



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

Tao Ma
May 23, 2024
Bled

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Introduction of CAAS



Research Institutes in Beijing

- ★ Institute of Crop Sciences
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- ★ Institute of Quality Standards and Testing Technology for Agro-Products
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Research Institutes outside Beijing

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- ★ 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



反刍动物及其幼畜营养代谢
中美联合研究中心

Sino-US Joint Lab on
Nutrition and Metabolism of Ruminants

Program of
International S&T Cooperation
国际科技合作 (2016YFE0100001)

中央级公益性科研院所基本科研业务专项
Fund for Central Non-profit
Scientific Institution (Y2010PT151)

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 | Cattle | Value | Goat | Value | Sheep | Value |
|-------------|-------------|-----------|-------------|------------|-------------|-----------|-------------|
| India | 111,856,246 | Brazil | 234,352,649 | India | 149,994,093 | China | 194,030,298 |
| Pakistan | 43,676,000 | India | 193,606,913 | China | 132,359,660 | India | 75,345,847 |
| China | 26,875,125 | USA | 92,076,600 | Nigeria | 88,037,053 | Australia | 70,234,655 |
| Nepal | 5,132,931 | Ethiopia | 67,961,433 | Pakistan | 82,503,000 | Iran | 55,582,000 |
| Philippines | 2,774,471 | China | 61,390,129 | Bangladesh | 60,000,000 | Nigeria | 50,284,350 |
| Vietnam | 2,231,600 | Argentina | 54,242,595 | Ethiopia | 49,323,166 | Chad | 45,081,553 |
| Myanmar | 2,000,000 | Pakistan | 53,436,000 | Chad | 46,438,592 | Turkey | 44,687,888 |
| Brazil | 1,598,268 | Mexico | 36,338,366 | Kenya | 34,529,910 | Sudan | 41,332,641 |
| Bangladesh | 1,508,000 | Chad | 35,749,982 | Sudan | 32,598,924 | Ethiopia | 35,069,956 |
| Egypt | 1,419,927 | Sudan | 32,318,770 | Mali | 27,832,624 | 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

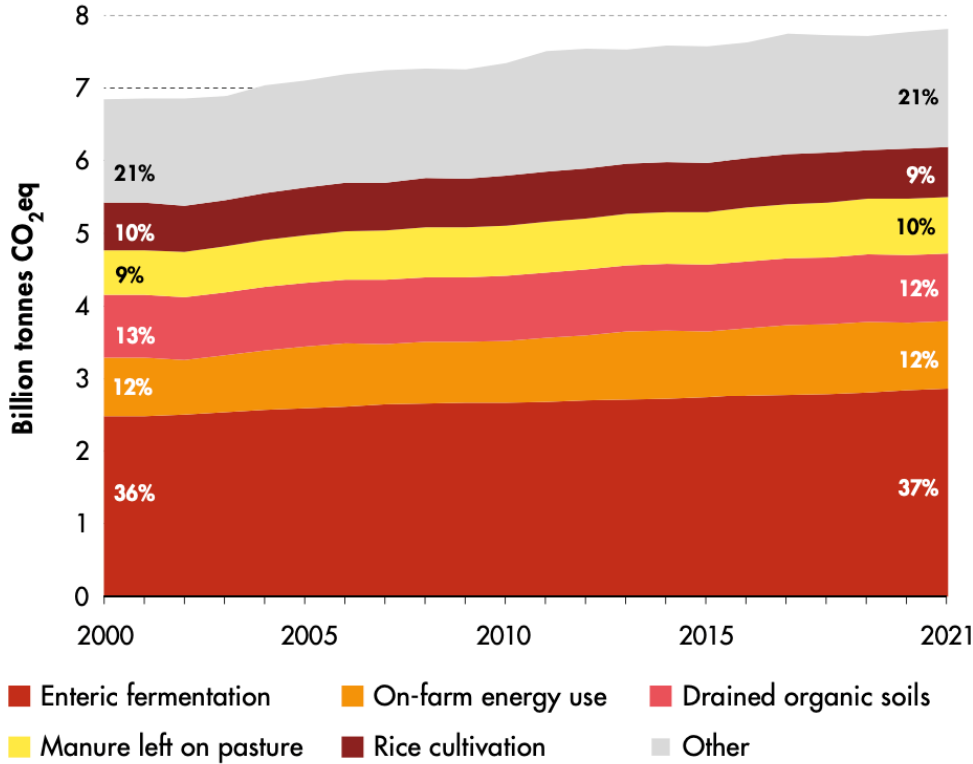
- Contributing to ~25% of the global milk production
- Employing more than 80 million farmers with 70% being smallholder farmers
- On average 2.2 milking cows and 0.7 milking buffaloes (Lindahl et al., 2020)



Overview of world GHG sources

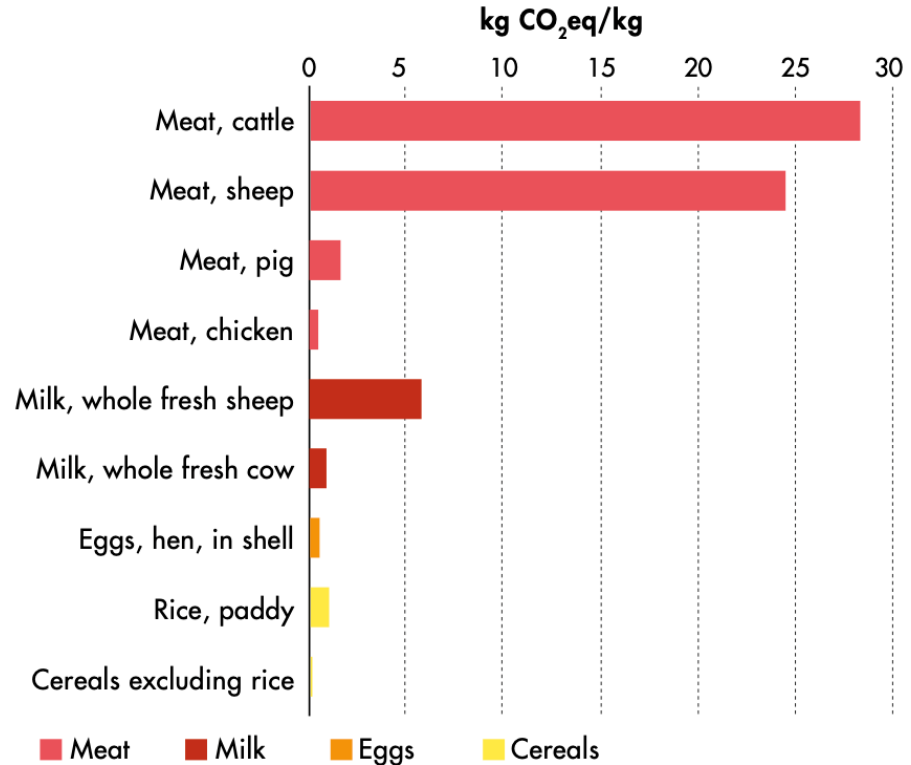


WORLD FARM-GATE GREENHOUSE GAS EMISSIONS BY ACTIVITY



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)

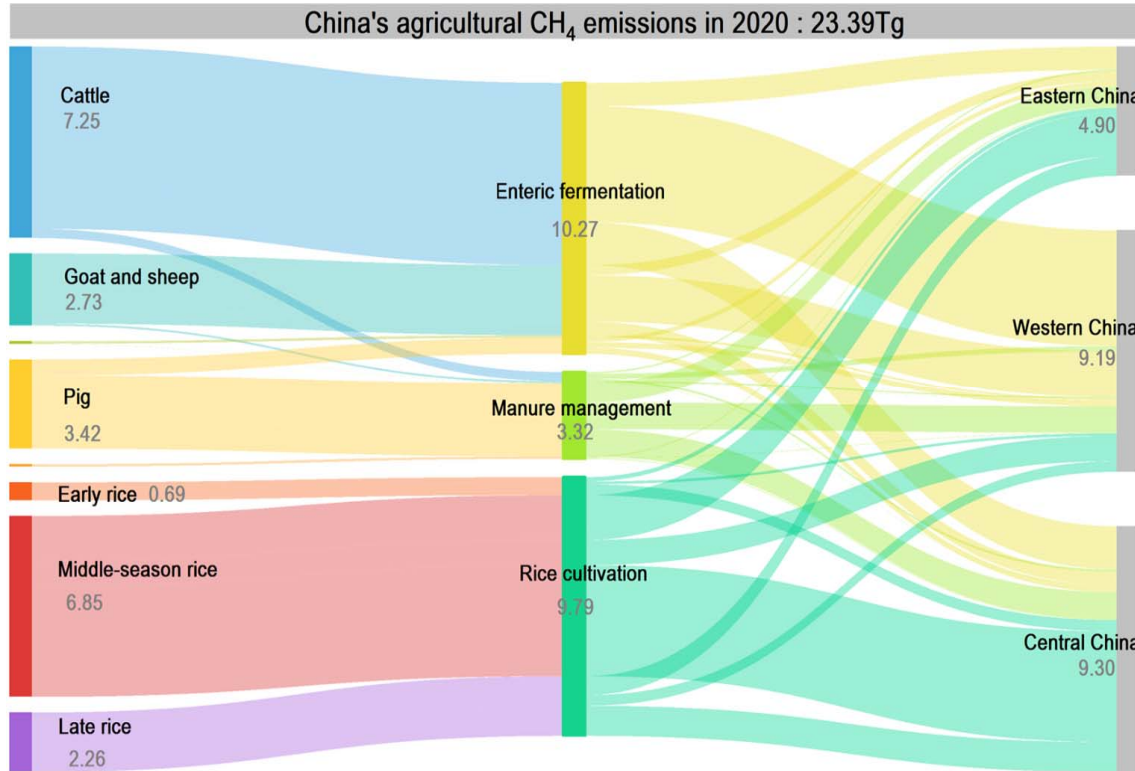


Source: FAO. 2023. Emissions intensities. In: *FAOSTAT*. Rome. [Cited October 2023].
<https://www.fao.org/faostat/en/#data/EI>
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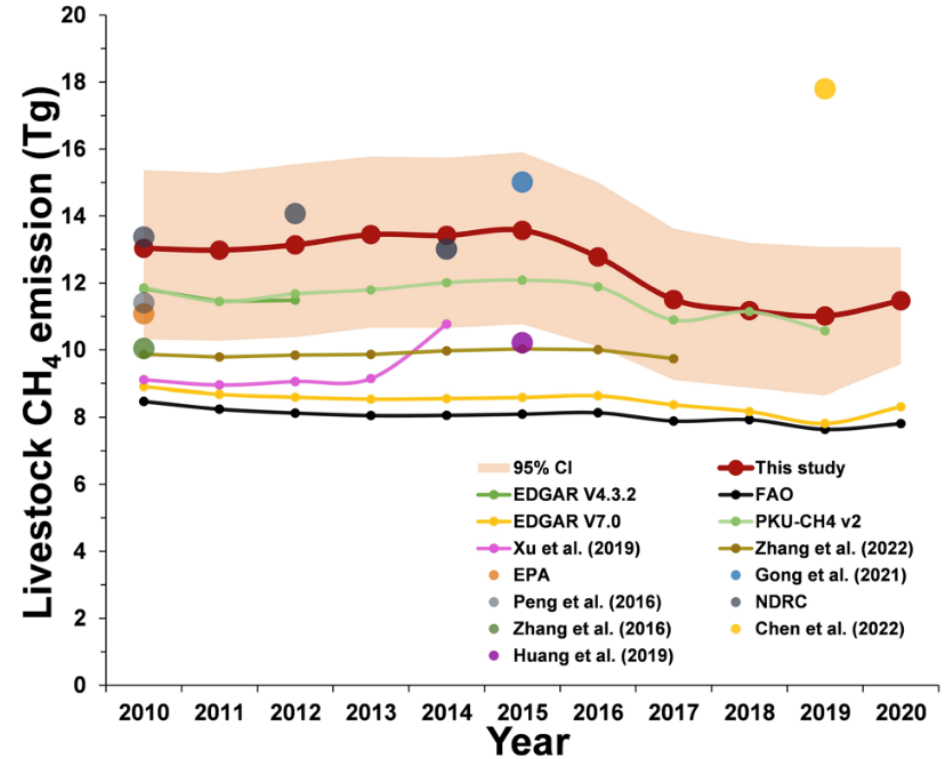
Livestock CH₄ emissions in China



- Enteric fermentation contributes to 10.27Tg of the total 23.39Tg CH₄ emission



Duan et al., 2023



Du et al., 2024

Livestock CH₄ emissions in India



- Methane emission from livestock animals reaches 12.74Tg

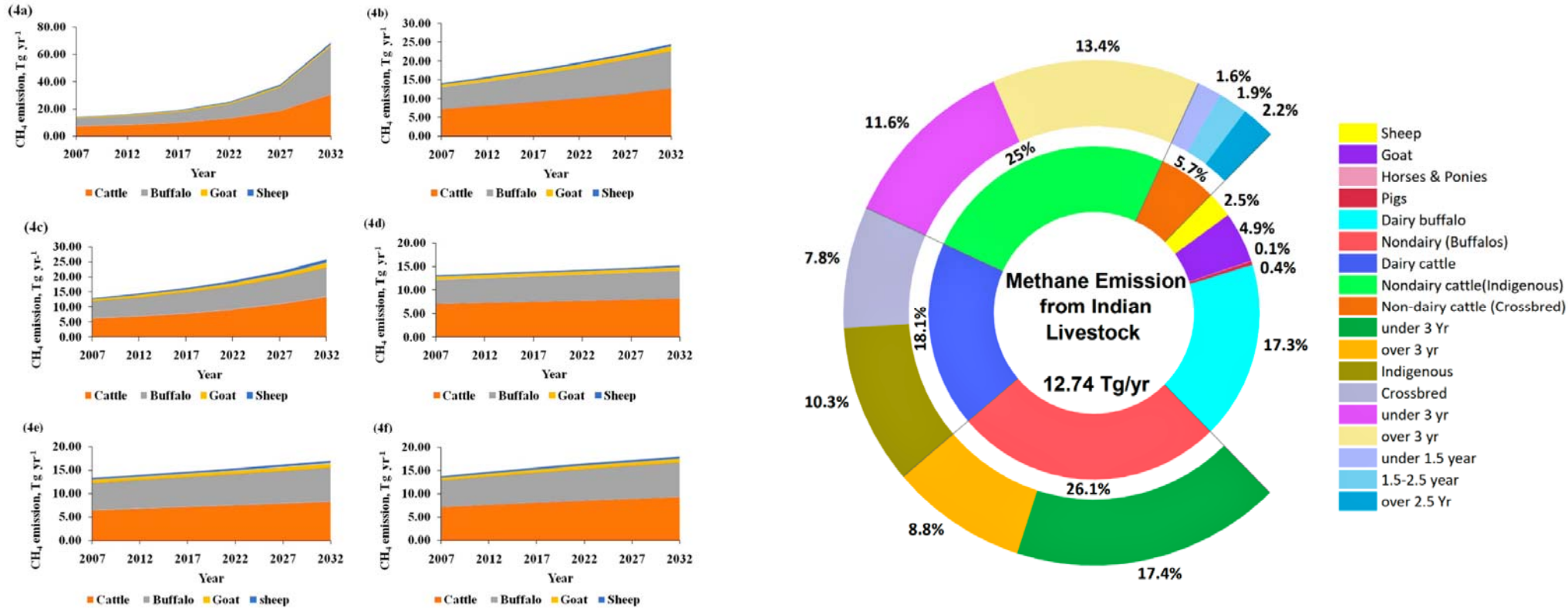


Fig. 4. Projected CH₄ emissions from livestock under different scenarios: (a): Under BS-I; (b): Under BS-II; (c): Under BS-III; (d): Under MS-I; (e): Under MS-II; (f): Under MS-III.

Kumari et al., 2016

Samal et al., 2024

Agro-byproducts used for ruminants in China and India



Oil rape/canola straw



Paddy straw



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

Tannins and saponin-based products

Harit Dhara – Anti Methanogenic Feed Supplement

भारत अनुप - राष्ट्रीय पशु पोषण एवं शरीर क्रिया विज्ञान संस्थान
ICAR - National Institute of Animal Nutrition and Physiology

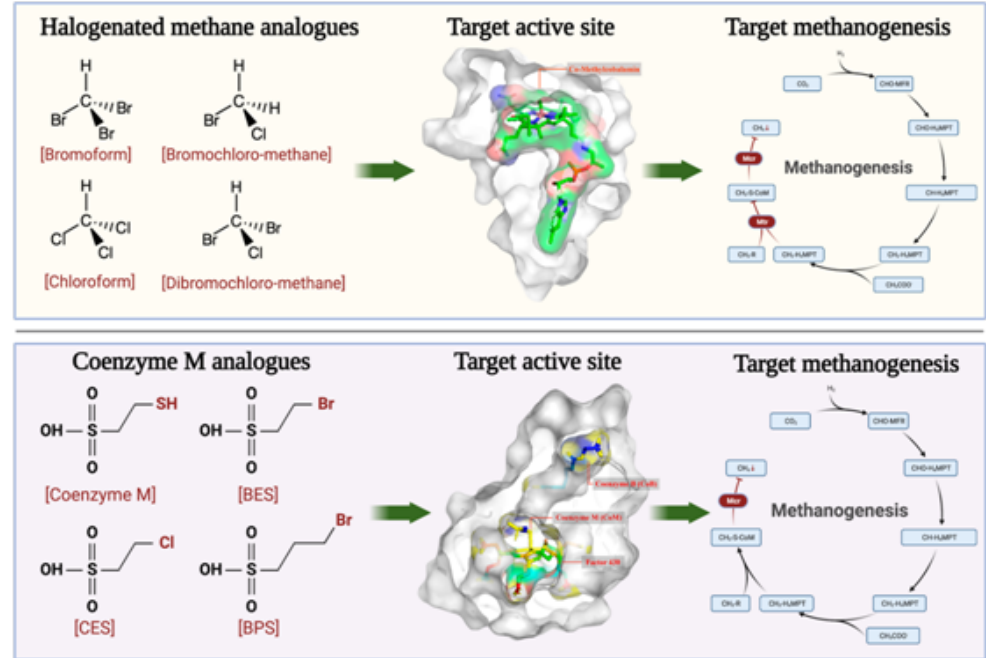


Environment Friendly
Increase Milk Production



Raksha Raghuwanshi

In silico method to screen potential feed additives



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

 Check for updates

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

Pradeep Kumar Malik¹, Shraddha Trivedi²,
Atul Purushottam Kolte^{3*}, Archit Mohapatra¹,
Raghavendra Bhatta¹ and Habibar Rahman²

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

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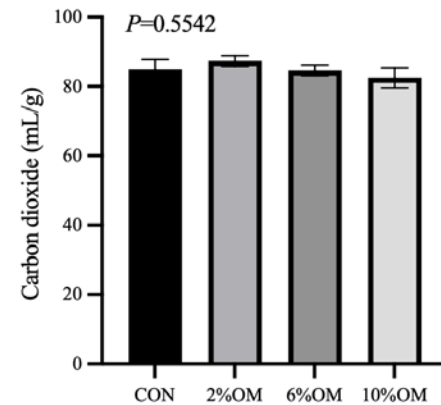
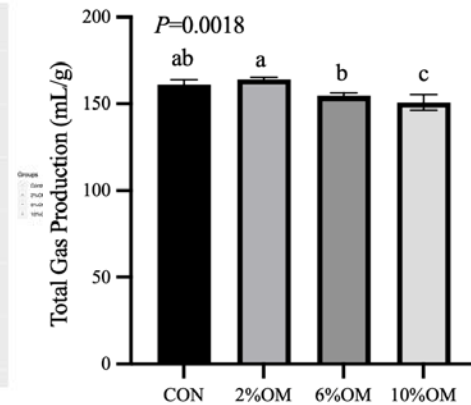
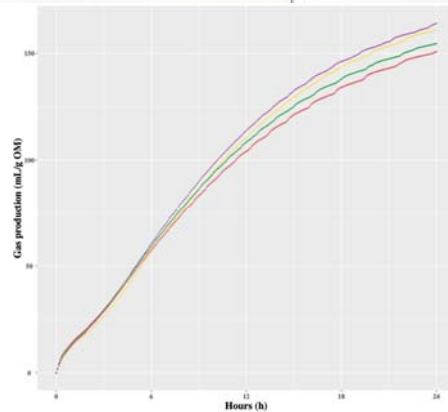
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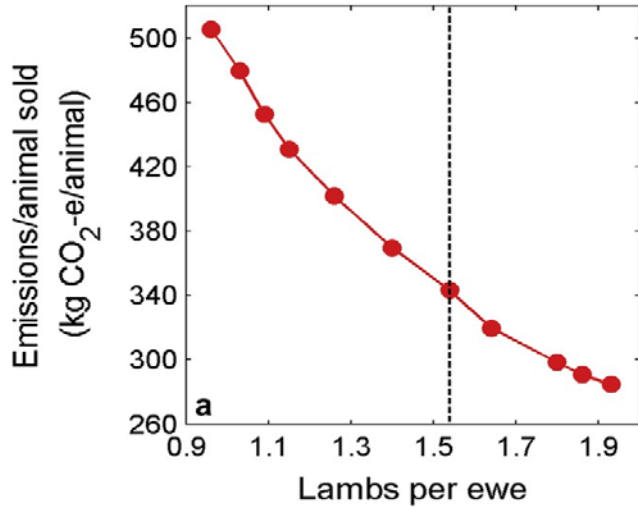
In-Silico and in-Vitro Studies Revealed that Rosmarinic Acid Inhibited Methanogenesis via Regulating Composition and Function of Rumen Microbiota

| | |
|-------------------------------|---|
| Journal: | <i>Journal of Dairy Science</i> |
| Manuscript ID | JDS.2024-24970.R1 |
| Article Type: | Research |
| Date Submitted by the Author: | 02-May-2024 |
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| Key Words: | Molecular docking, methyl-coenzyme M reductase, rosmarinic acid, methane emissions |

Evaluation the efficacy of different seaweed species



Genetic efforts in breeding animals in China



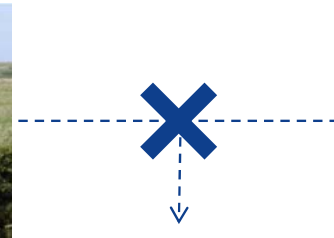
♂ East Frisian



♀ Small-tailed Han



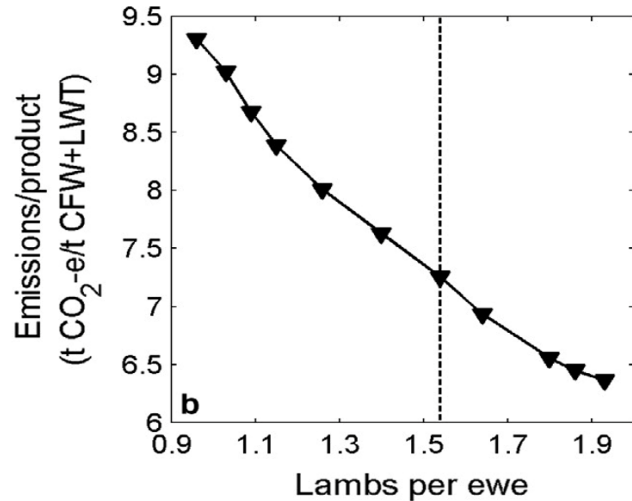
♂ F1



♀ Hu



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



Trait recording organizations in China



The screenshot shows the header of the Scientific Data Center website. It features a navigation bar with the following elements: a logo on the left, the text '中国科学院昆明动物研究所科学数据中心' (Scientific Data Center, Kunming Institute of Zoology, CAS), and a list of navigation links: '首页' (Home), '中心介绍' (Center Introduction), '数据标准' (Data Standards), '主题数据库' (Thematic Databases), and '联系我们' (Contact Us). On the right side of the navigation bar are two yellow buttons labeled '登录' (Login) and '注册' (Registration). Below the navigation bar is a large banner with a background image of a monkey. The banner contains the text '欢迎来到中国科学院昆明动物研究所科学数据中心' (Welcome to the Scientific Data Center of the Kunming Institute of Zoology, Chinese Academy of Sciences) in large white and yellow characters.

**Scientific Data Center,
Chinese Academy of Sciences**

The screenshot shows the header of the EYIMU company website. It features a navigation bar with the following elements: a logo on the left, and a list of navigation links: 'HOME', 'AGTT', 'SFIS', 'YIMUCLOUD', 'YIMUCONNECT', 'ABOUT', and 'CONTACT'. Below the navigation bar is a large banner with a dark background. The banner features a large number '1' followed by six circles, each containing a different cow. The text below the banner reads '一牧云服务奶牛头数超过100万头' (Over 1 Million Dairy Cattle Served by YIMUCloud) in large yellow and white characters.

EYIMU company

Trait recording organizations in India




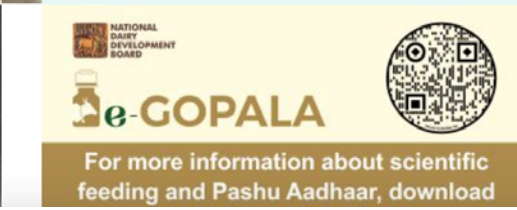

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**National Dairy
Development Board**

| | | |
|---|---|--|
| <p>Int. Subvention on working capital loans</p> | <p>e-Gopala</p> | <p>IDF RDC Kochi 2024</p> |
|  |  |  |

Ways to accelerate low methane emission breeding

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





An approach to reduce greenhouse gas emission in Chinese dairy farms through improving production efficiency

Working Paper No. 383


CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS)

Wei Wang
Jelle Zijlstra
Shengli Li

Working Paper

RESEARCH PROGRAM ON
Climate Change,
Agriculture and
Food Security



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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.



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



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