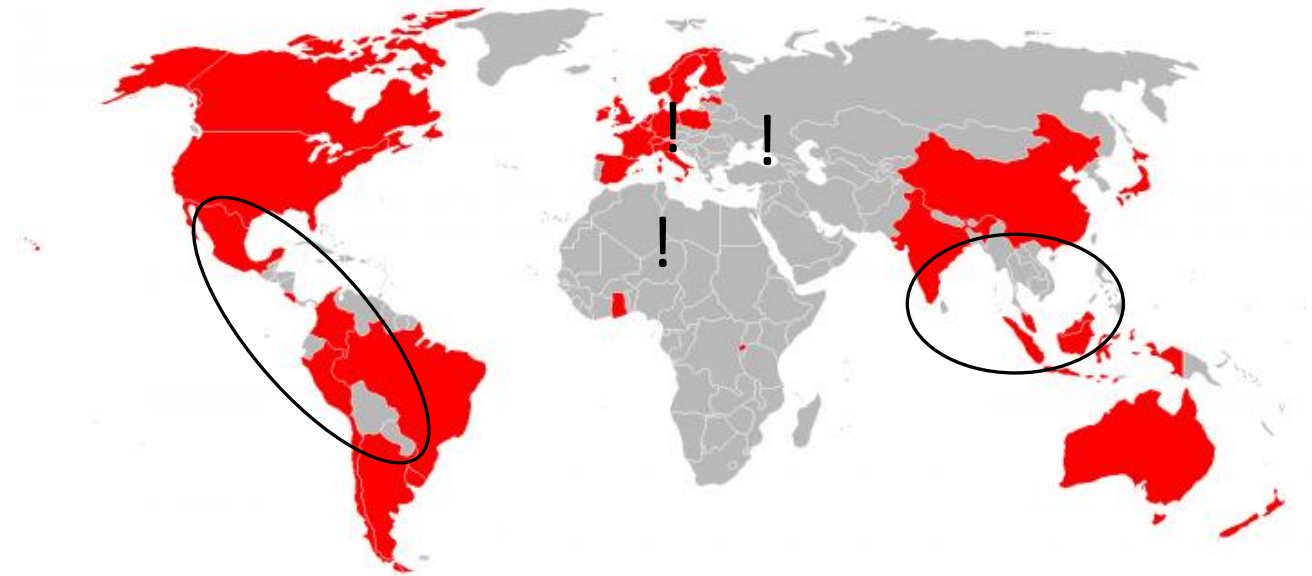


Countries represented in FNN

2014



Since 2020 Enteric Methane Flagships for Latin-America/Caribbean & SouthEast Asia + feed additives



- **120 members:** New colleagues joined since January 2024 = 32 from 8 countries

- Projects (**Global Network** 2014-2017; **CEDERS** 2017-2021; **Integrity** 2022-2025)
- Latin American/Caribbean and SouthEast Asian projects
- GRA **flagship** on **FEED ADDITIVES** 2022-2025
- Africa / Eastern Europe / Middle East?

Flagship project Feed additives

60 RESEARCHERS

23 COUNTRIES

46 INSTITUTIONS



GLOBAL DAIRY PLATFORM



NEW ZEALAND
AGRICULTURAL GREENHOUSE GAS
Research Centre

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



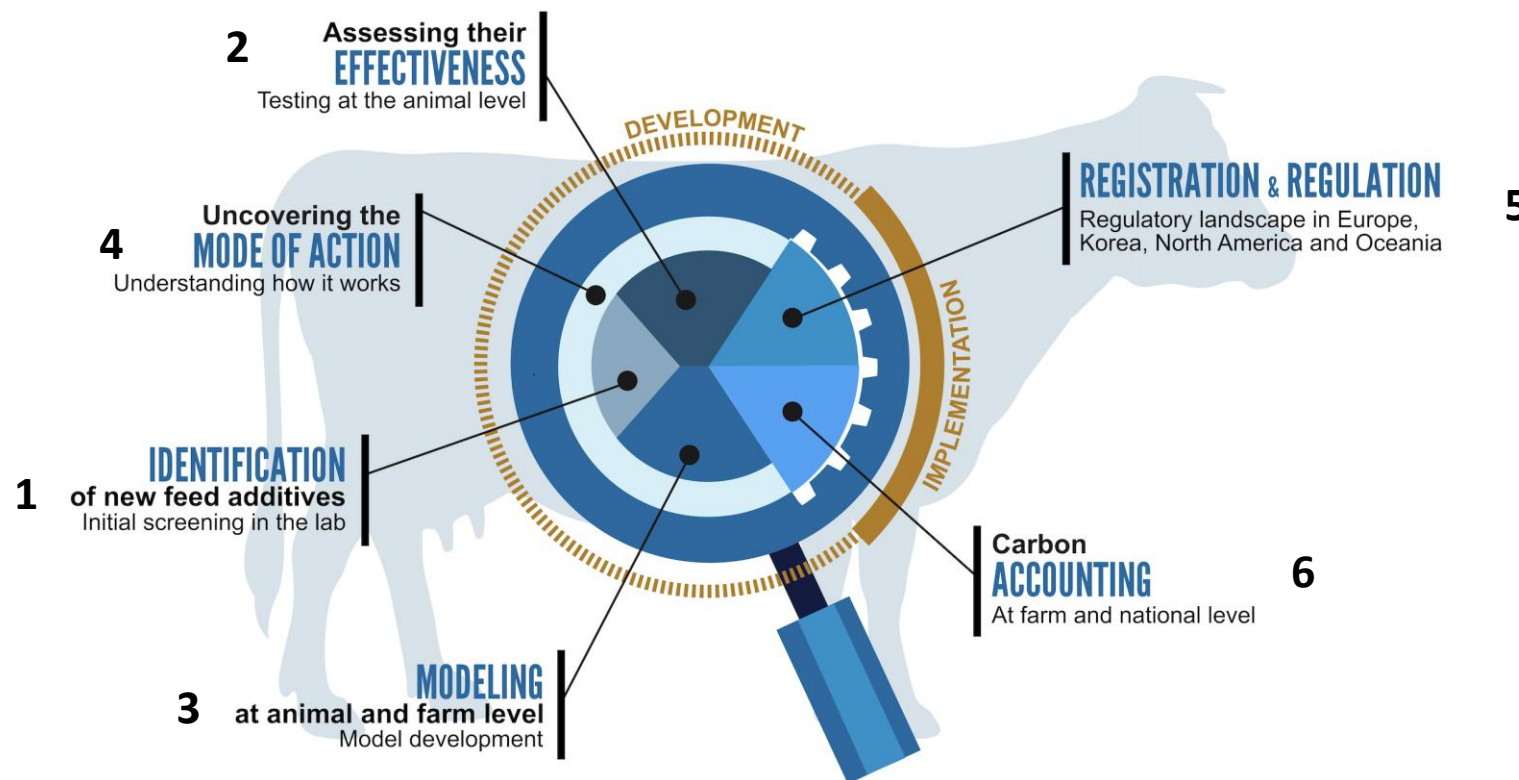
Ronaldo Vibart

Flagship project Feed additives

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TECHNICAL GUIDELINES TO DEVELOP AND IMPLEMENT ANTI-METHANOGENIC FEED ADDITIVES



Flagship project Feed additives

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

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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 Crusemann,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
<https://doi.org/10.3168/jds.2024-25050>

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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*}

JDS25050



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

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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 Guilherme 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>

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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
<https://doi.org/10.3168/jds.2024-25051>

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Special Issue: Regulatory frameworks and scientific evidence requirements for the authorization of feed additives to mitigate ruminant methane emissions

Ian 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-Ruiz⁸

JDS25051



J. Dairy Sci. 108:411–429
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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 Dorileo Leite,³ Andre M. Mazzetto,⁹ Bradley G. Ridoutt,^{10,11} David R. Yáñez-Ruiz,¹² and André Bannink¹³

- Bimonthly list of papers published by the groups in the network + jobs offers/opportunities
- Webinars x 2 – February 2025 – Feed additives Special Issue webinar (97 + 167 participants)
- Annual workshop – 7th October 2025
 - Updates
 - Attract African countries
 - Future activities
 - new coordinator(s)



9th GGAA
2025 · Nairobi, Kenya
5 - 9 October

International Greenhouse
Gas & Animal Agriculture
Conference

- Bimonthly list of papers published by the groups in the network + jobs offers/opportunities

	A	B	C	D	E	F
1	TITLE	Contact	DOI	Summary	Link	
2	Effect of combining the methanogenesis inhibitor 3-nitrooxypropanol ar	Muñoz, C., I. A. Muñoz,	https://doi	No single enteric CH ₄ mitig	https://www.scienc	
3	Indications for a lower methane yield from digested fibre in ruminants di	M. Terranova a,*, M. Kre	https://doi	It is assumed that the absolute amount of meth		
4	Evaluation of ruminal methaneand ammonia formation and microbiotac	Giulia Foggi 1*, Melissa	https://doi	Background Dietary supplements based on tan		
5	Predicting CO2 production of lactating dairy cows from animal, dietary, &	M. H Kjeldsen,1 * M. Joh	https://doi	Automated measurements of the ratio of conce		
6	Antimethanogenic activity of Monascus metabolites in the rumen reveale	Boudra, H., E. Rathahao	http://doi.	Monascus-fermented cereals reduce methane p		
7	Evaluating the effect of phenolic compounds as hydrogen acceptors wher	Huang, R., P. Romero, A	http://doi.	Some antimethanogenic feed additives for rum		
8	Crop-livestock-forestry systems as a strategy for mitigating greenhouse ga	Monteiro, A., L. Barreto	http://doi.	Intensification of livestock systems becomes es		
9	Review: Reducing enteric methane emissions improves energy metabolis	Morgavi, D. P., G. Canta	http://doi.	The production of enteric methane in the gastr		
10	Exploring the combination of Asparagopsis taxiformis and phloroglucino	Romero, P., E. M. Unger	http://doi.	Many strategies for mitigating enteric methane		
11	Recent Advances in Enteric Methane Mitigation and the Long Road to Sus	Roques, S., G. Martinez-	http://doi.	Mitigation of methane emission, a potent gree		
12	«Iodine intake and excretion from sheep supplemented with macroalgae	Vibeke Lind <vibeke.lind	10.3389/fa	The paper is a first of three	https://www.front	
13	Effects of graded levels of dietary pomegranate peel on methane and nitro	Niu P, Kreuzer M, Lieseg	10.3168	This study aimed to quantif	https://doi.org/10	
14	Rumen microbial degradation of bromoformfrom red seaweed (Asparago	Alejandro Belanchebela	10.1186/s4	This study aimed to investig	https://doi.org/10	
15	Evaluating the effect of phenolic compounds as hydrogen acceptorswhen	Alejandro Belanchebela	10.1016/j.j	Most mitigation strategies	https://doi.org/10	
16	Beef production and the beef evaluation system in Chile: Description, cha	Arias, RA.	https://doi	• Most Chilean beef production is based on pas		
17	Effect of a blend of cinnamaldehyde, eugenol and capsicum oleoresin on i	Sara M Tondini, Ali R I	https://doi	The objective of this stud	https://www.scienc	
18						

Database of papers published by members

FNN workshop at GGAA 2025

17:00-17:15: Workshop presentation and overview of FNN activities

David Yáñez-Ruiz, CSIC, Spain

17:15-17:45: Update on exploring a new modelling approach to help understand the variability in response to methane reducing feed additives.

Margaret Hill, Global Methane Hub

17:45-18:00: 'Research in Animal Production in Cameroon, potential links with FNN'

Kingsley A. ETCHU, IRAD, Cameroon

18:00-18:15: GEMS project - Accurate Gas Emissions Measures from Cattle with the GreenFeed System

Muthian Niu, ETH Zurich, Switzerland

18:15-18:30: MIPCLAN- Mitigation practices for low-carbon Livestock in sub-Saharan Africa (Living lab)

Tobi Akinropo, INRAe, France

18:30-19:00: Challenges and opportunities, future projects and steps of the network

David Yáñez-Ruiz, CSIC, Spain

André Bannink, WR, Netherlands

Florencia García, UNC, Argentina



- Follow up opportunities after Flagship project on ‘feed additives’: implementation
- Physiological aspects affecting response to feed additives
- Mapping feeding practices globally – FAO GLEAM
- Mitigating nutritional strategies in grazing systems
- How to better connect nutritionists with microbiome studies: training
- Needs and opportunities to expand FNN in Africa – capacity building (28 requests to join FNN)

- Coordination of FNN

Michael Kreuzer,

Alex Hristov, André Bannink, David Yanez

Florencia García & Sanne van Gastelen



Thank you

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