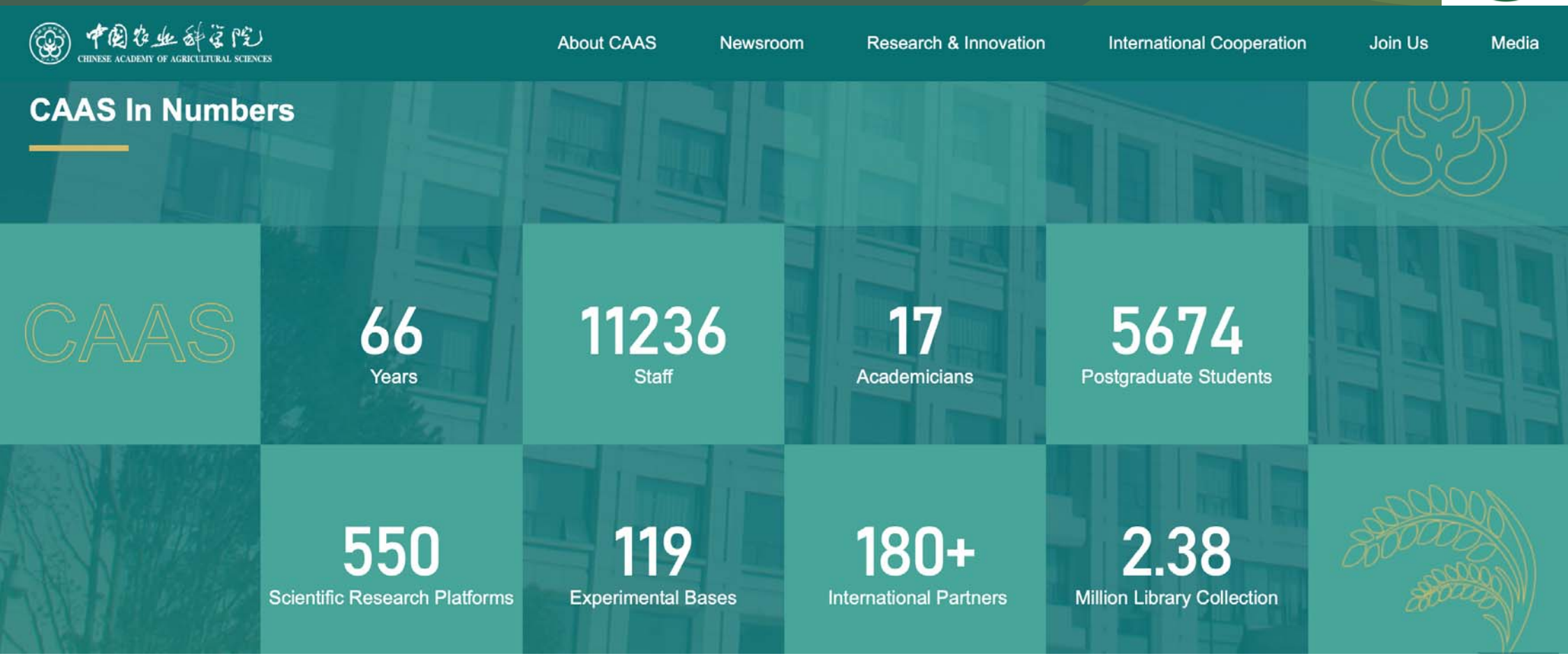
Methane emission from ruminants and current advances in mitigation strategies in China and India

Tao Ma

May 23, 2024

Bled

Introduction of CAAS



Introduction of CAAS

Research Institutes in Beijing

- Institute of Crop Sciences
- Institute of Plant Protection
- Institute of Vegetables and Flowers
- Institute of Environment and Sustainable Development in Agricultural
- Institute of Animal Sciences
- Institute of Apicultural Research
- Institute of Feed Research
- Institute of Food Science and Technology
- Biotechnology Research Institute
- Institute of Agricultural Economics and Development
- Institute of Agricultural Resources and Regional Planning
- Agricultural Information Institute
- Institute of Quality Standards and Testing Technology for Agro-Products
- Institute of Food and Nutrition Development of MARA

Research Institutes outside Beijing

- Institute of Farmland Irrigation
- China National Rice Research Institute
- Institute of Cotton Research
- Oil Crops Research Institute
- Institute of Bast Fiber Crops
- Institute of Pomology
- Zhengzhou Fruit Research Institute
- Tea Research Institute
- Harbin Veterinary Research Institute
- Lanzhou Veterinary Research Institute
- Lanzhou Institute of Husbandry and Pharmaceutical Sciences
- Shanghai Veterinary Research Institute
- Institute of Grassland Research
- Institute of Special Animal and Plant Sciences
- Agro-Environmental Protection Institute of MARA
- Biogas Institute of MARA
- Nanjing Institute of Agricultural Mechanization of MARA

Our research fields

- Improving health and growth of young ruminants through multiple strategies
- Determining the nutrient requirements of indigenous sheep and goat breeds
- Enhancing energy utilization efficiency of ruminants and methane mitigation
- Developing agro-byproducts that could replace soybean meal and high-quality grass

Our research facilities

Individual feeding stall

Automated calculation of feed intake

Studies of energy metabolism and methane mitigations

- Determining energy requirement of indigenous sheep
- Evaluating the effect of plant extract/microorganisms on methane emission

Studies of energy metabolism and methane mitigations

- Quantifying methane emission from Chinese Holstein cows
- Evaluating the effect of plant extract/microorganisms on methane emission

International collaboration on methane mitigation

- Collaborating with Prof. Alex Hristov since 2015

Ruminant population in China and India

In 2022, the population of ruminants in China and India reached 945 million, accounting for up to 22% of the global population (4.22 billion)

Buffalo	Value
India	111,856,246
Pakistan	43,676,000
China	26,875,125
Nepal	5,132,931
Philippines	2,774,471
Vietnam	2,231,600
Myanmar	2,000,000
Brazil	1,598,268
Bangladesh	1,508,000
Egypt	1,419,927

Cattle	Value
Brazil	234,352,649
India	193,606,913
USA	92,076,600
Ethiopia	67,961,433
China	61,390,129
Argentina	54,242,595
Pakistan	53,436,000
Mexico	36,338,366
Chad	35,749,982
Sudan	32,318,770

Goat	Value
India	149,994,093
China	132,359,660
Nigeria	88,037,053
Pakistan	82,503,000
Bangladesh	60,000,000
Ethiopia	49,323,166
Chad	46,438,592
Kenya	34,529,910
Sudan	32,598,924
Mali	27,832,624

Sheep	Value
China	194,030,298
India	75,345,847
Australia	70,234,655
Iran	55,582,000
Nigeria	50,284,350
Chad	45,081,553
Turkey	44,687,888
Sudan	41,332,641
Ethiopia	35,069,956
UK	33,066,000

FAOSTAT

Intensive sheep and goat farms in China

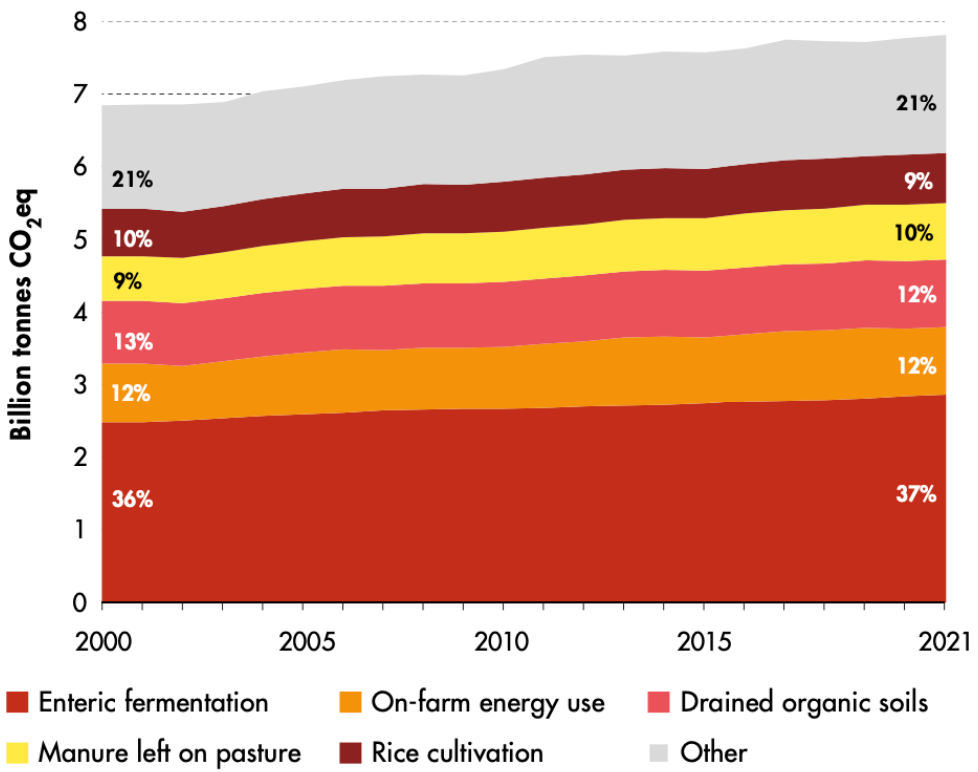
- Increasing s&g population and limited land for grazing
- Policy-oriented (~50% farms are expected to be intensive by 2025)

Smallholder dairy cattle farms in India

- Contributing to ~25% of the global milk production
- Employing more than 80 million farmers with 70% being smallholder farmers
- On average 2.2 milking cows and 0.7 milking buffaloes (Lindahl et al., 2020)

Overview of world GHG sources

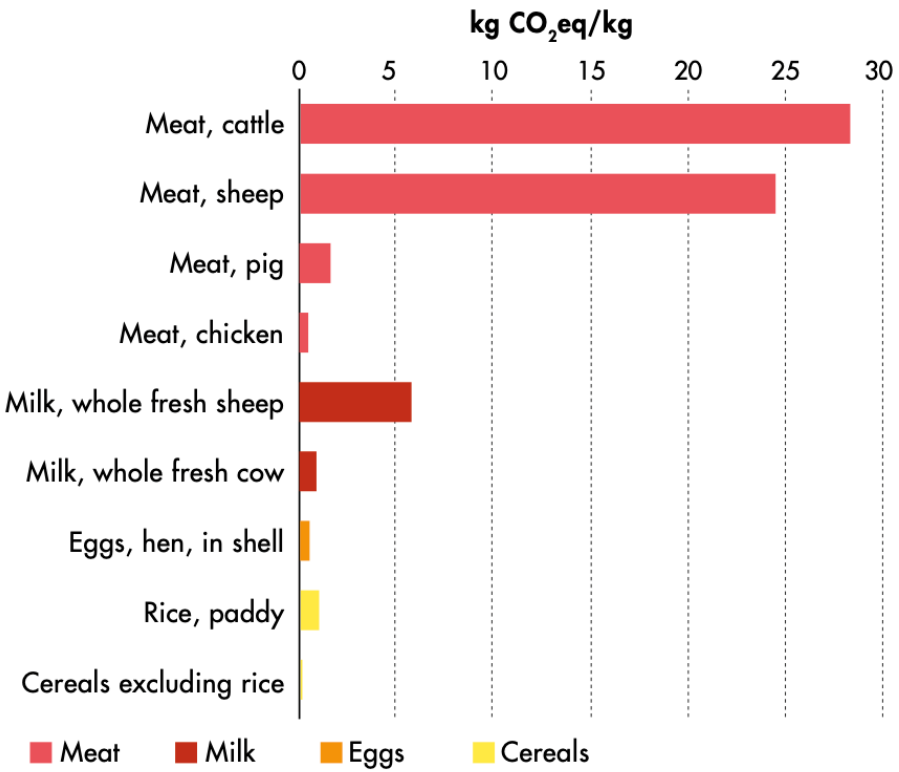
WORLD FARM-GATE GREENHOUSE GAS EMISSIONS BY ACTIVITY



Note: Percentages on the figure indicate the shares in the total; they may not tally due to rounding.

Source: FAO. 2023. Emissions totals. In: *FAOSTAT*. Rome. [Cited October 2023].
https://www.fao.org/faostat/en/#data/GT
Download: https://doi.org/10.4060/cc8166en-fig67

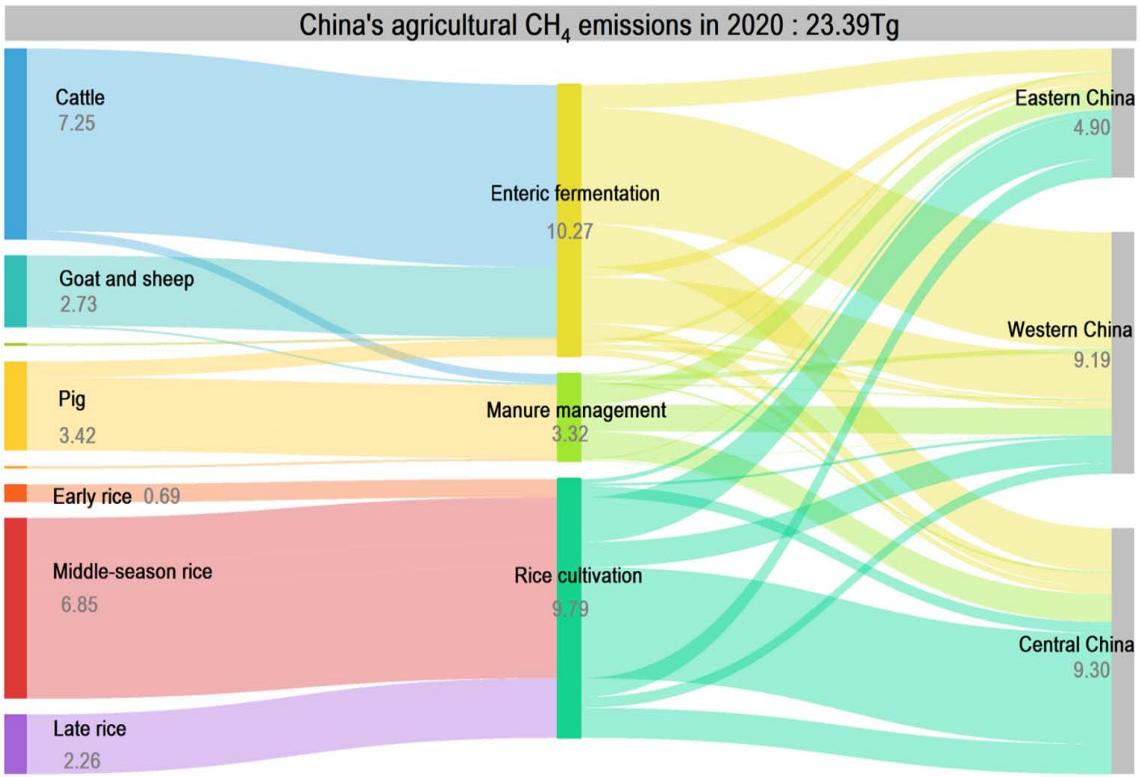
WORLD EMISSIONS INTENSITY OF AGRICULTURAL COMMODITIES (2021)



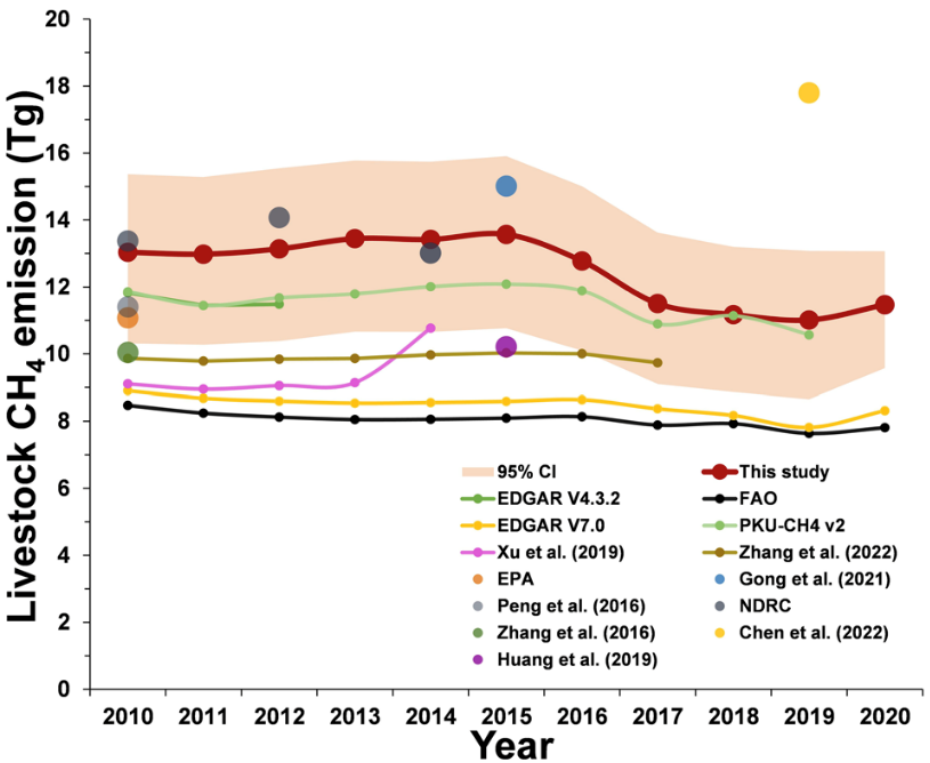
Source: FAO. 2023. Emissions intensities. In: *FAOSTAT*. Rome. [Cited October 2023].
https://www.fao.org/faostat/en/#data/EI
Download: https://doi.org/10.4060/cc8166en-fig68

Livestock CH_4 emissions in China

- Enteric fermentation contributes to 10.27Tg of the total 23.39Tg CH_4 emission



Duan et al., 2023



Du et al., 2024

Livestock CH4 emissions in India

- Methane emission from livestock animals reaches 12.74Tg

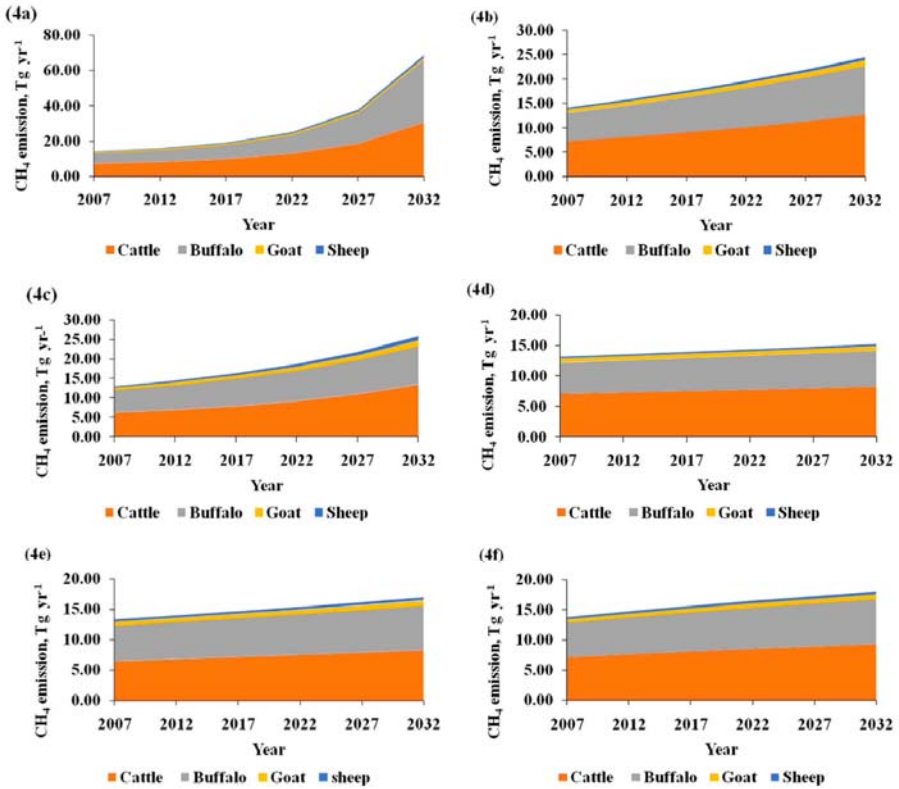
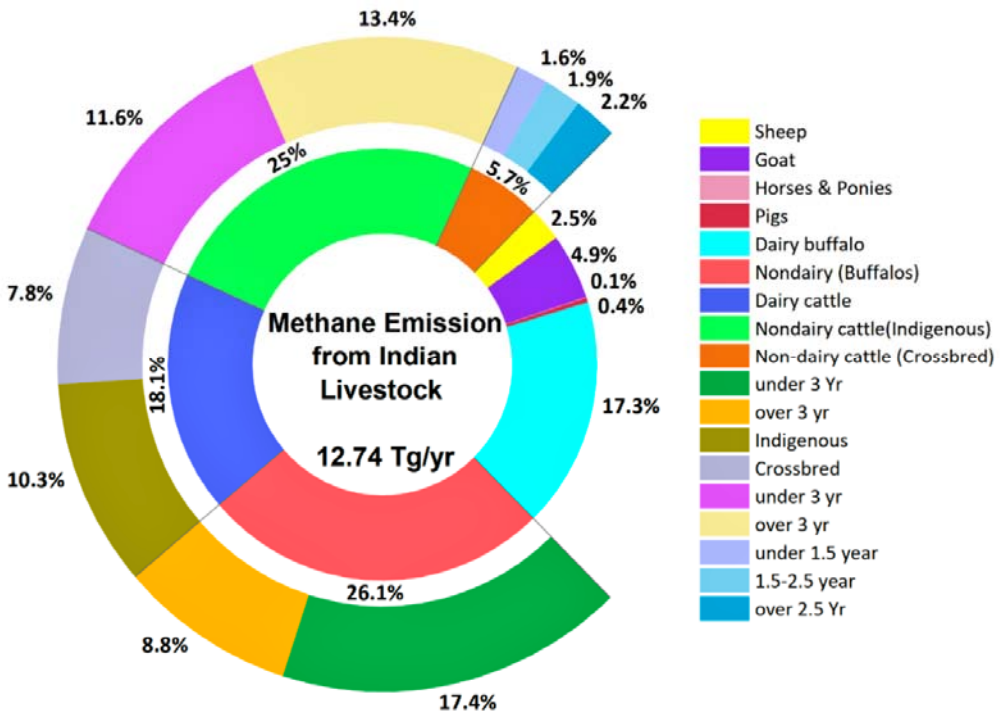


Fig. 4. Projected CH_4 emissions from livestock under different scenarios: (a): Under BS-I; (b): Under BS-II; (c): Under BS-III; (d): Under MS-I; (e): Under MS-II; (f): Under MS-III.

Kumari et al., 2016



Samal et al., 2024

Agro-byproducts used for ruminants in China and India

Oil rape/canola straw



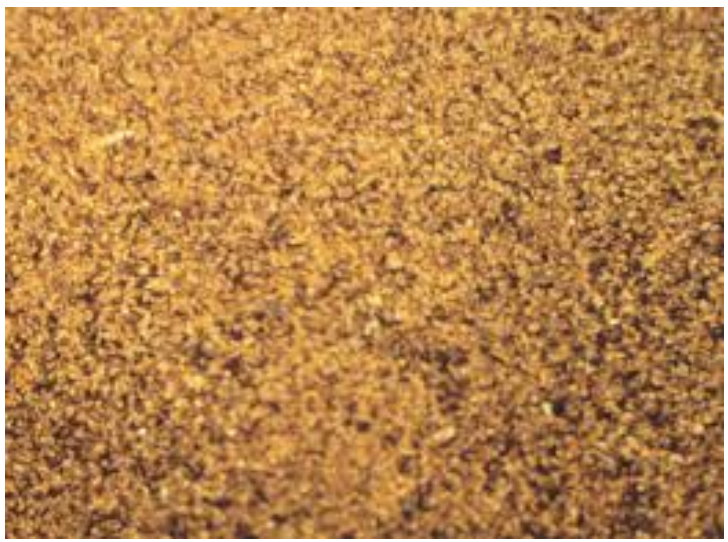
Paddy straw



Agro-byproducts used for ruminants in China and India

Seeking for soybean meal ‘replacer’

China imported 100.86 million tonnes of soybeans in marketing year 2022-23 on the strength of Brazilian shipments, and sustained demand from the country’s feed sector is expected to push 2023-24 to similar levels.



Canola meal

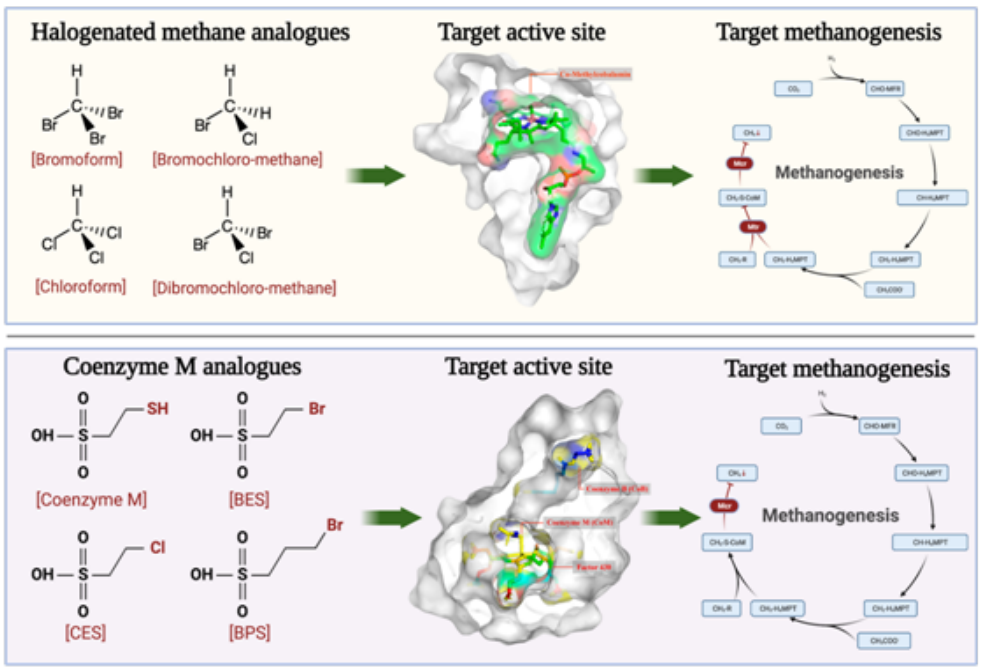
Cottonseed meal

Sunflower seed meal

Feed additives for methane mitigation in China and India

Tannins and saponin-based products

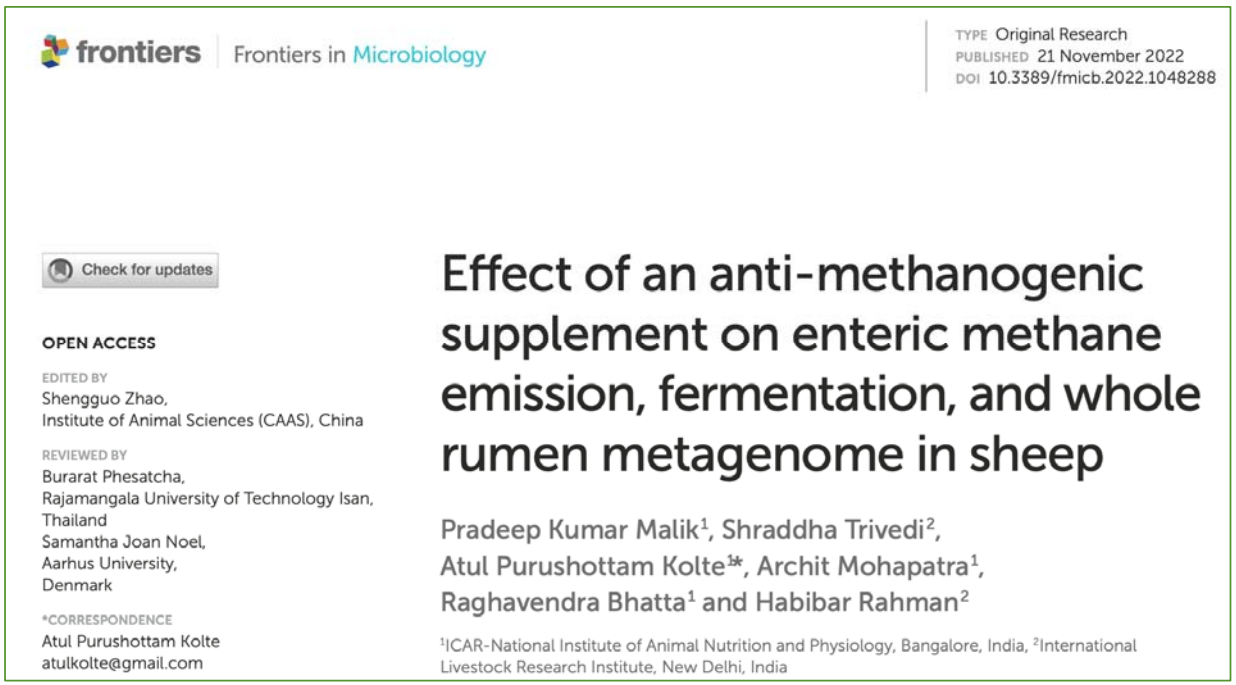
In silico method to screen potential feed additives



Feed additives for methane mitigation in China and India

The anti-methanogenic supplement has the potential to decrease enteric methane emission (~22%) at the recommended level (5% of DM) of supplementation

Supplementation of rosmarinic acid (molecular docker approach) decreased hydrogen production and methane production



frontiers | Frontiers in Microbiology

TYPE Original Research
PUBLISHED 21 November 2022
DOI 10.3389/fmicb.2022.1048288

Check for updates

OPEN ACCESS

EDITED BY
Shengguo Zhao,
Institute of Animal Sciences (CAAS), China

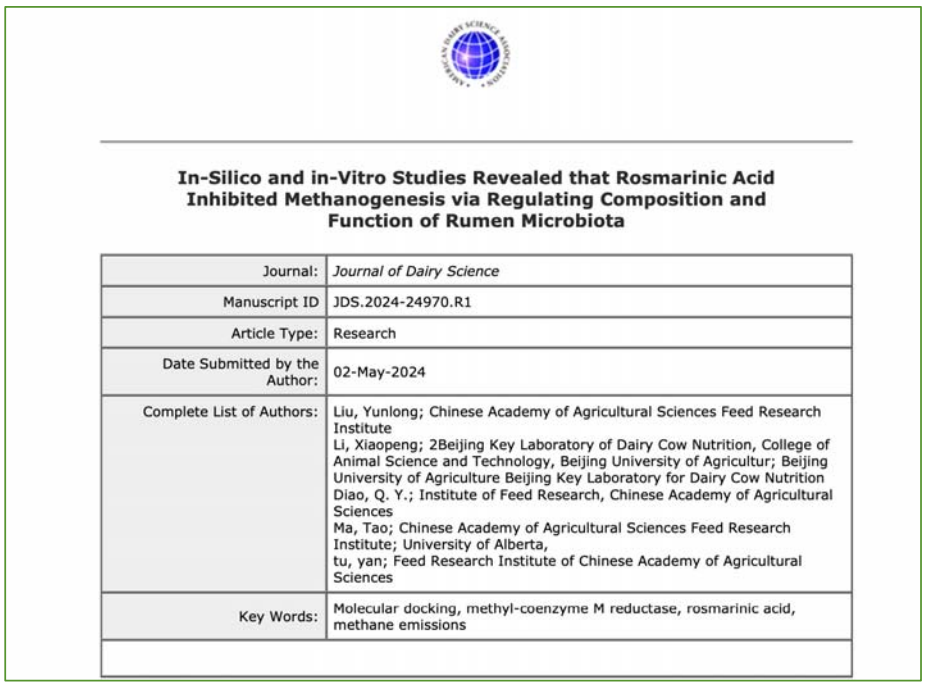
REVIEWED BY
Burarat Phesatcha,
Rajamangala University of Technology Isan, Thailand
Samantha Joan Noel,
Aarhus University,
Denmark

*CORRESPONDENCE
Atul Purushottam Kolte
atulkolte@gmail.com

Effect of an anti-methanogenic supplement on enteric methane emission, fermentation, and whole rumen metagenome in sheep

Pradeep Kumar Malik[1], Shraddha Trivedi[2], Atul Purushottam Kolte[1]*, Archit Mohapatra[1], Raghavendra Bhatta[1] and Habibar Rahman[2]

[1]ICAR-National Institute of Animal Nutrition and Physiology, Bangalore, India, [2]International Livestock Research Institute, New Delhi, India

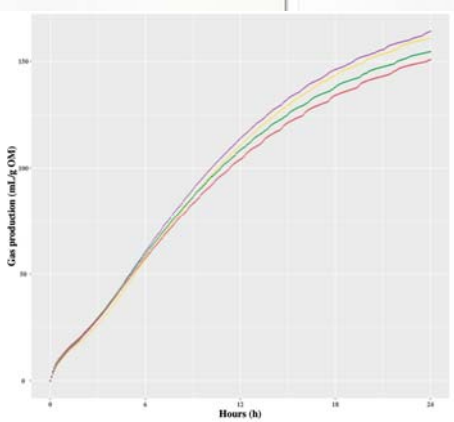


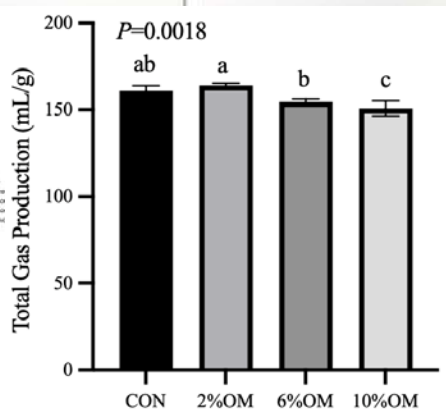
In-Silico and in-Vitro Studies Revealed that Rosmarinic Acid Inhibited Methanogenesis via Regulating Composition and Function of Rumen Microbiota

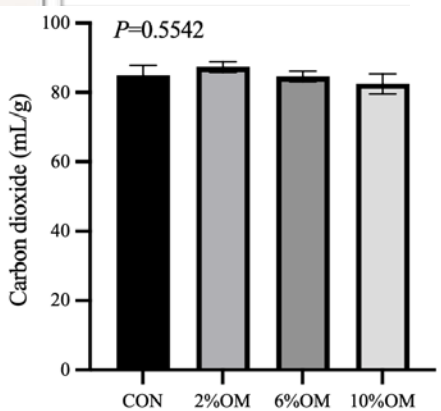
Journal:	*Journal of Dairy Science*
Manuscript ID	JDS.2024-24970.R1
Article Type:	Research
Date Submitted by the Author:	02-May-2024
Complete List of Authors:	Liu, Yunlong; Chinese Academy of Agricultural Sciences Feed Research Institute Li, Xiaopeng; 2Beijing Key Laboratory of Dairy Cow Nutrition, College of Animal Science and Technology, Beijing University of Agricultur; Beijing University of Agriculture Beijing Key Laboratory for Dairy Cow Nutrition Diao, Q. Y.; Institute of Feed Research, Chinese Academy of Agricultural Sciences Ma, Tao; Chinese Academy of Agricultural Sciences Feed Research Institute; University of Alberta, tu, yan; Feed Research Institute of Chinese Academy of Agricultural Sciences
Key Words:	Molecular docking, methyl-coenzyme M reductase, rosmarinic acid, methane emissions

Feed additives for methane mitigation in China and India

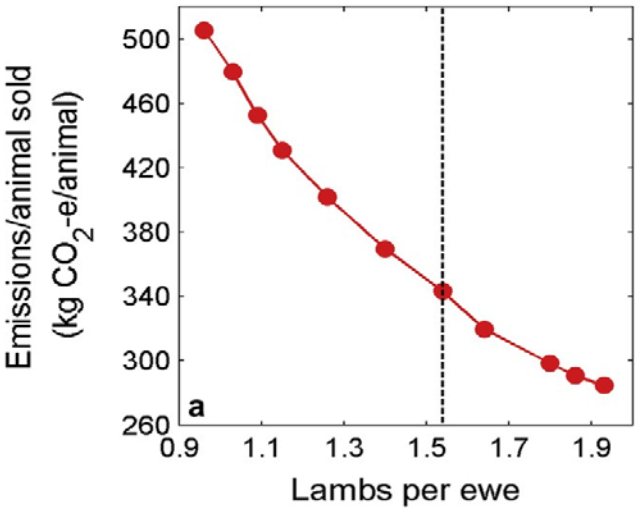
Evaluation the efficacy of different seaweed species

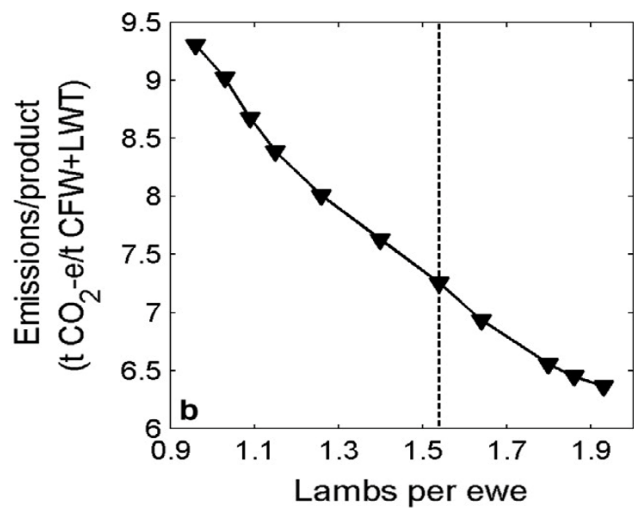






Genetic efforts in breeding animals in China





♂ East Frisian

♀ Small-tailed Han

♂ F1

♀ Hu

F2
(1/4EF 1/4Han 2/4Hu)

Trait recording organizations in China

Scientific Data Center, Chinese Academy of Sciences

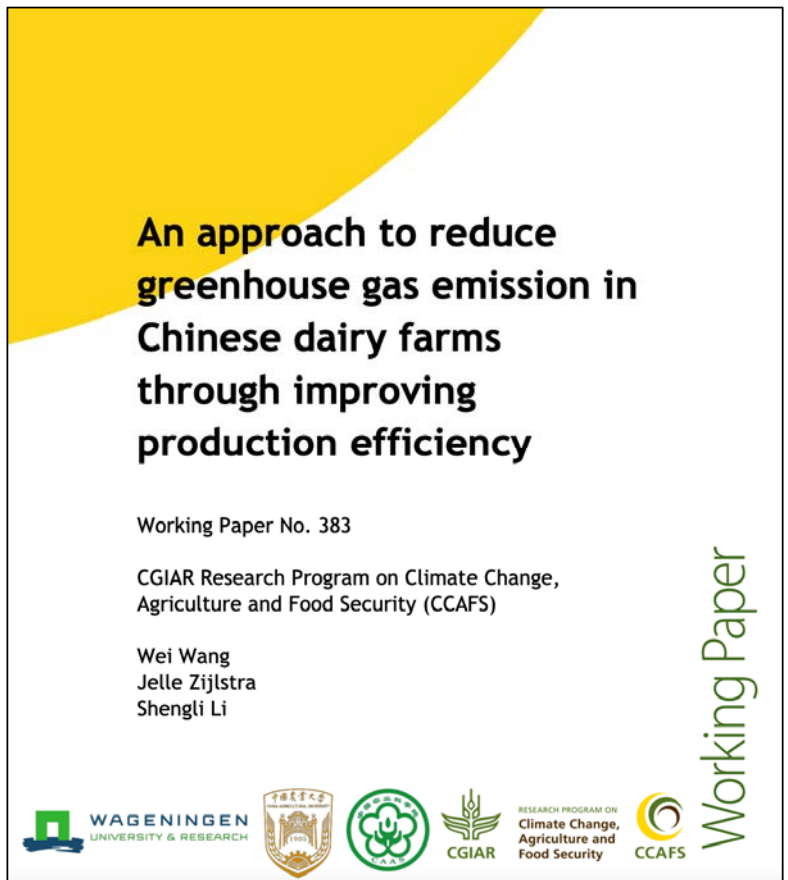
EYIMU company

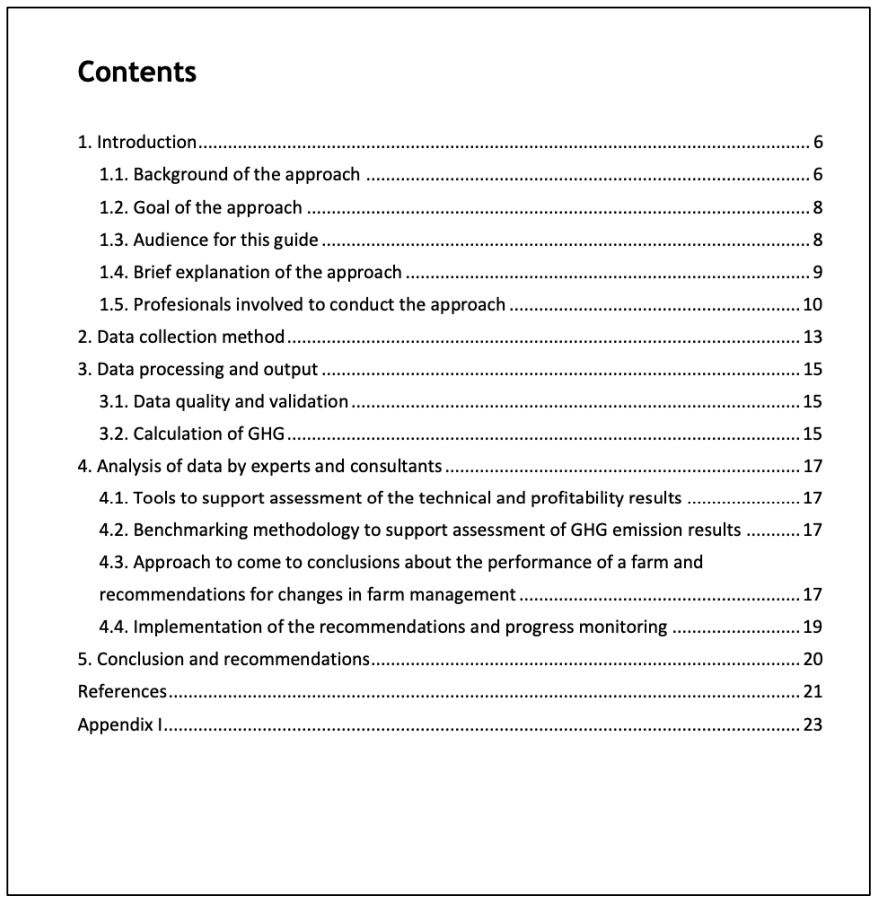
Trait recording organizations in India

National Dairy Development Board

Ways to accelerate low methane emission breeding

Data collection is priority-herd characteristics, feeding input, feed formulation, energy consumption, manure management/disposal





Contents

Ways to accelerate low methane emission breeding

Joint research

•Bio-economic model and life cycle assessment (LCA) analysis were combined to determine the intensity values (IVs) of important genetic traits of dairy cows.

•Different selection indices were developed based on different breeding goals.

•Based on the indices, farm profit and GHG emission intensity can be balanced.

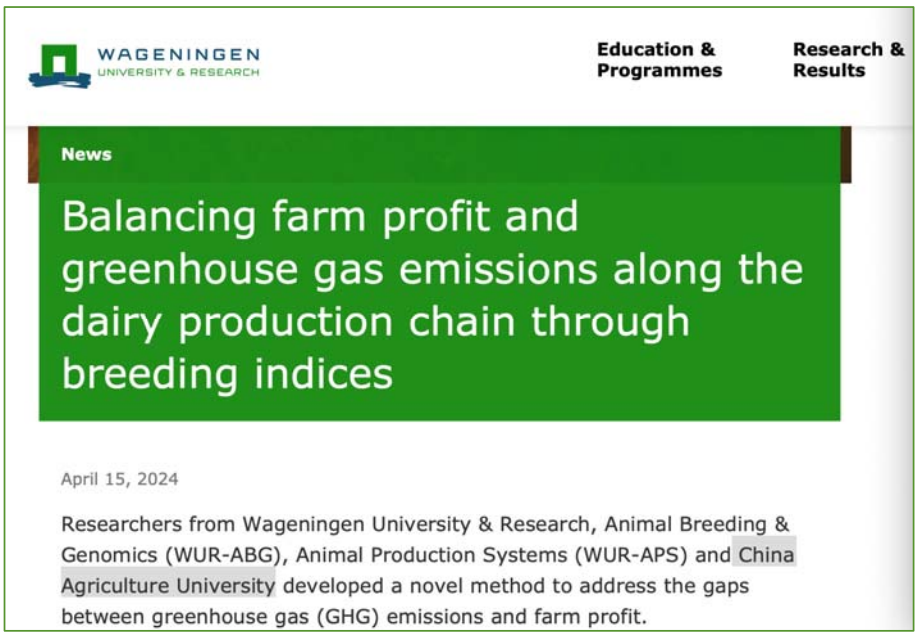
ELSEVIER

Journal of Cleaner Production

Volume 451, 20 April 2024, 142099

Balancing farm profit and greenhouse gas emissions along the dairy production chain through breeding indices

Rui Shi [a b c 1], Yue Wang [b 1], Corina E. van Middelaar [b], Bart Ducro [c], Simon J. Oosting [b], Yong Hou [d], Yachun Wang [a], Aart van der Linden [b]



WAGENINGEN UNIVERSITY & RESEARCH

Education & Programmes

Research & Results

News

Balancing farm profit and greenhouse gas emissions along the dairy production chain through breeding indices

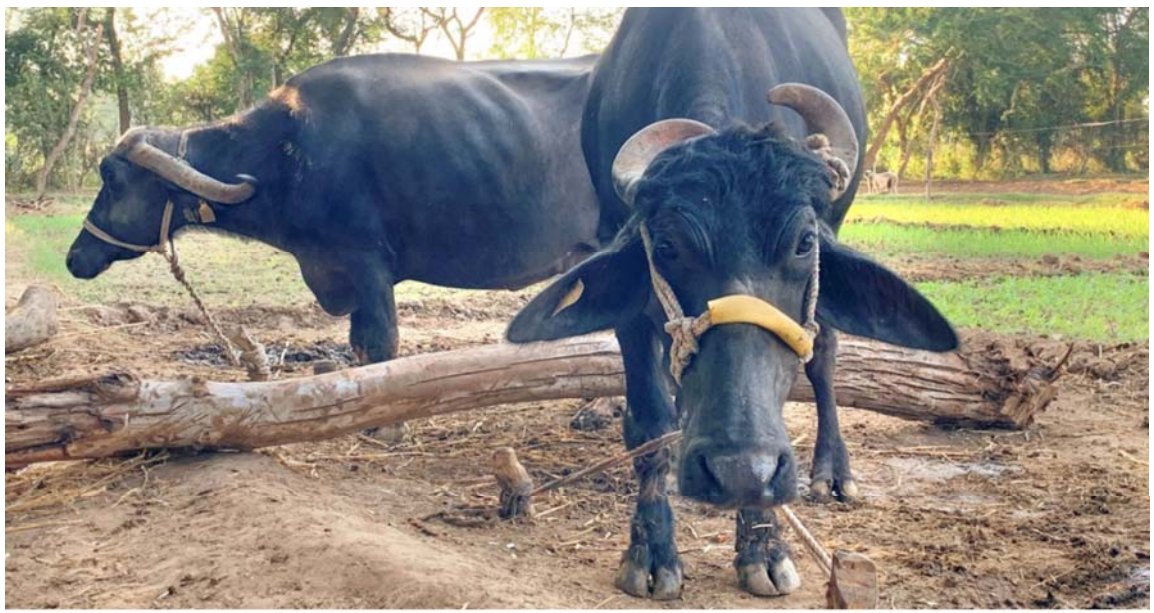
April 15, 2024

Researchers from Wageningen University & Research, Animal Breeding & Genomics (WUR-ABG), Animal Production Systems (WUR-APS) and China Agriculture University developed a novel method to address the gaps between greenhouse gas (GHG) emissions and farm profit.

Joint research

There's currently a shortage of feed in India, so farmers give their cattle whatever they can, which is mostly lower quality and higher emitting. Whatever measures are taken to reduce methane emissions, it should have **minimal impact on farmers' livelihoods**, and should account for the ways people raise their livestock.

https://apnews.com/article/methane-emissions-dairy-farming-climate-change-india-global-warming-agriculture-5aa77866e27f6d94e14e4e394e0b7201



Joseph McFadden/Provided

Horned cattle on a typical smallholder farm in India, a country which is home to more than 300 million cattle and 85 million small farms.

Cornell, EDF aim to reduce methane output for India's dairies

THANKS FOR YOUR ATTENTION

中国农业科学院饲料研究所
INSTITUTE OF FEED RESEARCH OF CHINESE ACADEMY OF AGRICULTURAL SCIENCES