



Enteric Fermentation R&D Accelerator

Annual Report

2025



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The Enteric Fermentation R&D Accelerator (the Accelerator) is the largest globally coordinated public-good investment in breakthrough research tackling livestock methane emissions.

The Accelerator is an initiative of the **Global Methane Hub**.



Building Momentum. Raising Ambition.

It's satisfying to look back on 2025 and see important progress - not only in advancing the implementation of the Accelerator's research strategy, but also observing some key signals from a number of companies across livestock value chains, in terms of their ambition.

We welcomed the Department for Environment, Food & Rural Affairs of the United Kingdom to the Board of Funders. We're very grateful for their support and active participation in shaping the implementation of our strategy.



The enteric fermentation research ecosystem is growing and becoming more connected through our grantmaking and convenings, which are key to raise awareness and bring diverse stakeholders together to identify synergies and opportunities for collaboration. For our part, now that we have an active portfolio of projects across the breadth of the Accelerator's research agenda, we have been very deliberate in facilitating connections between research groups within the microbiome, low-methane genetics, vaccine, and data ecosystem.

Highlights in our coordination efforts in 2025 include the launch of our low-methane genetics initiative, representing the most ambitious globally coordinated effort to date. In addition, we were represented on the scientific committee at the Greenhouse Gases in Animal Agriculture conference, where we leveraged meaningful opportunities to raise awareness of the Accelerator's work. The annual State of the Science Summit on Reducing Methane from Animal Agriculture is becoming a key fixture on the enteric methane calendar, and 2025 was no exception, with GMH, the Accelerator's Science Oversight Committee, and many of our grantees represented. We also organized convenings in the margins of the European Association for Animal Production and the International Veterinary Immunology Symposium. These and other activities strengthen and consolidate these communities and enable us to fully exploit synergies across groups, agree on common protocols and procedures, in the firm belief that through this approach the whole will be greater than the sum of the parts.

As mentioned, we have also seen exciting progress in the communication of goals and plans by companies across the food value chain. Companies, including Danone, Bel Group, Lactalis USA, Clover Sonoma, General Mills, and Starbucks, have published specific methane emissions plans or disclosures, and Marfrig/BRF was the first meat producer to set a specific, publicly announced target to reduce methane emissions. These commitments send vital demand signals to investors in innovation so that enteric fermentation mitigation solutions can successfully compete for capital alongside other climate and agritech investment opportunities in the marketplace.

Hayden Montgomery

Executive Director, Enteric Fermentation R&D Accelerator
Program Director, Agriculture, Global Methane Hub

From Discovery to Deployment

Over the past two years, the Accelerator has funded research in seven priority areas: Inhibitors, Low-methane Genetics, Measurement Tools, Vaccines, Anti-methanogenic Feedstuffs, Rumen Microbiome, and Physiology & Behavior.

To monitor progress across the portfolio, two complementary metrics are applied. First, Technology Readiness Levels (TRLs) provide a big-picture view of where each technology sits on the maturity scale, from basic research to commercial deployment, capturing strategic advancement over time. The expected TRL trajectory for the portfolio in each research area can be found on page 5. Second, individual project milestones track operational progress and specific deliverables with each project and initiative, offering granular detail on day-to-day implementation. While milestones reflect what is happening on the ground, they do not always capture the broader strategic picture, making TRLs and individual project milestones most powerful when used together.

In 2025, four of the seven research areas demonstrated notable advancement.



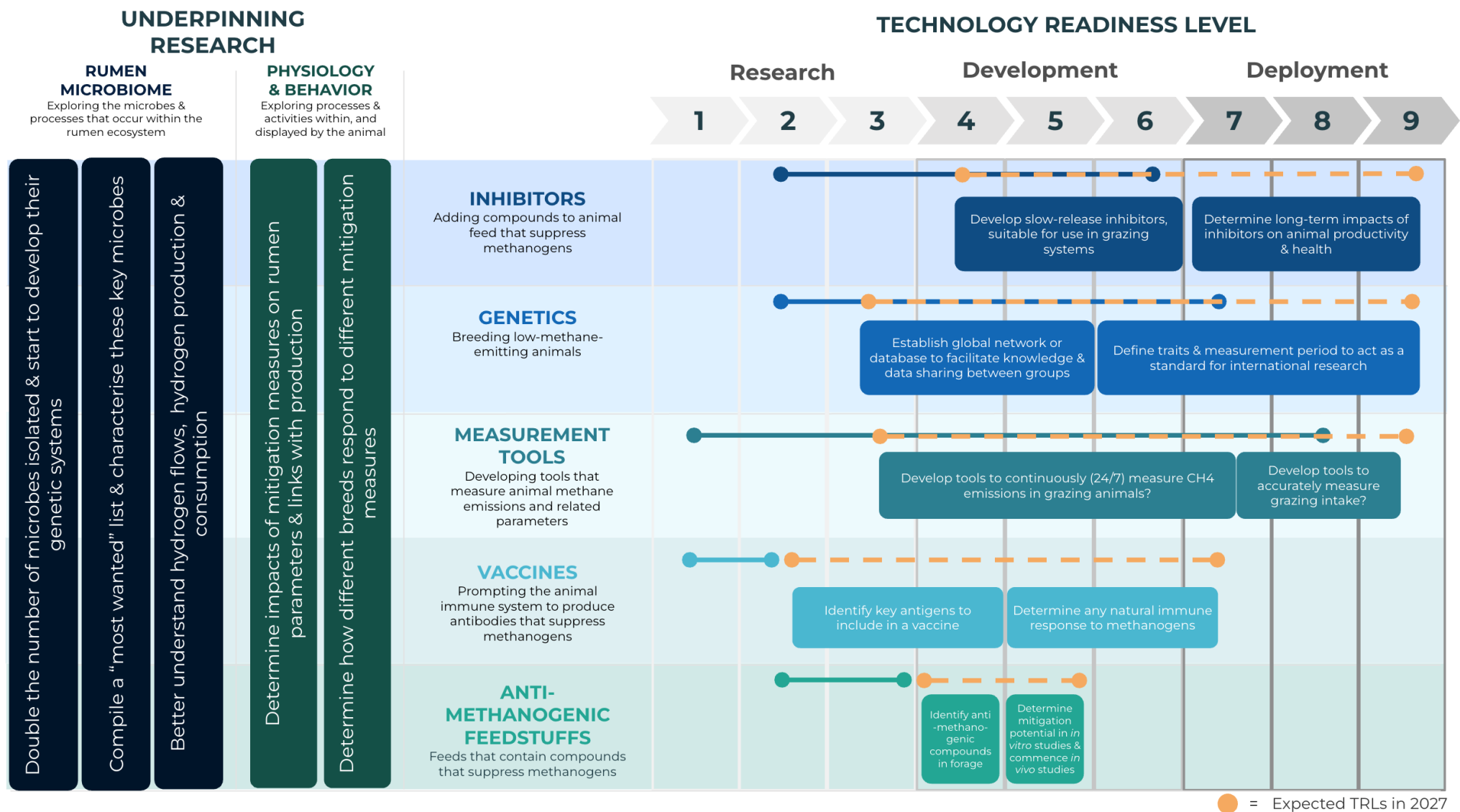


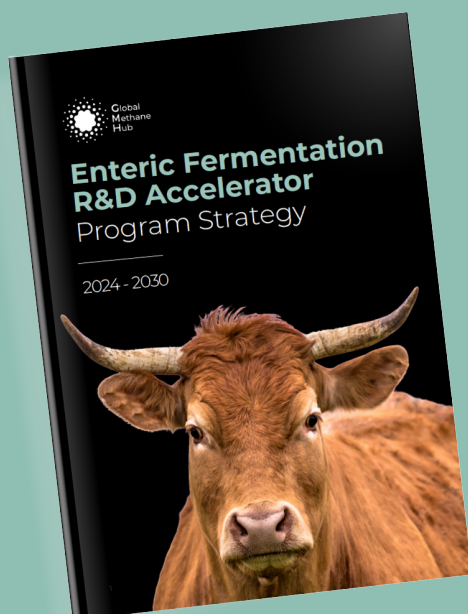
Figure 1. An overview of research areas, their current and expected TRLs, and key outputs necessary to reach expected TRLs.

An Evolving Strategy

As the portfolio matures, the Accelerator will continue to expand its research agenda by incorporating new areas and deepening existing ones as evidence emerges. A notable example is Physiology & Behavior, where an initial evidence mapping exercise identified gaps in understanding of key physiological parameters, such as passage rate and rumination, and their influence on methane emissions, as well as physiological differences between low- and high-methane-emitting animals. These gaps have been prioritized and will be addressed through targeted research investments in the near term.

Building on these learnings, Early-Life Intervention (pre- and post-natal) has been identified as a particularly promising new research priority, given the potential to intervene just once in an animal's life. We will be integrating this focus into our strategy, reflecting our commitment to staying at the forefront of science and accelerating the translation of findings into practical solutions for livestock systems globally.

Early-Life Intervention has been identified as a particularly promising new research priority.



The Enteric Fermentation R&D Strategy identifies current research needs, explains why they are needed, and outlines the priorities for Accelerator funding.

READ OUR STRATEGY

Our progress across research priority areas

The EFA pipeline continues to show meaningful progress across research priority areas, with key projects recording TRL advancements and new grants expanding the scope of the portfolio.

Inhibitors

The Inhibitors area represents the most active area of the EFA portfolio, with 11 projects currently underway — five funded through the pooled fund and six through aligned funding. Projects cover a broad range of activities, from AI-driven compound discovery and proof of concept of novel compounds, to the evaluation of known and available products focused on elucidating long-term efficacy and lactation performance. Research is also investigating the fate of bromoform-based compounds, including their potential absorption, metabolism, and transfer into milk when fed to dairy cows. The long-term 3-NOP study has advanced from TRL 6 to TRL 7, marking a significant milestone and providing important evidence to support broader adoption across production systems.

The inhibitors portfolio is moving methane mitigation from discovery to delivery.



Genetics

Low-Methane Genetics is one of the most globally active areas of the EFA portfolio, with 12 projects currently underway — five funded through the pooled fund and seven through aligned funding. These efforts will screen more than 100,000 animals, collect methane emissions data, and scale up low-emission breeding practices across public and private breeding programmes. Recently approved grants are expanding the research to small ruminants in Asia and Africa and dairy cattle in India, with the aim of developing breeding values for local breeds across diverse production systems — one of the most ambitious globally coordinated genetics efforts ever undertaken for methane mitigation. Future projects will further extend this reach to buffalo, Asian cattle, and tropical breeds in Brazil, reflecting the Accelerator's commitment to ensuring that low-emission genetics solutions are relevant and accessible to farmers everywhere.

One of the most ambitious globally coordinated genetics efforts ever undertaken for methane mitigation.



Measurement tools

The Measurement Tools area currently has two key projects in the portfolio, the potential applicability of these innovations is enormous. The ZELP Sense device is currently under validation, including in grazing systems, with further studies planned with beef cattle. This low-cost, real-time and scalable wearable solution has the potential to significantly increase research capacity and support MRV activities globally, enabling methane measurement to scale across diverse production systems. Complementing this, the GreenFeed Emissions Measurement System (GEMS), led by Cornell University and five international partners, is compiling data from over 100 studies conducted by 40 research teams into an international dataset to establish standard operating procedures to strengthen the quality of methane data collected globally.

Vaccines

The Vaccines area has three projects currently underway — one funded through the pooled fund and two through aligned funding. The two aligned grants are progressing well, with activities planned to conclude in 2027. Together, these outcomes are expected to elucidate the mechanisms for antibody-driven inhibition of methanogen growth, laying the scientific foundation for the next phase of vaccine development, with new proof of concept studies already being planned to commence during 2026.



From wearable methane sensors to vaccine discovery, these projects are creating the tools, evidence, and scientific foundations needed for methane solutions to scale.

Anti-methanogenic feedstuffs

In vivo studies with small ruminants are underway, using newly installed respiration chambers to test selected forages with anti-methanogenic potential. This work is being conducted across three project sites as part of the Low-Methane Forages (LMF) project led by the Alliance of Bioversity International and CIAT, in collaboration with ILRI and ICARDA. Identifying naturally occurring, low-methane forage grasses holds enormous promise for smallholder farmers and low- and middle-income countries where methane inhibiting additives may initially be out of reach.

Rumen microbiome

With four projects currently underway, the Rumen Microbiome area is building foundational knowledge critical to the broader mitigation research agenda. The CH₄IEF trial will provide detailed information on rumen microbiome processes and functions when administering two different inhibitors (3-NOP and bromoform), including insights into where redirected energy is going and whether methane mitigation can consistently deliver productivity co-benefits. The Rumen Gateway project has progressed from TRL 2 to TRL 3, with an ongoing stakeholder survey informing the development of a "Most Wanted List" of rumen microorganisms to guide targeted isolation, characterisation, and storage in public microbial culture collections and biobanks globally — a resource that will benefit the entire research community for years to come.



From low-methane forages to microbiome discovery, this work is building the foundations for methane solutions that can reach more farmers, in more places.

Physiology and Behaviour

An evidence mapping exercise was conducted in 2025, and upon completion, it has brought important insights to the Physiology research area by synthesising existing knowledge and identifying key measurable indicators that are important to include in in vitro and in vivo trials. This is particularly valuable given growing ethical concerns around intensive sampling and the use of rumen-cannulated animals, where minimizing animal intervention while advancing scientific understanding is a priority. These insights are already shaping the Accelerator's next investments in this area.

The progress described across these seven research areas reflects the Accelerator's ambition and momentum — and our 2026 goals, outlined on the following page, build directly on these foundations to accelerate the translation of science into real-world impact.



2026 Goals

1

INHIBITORS

Mitigation co-benefits and animal health

Assess impact of methane mitigation strategies, including inhibitors, on animal health and welfare, immune function, and feed efficiency.

5

RUMEN MICROBIOME

Accelerate culturing of most wanted microbes

Advance microbial research through the culturing and isolation of rumen microorganisms, making accessible to researchers and technology developers the 'Most Wanted List' of rumen microbes.

2

GENETICS/INHIBITORS

Genotype x Inhibitors

Investigate how the genetic profile of low-methane animals influences their response to inhibitory compounds across different geographies and relevant breeds.

6

PHYSIOLOGY AND BEHAVIOR

Animal physiology

Investigate the physiological differences between low- and high-methane-emitting animals, examining how these differences influence nutrient absorption and partitioning.

3

MEASUREMENT TOOLS

Commercial release of wearable device ZELP Sense

Scale up research capacity and MRV activities through the commercial release of a low-cost wearable methane measurement device.

7

OTHER

Early-life intervention

Develop a dedicated research agenda informed by the outcomes of a scientific convening in London, establishing early-life intervention as a new addition to the Accelerator's portfolio.

4

VACCINE

Vaccine development

Accelerate testing of next-generation antigens, demonstrate proof of concept in vivo, and advance understanding of antibody classes.

8

OTHER

Strategic fundraising

Expand fundraising efforts to include more government and industry partners, alongside renewals from existing donors.

Our Funding Progress

Through December 31, 2025

\$100

**MILLION
SECURED**

for the pooled fund from
philanthropy, government,
and the private sector

\$42

**MILLION
GRANTED**

from the
Accelerator pooled
fund (since 2023)

\$122

**MILLION
GRANTED**

from the Accelerator
pooled fund and aligned
funding (since 2023)

21

GRANTS

approved from the
Accelerator pooled fund
across the seven priority
research (since 2022)

\$80

MILLION

in leveraged
funding through
aligned funders

21

EVENTS

with researchers,
grantees, and funders to
reinforce shared priorities
(since 2022)



Portfolio Highlights

GENETICS

Global Methane Genetics

Some animals naturally produce less methane than others, and science is now scaling this advantage. Even within a single herd, some animals emit up to 30% less methane than others. By identifying and breeding from these naturally low-emitting animals—just as farmers have done for centuries for milk yield, fertility, or disease resistance—this approach can lead to substantial, permanent emissions reductions across the industry without requiring farmers to change how they feed or raise their livestock. With the support of the Bezos Earth Fund and the Accelerator, the Global Methane Genetics Initiative is working to collect methane emissions data, diet and production information, and genetic information from more than 100,000 animals, to scale up low-emission breeding programs across North America, Latin America, Europe, Africa, and Oceania, covering diverse breeds and species.



Breeding from naturally low-emitting animals offers a permanent pathway to reducing livestock methane.

Photo credit:
Gabriel Ciappesoni

Portfolio Highlights

MEASUREMENT TOOLS

GreenFeed Emissions Measurement System

Accurate methane measurements require high-quality data, and there are approximately 800 GreenFeed units deployed across the globe. The GreenFeed Emissions Measurement System (GEMS) is a multidisciplinary, multi-institute project led by Cornell University and five international partners, with the goal of establishing international standards and guidelines to improve the estimation of enteric gas emissions from beef and dairy cattle across diverse production scenarios. To achieve this, research teams were invited to submit their GreenFeed data, and the response was unprecedented: over 100 studies from 40 research teams were received, far exceeding initial expectations. This data is being compiled into an international dataset, cross-validated, and will be used to establish standard operating procedures. This approach will strengthen the quality of methane data collected globally, supporting more reliable and accurate research outcomes.

Global standards for methane measurement will strengthen the accuracy and reliability of livestock emissions data.



Photo credit: Dr Mutian Niu, ETH Zürich

Portfolio Highlights

RUMEN MICROBIOME

CH₄IEF: an Animal Trial for Methane Inhibition and Electron Flow

The primary objective of this research is to understand the routes of electron flow and identify how these can be redirected away from methane production towards animal production, which is essential for driving mitigation at scale. Additionally, while inhibitory compounds can directly suppress methane production in the rumen, the long-term efficacy of these compounds remains unclear. With the support of the New Zealand Ag Emissions Centre, we are evaluating 3-NOP and bromoform, two inhibitors with known efficacy but distinct mechanisms of action, to create a rumen environment under inhibited conditions and monitor the impact on the microbiome and its function.

Understanding how microbial energy pathways can be shifted away from methane and towards production or other benefits will aid adoption.



Photo credit: Ag Emissions Centre, New Zealand

Portfolio Highlights

RUMEN MICROBIOME

Genetic Toolkits

The rumen microbial ecosystem that drives methane formation is diverse, complex, and poorly understood. A key barrier to progress is that rumen microbes are strictly anaerobic, making them laborious and challenging to work with. Furthermore, genetic tools to manipulate their metabolism at both the cellular and system levels have not yet been developed, limiting the ability to study microbial processes and develop new mitigation technologies. A global team of anaerobic microbiologists and molecular geneticists has been assembled. Critical infrastructure and laboratory protocols have been established, microbes have been isolated in pure culture and transformation experiments have commenced. The successful development of these tools would represent a significant breakthrough in advancing our understanding of rumen microbial processes and would help unlock new pathways for mitigation.

Developing genetic tools for key rumen microbes could unlock new pathways for methane mitigation.



Photo credit: Dr Roderick Mackie, University of Illinois Urbana-Champaign

Our Reach

Because we set up the Accelerator to be more agile and efficient than existing funding mechanisms we were able to establish globally inclusive, multidisciplinary research teams, engaging the enteric methane challenge from many points of view.

32

COUNTRIES

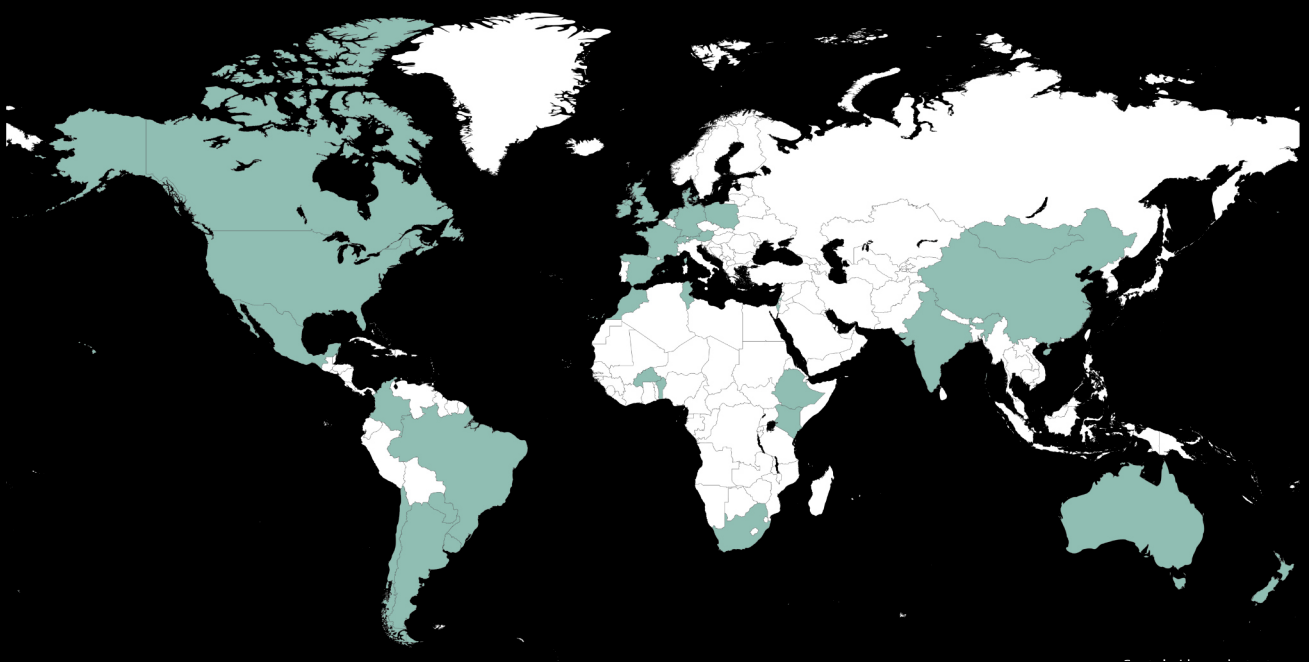
involved in research projects of the Accelerator

69

GRANTEES & SUB-GRANTEES

funded in support of the Accelerator (since 2022)

Geographical Reach of Accelerator Grantees



Lessons Learned

As the Accelerator's portfolio grows in scale and reach, each year brings valuable insights that shape how we design and deliver our grants. Three key lessons stand out from 2025.

Dedicated coordination accelerates impact

A key lesson from 2025 is the value of having a dedicated project coordinator embedded within consortium grants. Across our funded projects, we have observed that an on-the-ground coordinator significantly accelerates implementation, enhances communication among partners, and ensures that project milestones are met in a timely manner. A strong example is the Rumen Gateway Project, led by Queen's University Belfast, a consortium of more than 25 collaborating institutions that established a global network of rumen microbe culture hubs. The presence of dedicated coordination within this project has been fundamental in managing such a large and geographically diverse partnership. This insight will inform how we structure future consortium grants.



Interlinked projects shape portfolio delivery

Projects across our portfolio are often closely interconnected, with outputs from one grant becoming inputs for the next. This is particularly evident in measurement work, where advances link directly to genetics and microbiome research, which in turn inform physiological understanding and mitigation strategies. As our portfolio scales, thoughtful sequencing and coordination will remain important to sustaining momentum, strengthening scientific integration, and maximizing impact.

Capacity building: a work in progress

Building on our commitment to connect research groups and support the next generation of scientists, 2025 was an important first step. We supported 12 students to attend the Global Greenhouse Gas & Animal Agriculture conference (GGAA), a major international event held every three years, providing PhD students and early-career researchers with a critical opportunity to engage with the global methane mitigation community. Additionally, the **CLIFF-GRADS** programme, an initiative of the CGIAR and Global Research Alliance on Agricultural Greenhouse Gases, we are supporting 30 PhD students from low- and middle-income countries to undertake research stays of up to six months within our funded projects globally, building applied research skills and developing technical expertise at leading international research institutions. Getting researchers into the same room, across geographies and career stages is invaluable, and that access to these opportunities remains limited. There is more to do, and expanding our reach remains a priority as we scale our portfolio.

With your continued support, we are well-positioned to turn these learnings into action and drive even greater impact in 2026.



Our Funders



BEZOS
EARTH
FUND

DANONE



An Roinn Talmhaíochta,
Bia agus Mara
Department of Agriculture,
Food and the Marine

Gates Foundation



Gerstner
PHILANTHROPIES



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