ICAR 2026 PRESENTATION

Building a Global Integrated Methane Data Ecosystem

Harmonizing Measurement, MIR, and Genomic Data to Accelerate Livestock Methane Mitigation

Hanlu Zhang, Puchun Niu, Miel Hostens

Cornell University

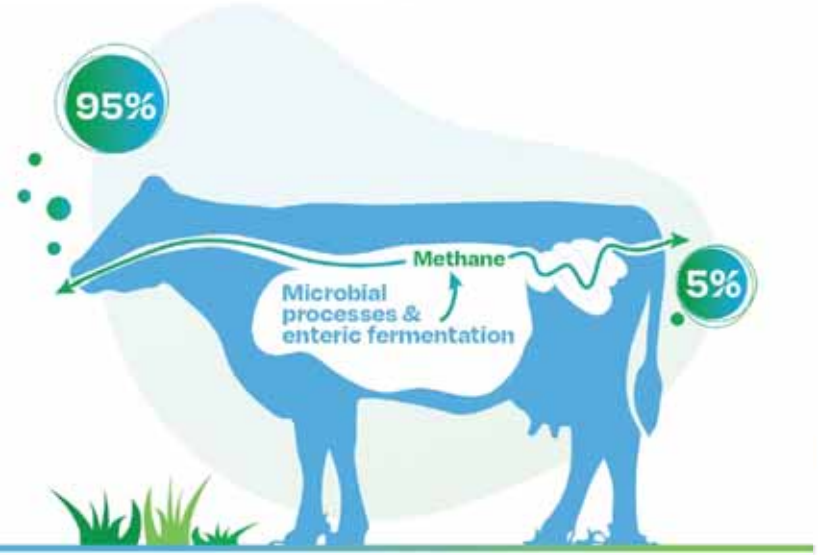
International Committee for Animal Recording (ICAR) • Verona, Italy

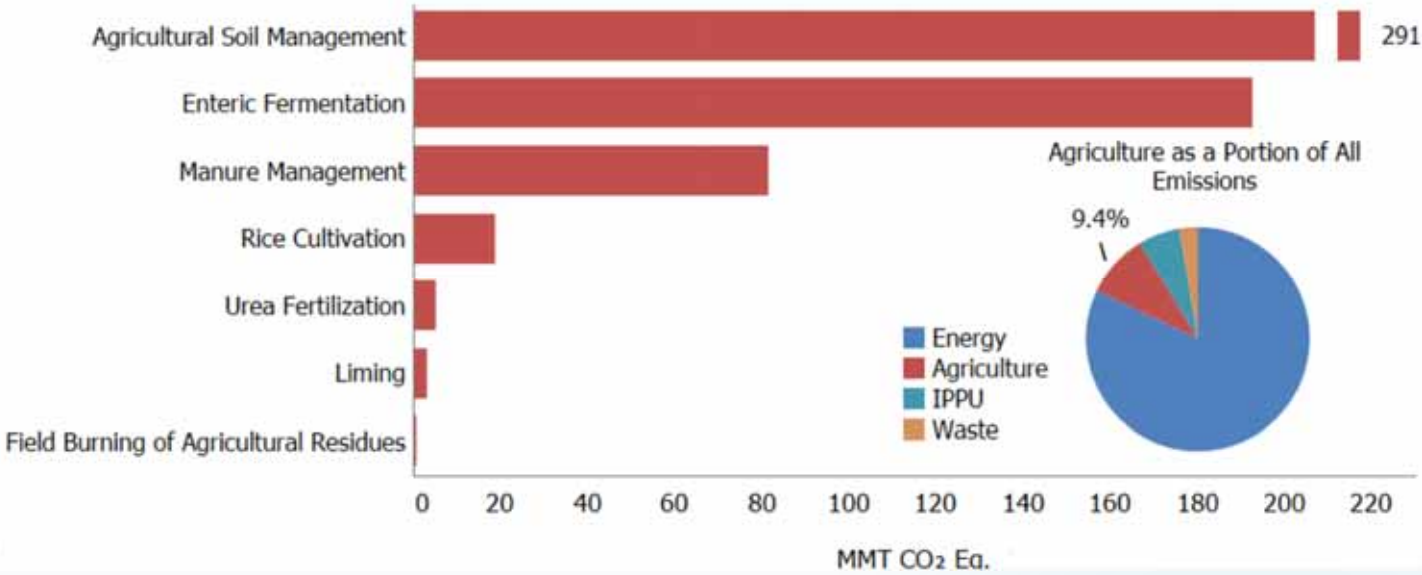
BOVI-ANALYTICS

Background

https://www.dairyconservation.org/enteric-emissions

The Enteric Methane Challenge





United States Environmental Protection Agency. 2024. Draft Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2022. https://www.epa.gov/ghgemissions/draft-inventory-us-greenhouse-gas-emissions-and-sinks-1990-2022.

Enteric methane is the single largest source of GHG emissions in the fluid milk chain (USDA, 2021).

BOVI-ANALYTICS

Background

Enteric Methane Mitigation

Accurate measurement

Moving from estimates to high-fidelity, real-time data

Standardizing protocols

Establishing baselines

Reducing uncertainty

Scalable prediction tools

Lowering the cost of monitoring by using proxies

Developing models

Farm-level reporting

Management systems

Coordinated global collaboration

Harmonizing data across borders

Model accuracy

Aligning industry

Scaling projects

BOVI-ANALYTICS

Background

Accurate measurement

Scalable prediction tools

Coordinated global collaboration

The Challenge

⚠ Fragmented Research

- **Siloed Pipelines:** Fragmented across sensors, biology, and institutes.
- **Data Duplication:** Inefficient use of limited global research funds.
- **Isolated Assets:** Missing alignment between gas data and multi-omics.

Mitigation Objectives

- **Statistical Power:** Essential to identify low-methane genetics.
- **Unified Metrics:** Comparable baseline phenotypes across countries.
- **Scalable Proxies:** Deployable, low-cost proxies on commercial herds.

BOVI-ANALYTICS

Core Research Objectives

1. Harmonize Phenotypes

- Standardize measurement
- Establish procedural benchmarks
- Improve global comparability

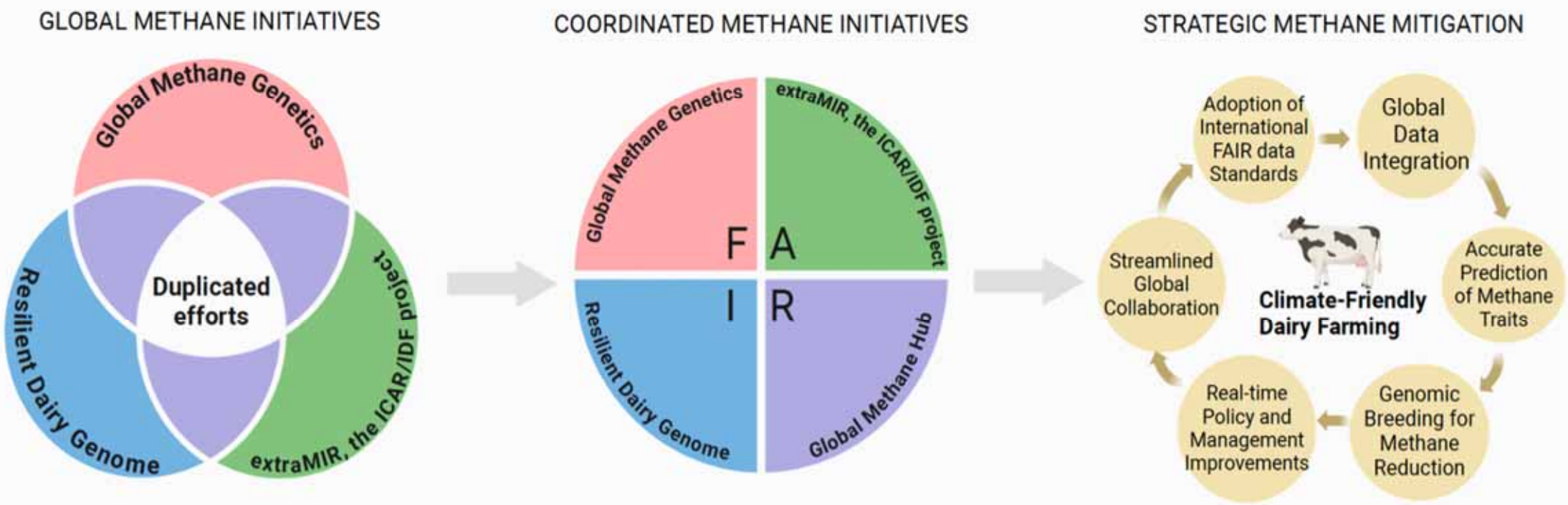
2. Integrate Multi-Modal data

- Mid-infrared (MIR) milk spectra
- High-density animal genotypes
- Dietary & performance covariates

3. Predictive Pipelines

- Shared cloud workflows
- Robust prediction models
- Low-methane genetic selection

Objectives



BOVI-ANALYTICS

Objectives

Accurate measurement

Scalable prediction tools

Coordinated global collaboration

The GEMS Foundation

Scaling Up Methane Recording

Our ongoing initiative expands **GEMS (*Accurate Gas Emissions Measures from Cattle with the GreenFeed System*).**

We are establishing an international data consortium that bridges raw methane gas phenotypes with MIR, genomic and management profiles.

BOVI-ANALYTICS

Primary institutions

Agriculture and Agri-Food Canada

UC DAVIS UNIVERSITY OF CALIFORNIA

une University of New England

UNIVERSITY of GUELPH

ETH zürich

Additional Contributors

cirad

AG EMISSIONS CENTRE

Embrapa

GLOBAL RESEARCH ALLIANCE

ICAR

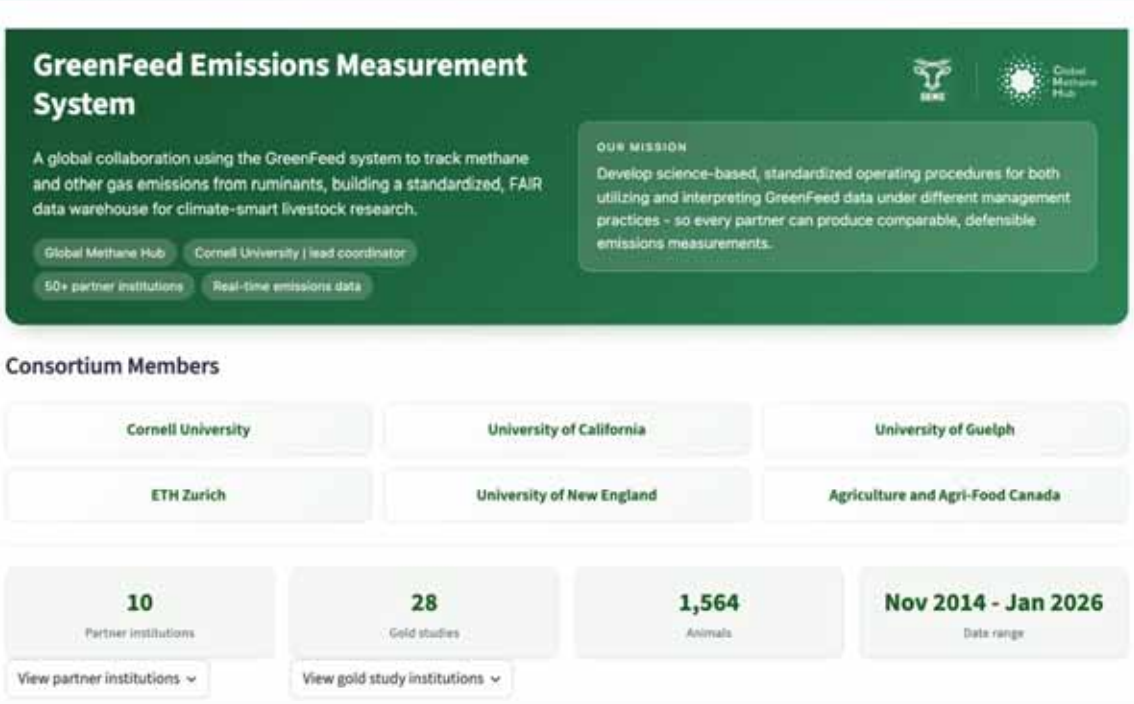
LIC

Global Methane Genetics

Current stage

Global Traction & Engagement

30+ Global Cooperating Organizations



Active Global Support

Within the first 2 months: **13 major organizations** signed

Data from ~**80 distinct animal research studies** is actively flowing into our pipeline.

Objectives

FAIR Data Infrastructure

Centralized Data Lake

Aggregates raw gas emissions, feed intakes, MIR spectrums...

Automated Validation

Programmatic quality checks to sanitize inputs, adjust sensor drift, and flag anomalies.

Legal Frame (DUA)

Standardized Data Usage Agreements protect institutional IP while easing sharing.

ICAR-Aligned Interoperability

Maps disparate international databases into one consistent, standardized recording matrix.

BOVI-ANALYTICS

Current stage

Integrated Data Matrix

Data Layer	Measurement Methods	Primary Purpose	Harmonization Status
Methane Phenotypes	GreenFeed, Respiration Chambers, SF6	Direct gas emission quantification	Active Collection
Milk Spectra	Mid-Infrared (MIR) Spectroscopy	Scalable proxy-based predictions	Pipeline Integrated
Genomics	High-Density Genotyping Platforms	Animal breeding & genetic evaluations	DUA Developing
Metadata	Diet Details, Intake & Production	Covariate adjustment & nutritional modeling	Active Collection

BOVI-ANALYTICS

Final outcome

Integrated Biological Layers

1. Mid-Infrared (MIR) Spectra

Captured standardly in milk recordings to build low-cost, scalable proxies for individual methane output.

2. Genotypes & Selection

Connects physical emissions to genotypes, increasing the accuracy of genomic breeding indexes.

3. Cohort Metadata

Metadata are mapped, eliminating database biases during prediction modeling.

$$CH_4 = f(\text{MIR Spectroscopy} + \text{Genomics (GEBV)} + \text{Nutritional Covariates})$$

BOVI-ANALYTICS

Q & A

Questions, suggestions, willing to collaborate?

gems@cornell.edu

Join us in building a unified global methane data ecosystem to accelerate livestock mitigation.

BOVI-ANALYTICS