DAIRY METHANE ACTION PLAN (DMAP)

A guide to planning and disclosing actions to reduce dairy methane emissions

Environmental Defense Fund
Ceres
Pure Strategies Inc.


CH_4

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Environmental Defense Fund

With more than 3 million members, Environmental Defense Fund creates transformational solutions to the most serious environmental problems. To do so, EDF links science, economics, law, and innovative private-sector partnerships to turn solutions into action.

Dairy Methane Action Alliance

The Dairy Methane Action Alliance (DMAA) is a global initiative to accelerate action and transparency on methane across the dairy sector. By joining this groundbreaking initiative, signatory companies commit to account for and publicly disclose methane emissions within their dairy supply chains and to publish and implement a comprehensive methane action plan. Environmental Defense Fund and the sustainability nonprofit Ceres will help to ensure companies are making progress against key milestones.

At the time of printing this guide in May 2025, DMAA signatories include: Agropur, Bel Group, Clover Sonoma, Danone, General Mills, Idaho Milk Products, Kraft Heinz, Lactalis USA, Nestlé, Savencia Fromage & Dairy, and Starbucks.

Ceres

Ceres is a nonprofit advocacy organization working to accelerate the transition to a cleaner, more just, and sustainable world. United under a shared vision, our powerful networks of investors and companies are proving sustainability is the bottom line—changing markets and sectors from the inside out.

Pure Strategies Inc.

Pure Strategies is a sustainability consulting firm that empowers brands, retailers, and NGOs to realize meaningful environmental and social improvement. Founded in 1998, Pure Strategies helps companies on their sustainability journey with a focus on goal setting, effective management strategies, and redesigning products and supply chains that deliver value to the business and society.

Acknowledgments

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Report design: C.G. Coleman

The complete report is available online at https://business.edf.org/dairy-methane-action-plan.

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FOREWORD

STEFANIA AVANZINI
Director, Agriculture & Food
WBCSD

Climate transition planning is an essential tool for translating corporate decarbonization ambition into action. Transition plans are more than climate disclosures — they are strategic roadmaps that help companies embed net-zero and nature-positive goals into core business operations, align internal stakeholders, and build confidence among investors, customers, and the public.

The World Business Council for Sustainable Development (WBCSD) supports companies in aligning sustainability with business strategy, finance, and risk management. We are helping our members bring transition planning to life by integrating sustainability into capital planning, financing decisions, and enterprise risk assessments. In doing so, we aim to build resilience into business models while advancing long-term value creation.

This work is particularly critical in agrifood value chains where climate risks and mitigation opportunities — such as reducing methane emissions — are tangible and immediate. Methane emissions present a material challenge to delivering climate goals as well as an opportunity for immediate progress. Methane's short atmospheric lifespan means that targeted reductions can have rapid climate benefits. Cutting methane emissions in agriculture can also support nature, improve farmer livelihoods, and enhance supply chain resilience.

WBCSD welcomes the release of the **Dairy Methane Action Plan guide**, developed by Environmental Defense Fund (EDF) in partnership with Ceres and with support from Pure Strategies. This first-of-its-kind resource provides companies with practical tools to operationalize their methane reduction goals. With clear templates and solution evaluation tools, this guidance supports companies at different stages in their sustainability journeys. EDF recognizes that while this is an exciting time for methane innovation, the range of current and emerging solutions can be overwhelming. The guide helps companies navigate this challenge through an evaluation table presenting a range of characteristics to consider for several methane solutions.

We are encouraged to see a growing focus on commodity-specific transition planning, a practice that we believe should be scaled across agriculture and food value chains. We look forward to future opportunities for similar leadership and collaboration with EDF, partners, and our member companies in another high impact commodity-specific transition planning initiative — the WBCSD-led Rice Action Alliance for accelerating low-emissions and resilient rice production, launching in the second half of 2025.

WBCSD's Agriculture and Food Pathway brings together leading companies to raise ambition, accelerate action, and strengthen accountability on climate, nature, and equity. EDF's guidance aligns strongly with this mission, and we appreciate their contribution to the growing toolkit available to business.

We invite stakeholders across the dairy and broader agrifood value chain to join the Dairy Methane Action Alliance and to take bold, credible steps in climate transition planning. We are pleased to work with EDF to build momentum in corporate action on methane reduction. With an expanding set of solutions and increasing urgency to act, now is the time to move from ambition to action.

Stefania Avanzini
Director, Agriculture & Food
World Business Council for
Sustainable Development (WBCSD)

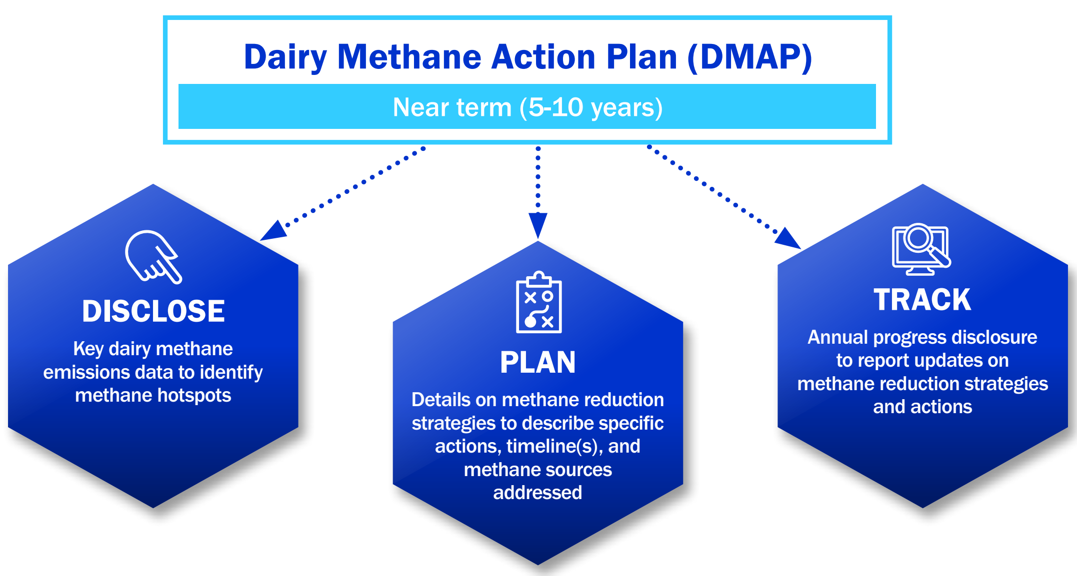
EXECUTIVE SUMMARY

Reducing methane emissions, particularly from dairy cattle, is a critical opportunity for slowing the rate of global warming in the near term, given methane's high potency and short-lived nature in the atmosphere compared with carbon dioxide (CO_2). With the intensifying operational, productivity, regulatory, reputational, and market risks that climate change poses to companies, especially those in the food sector, methane action offers a powerful opportunity to drive innovation and enhance resilience throughout supply chains. Dairy value chain actors are increasingly aware of the critical role they must play in driving methane reductions, and as a result, are prioritizing methane mitigation by measuring and disclosing their methane emissions, setting emissions reduction targets, assessing their impacts, and engaging on farm to drive reductions. The Dairy Methane Action Alliance (DMAA), Environmental Defense Fund (EDF), and Ceres have developed guidance to help companies eager to take a leadership position on dairy methane work through every stage of this process.

Climate transition action plans (CTAPs) are critical tools for disclosing emissions and reduction goals and aligning on the strategies and action items needed to address the business risks of climate change. A dairy methane action plan (DMAP) is a targeted plan that focuses specifically on addressing methane emissions from livestock. Although DMAPs should support broader climate strategies and CTAPs, companies can get started by building a DMAP even if they have not yet developed their CTAP. Building on separate accounting and disclosure guidance, this guide details how companies can develop DMAPs to articulate and disclose programs and projects to reduce dairy methane emissions in the near term. Integrating DMAPs into overarching climate plans helps to provide a comprehensive and transparent view of climate actions, thus underscoring methane mitigation as an industry priority.

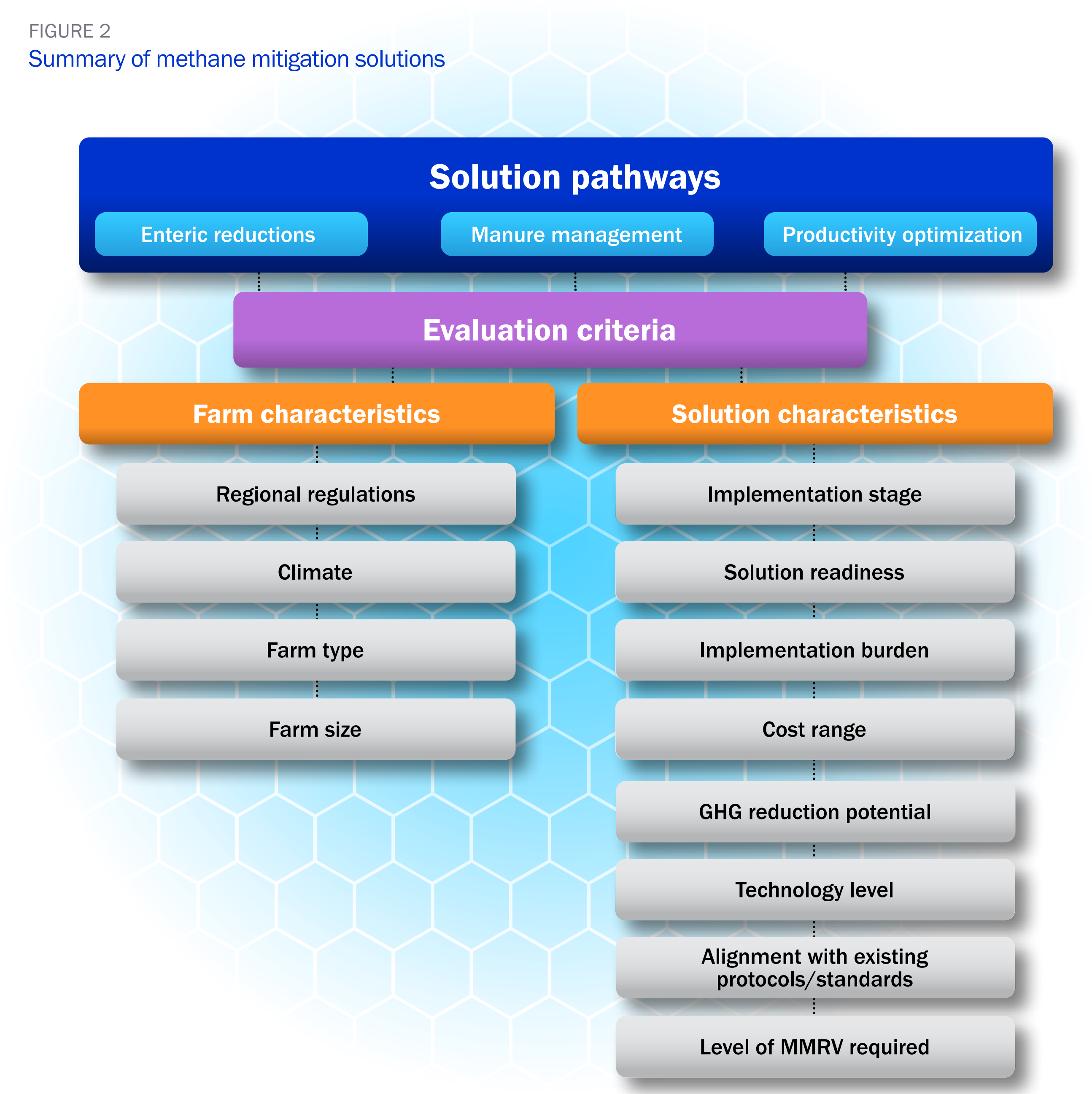
The DMAP presented in this guide provides a framework for companies to outline key methane disclosures, plans to reduce dairy methane emissions, and progress toward methane reductions.

FIGURE 1
Components of DMAPs



This guide also evaluates different [methane mitigation solutions](#) to help companies identify relevant reduction opportunities within their operations and supply chains. Companies can then implement these solutions to drive competitive advantages, reduce climate risk, and position their business for a lower-emissions global economy.

FIGURE 2
Summary of methane mitigation solutions



INTRODUCTION

INTRODUCTION

Background

Climate action planning is crucial for companies across all sectors of the global economy facing mounting pressure to address climate change. Early planning can provide organizations with measurable and concrete steps for mitigating the operational, reputational, and market risks climate change poses to business. It can also support the business case for setting company-wide climate objectives, including near-term greenhouse gas (GHG) emissions reduction targets, net-zero targets, and other climate-related goals, and demonstrate industry leadership.

As climate risks to supply chains escalate, companies, especially those that rely on agricultural commodities, become increasingly vulnerable. Physical impacts such as extreme weather events, rising sea levels, and droughts; resource scarcity such as decline in crop yields and energy supply instability; cost volatility for commodities and insurance; and transition impacts such as rapid technological shifts, all pose significant threats to business as usual. Mitigating agricultural sources of methane can help companies build more resilient supply chains that can more nimbly respond to climate-related disruptions, thereby reducing risk and driving business value.

Globally, regulations pertaining to GHG emissions are emerging in response to these operational risks caused by climate change. Reducing agricultural methane can also help companies mitigate the financial risks driven by these new policies. For example, in 2030, Denmark will implement a carbon tax on livestock farming that will apply to all GHG emissions from animal digestion and manure handling. This tax on farmers will shrink farmers' operating margins unless companies help them mitigate their methane emissions. While other policy levers, such as the EU Carbon Border Adjustment Mechanism, do not currently apply to agricultural commodities, agricultural products and their associated emissions could be regulated in the future.

Further, regulations such as the EU Corporate Sustainability Reporting Directive (CSRD) and the California Climate Corporate Data Accountability Act (SB253) will require some companies to disclose Scope 1-3 emissions, including those from agriculture. CSRD will also require companies to develop transition plans detailing how they will achieve emissions reductions. As stakeholders continue to demand transparency around corporate GHG emissions and reduction plans, companies must work to reduce agricultural methane to mitigate operational, financial, and reputational risk.

CTAPs are critical tools for disclosing emissions and reduction goals, aligning on the strategies and action items needed to address the business risks of climate change, and progressing in all of these areas. CTAPs should also serve as company roadmaps that help internal and external stakeholders align on emissions reduction ambitions and plans, deliver leadership across the industry, and support core functions in implementing the work. Disclosing corporate emissions and reduction plans provides transparency to external stakeholders, including suppliers, customers, and institutional investors, who seek, but often lack, detailed information on how companies intend to achieve their climate goals. Publicly disclosing emissions reduction plans also sends crucial market signals on the importance of the solutions needed to activate corporate climate plans.

On-farm methane emissions from dairy production often represent a substantial proportion of total emissions for food sector companies that produce, source, process, and/or sell dairy products. Livestock agriculture contributes nearly 15% of global anthropogenic GHG emissions, with methane from enteric fermentation and manure management representing over half of livestock emissions.[1, 2] Reducing methane in the near term can help drive immediate reductions in the rate of warming in the next few decades because of methane's short-lived nature and high potency compared to CO_2. Near-term action on methane is one of the most effective ways for companies to progress on their climate goals, reduce the systemic risk of climate change, and increase resilience in their operations and supply chains.

Importance of methane action planning

Companies with dairy in their supply chains—from cooperatives (co-ops) and processors to consumer packaged goods brands (CPGs) and retailers—can address methane emissions to achieve GHG reductions and other climate-related goals as well as mitigate exposure to risks from existing and emerging regulations. Due to methane's high 20- and 100-year global warming potentials (GWPs), unabated methane emissions will continue to have an outsized impact on global climate change during this critical decade for action. Investors and governments will expect significant reductions in methane emissions as they evaluate the levers available to reduce planet warming.

CTAPs have emerged as a tool to increase accountability and planning in corporate climate action. They help companies chart a roadmap towards reductions while ensuring companies are on track to achieve their climate-related goals, mitigate climate-related financial risks, and help the world transition to a lower emissions economy.

A leading CTAP articulates the strategies and actions a company will take in the near term (5-10 years) to achieve its public climate goals while supporting a just transition. These plans should be specific to the company and grounded in sector-specific contexts. CTAPs should also succinctly outline the company's transition strategy and concrete actions to drive full scope emissions reductions across the business.

A company's CTAP should identify what climate hotspots it must address to meet its goals and how it intends to mitigate emissions from those hotspots. Companies that produce or source high volumes of dairy cannot meet their climate goals without prioritizing methane. As such, CTAPs should include a component that outlines a clear plan for how a company will reduce agricultural dairy methane emissions. Building out a robust DMAP, either as part of a CTAP or on its own, can help dairy-producing and -sourcing companies achieve emissions reduction goals and mitigate climate-related regulatory and market risks. A DMAP should build on companies' methane disclosures to elaborate on the strategies needed to reduce dairy methane across their operations and/or sourcing.

Companies that produce and source dairy experience many other sustainability risks beyond just climate, such as biodiversity, water, worker well-being, and animal welfare. To ensure companies consider dairy methane planning alongside these topics, DMAPs should be embedded within corporate ESG governance systems. While this guide specifically focuses on how companies can plan to address dairy methane emissions, companies should consult other resources to ensure that they have plans to address sustainability risks and opportunities across their agricultural supply chains.

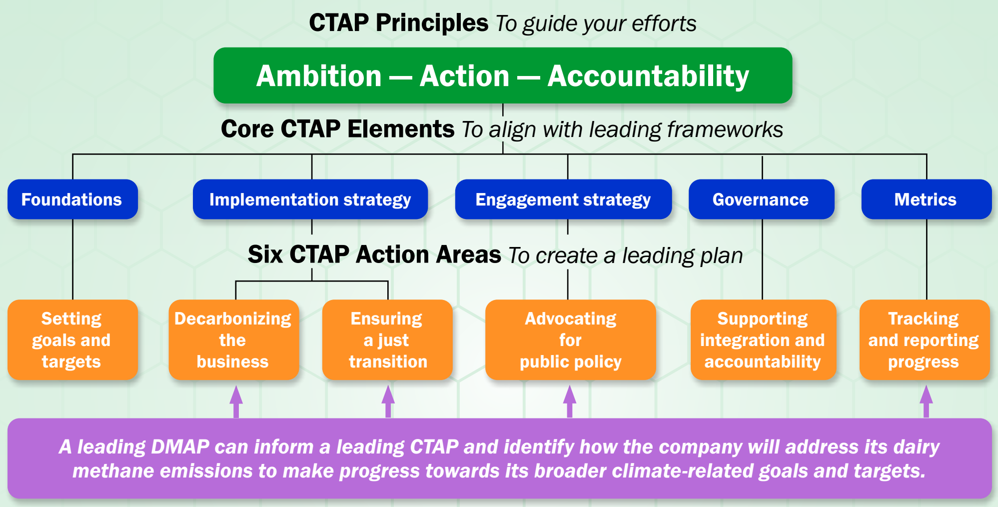
BOX 1

How methane fits into a CTAP

As described in Ceres' report, Blueprint for Implementing Leading Climate Transition Action Plans, a CTAP should identify how a company will address its main climate-related impacts. For companies that produce or source dairy, methane is likely a significant source of GHG emissions and, thus, a pivotal lever for achieving emissions reduction goals and mitigating climate-related risks.

FIGURE 3

How a DMAP fits into a CTAP



For example, in its Climate Transition Action Plan, General Mills estimates that addressing emissions from dairy will achieve 7% of its 2030 target to reduce value chain emissions by 30%. General Mills articulates that it will focus on dairy methane emissions and estimates that it can potentially reduce dairy emissions 40% by 2030 through improved manure management, rotational grazing, feed optimization, cow health and longevity.

Leading companies, such as General Mills and Danone, are using this guide to develop their DMAPs, which provide stakeholders with more details and concrete plans for how they will work across their supply chains to achieve dairy methane reduction targets, as outlined in their CTAPs.

For more information on CTAPs, see the following resources:

Cross-sector guidance

- Ceres: Blueprint for Implementing Leading Climate Transition Action Plans
- We Mean Business Coalition: Climate Transition Action Plans
- Transition Plan Taskforce: Disclosure Framework

Sector-specific guidance

- Ceres: Investor Guide to Climate Transition Plans in the U.S. Food Sector and the Food Emissions 50 Benchmark Methodology
- Transition Plan Taskforce: Food and Beverage Sector Guidance

Methane action plans and, more generally, CTAPs are designed to be iterative. Corporate methane action plans will evolve with new and updated strategies as work is completed, challenges are encountered, new technology becomes available, and goals are accomplished. Additionally, as more companies work to reduce agricultural methane, accounting for emissions abated by specific practices and/or technologies will become easier and more standardized over time. There may also be emerging opportunities for companies to co-invest in dairy methane mitigation solutions along value chains to reduce Scope 3 emissions.

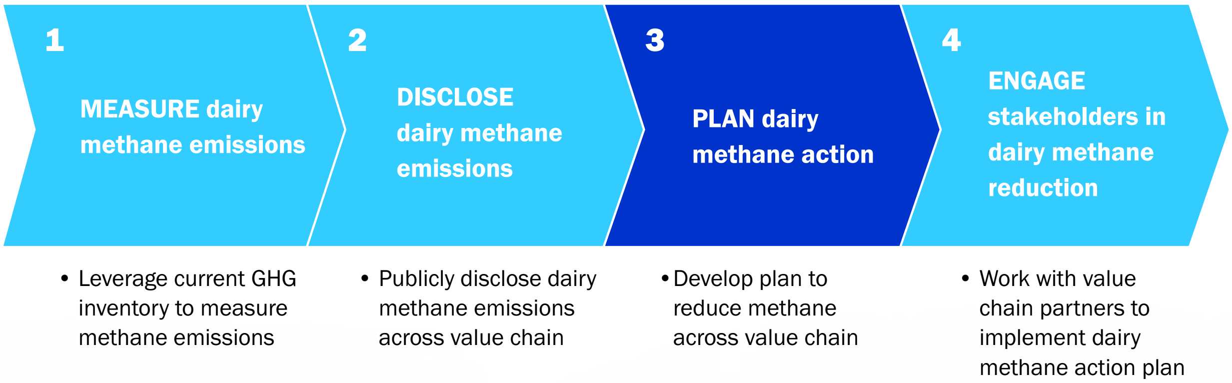
Purpose of the guide

This guide aims to provide dairy-producing and -sourcing companies with a common DMAP framework that supports planning and disclosing near-term actions to reduce dairy methane emissions as part of a broader climate strategy. Establishing a common DMAP framework and template simplifies and harmonizes the planning process by clearly outlining the core elements needed to plan and act on dairy methane, regardless of company size or geography. While this guidance demonstrates best practices for developing a leading DMAP to support immediate and robust corporate action, specific content in a DMAP will depend on the company's unique needs. This guide also provides an overview of different dairy methane mitigation strategies and solutions to help companies consider which methane reduction solutions are most relevant to their operations and supply chains based on various evaluation criteria. This guide includes:

- **A DMAP overview**, which outlines key considerations for implementing methane reduction activities, including:
    1. Key dairy methane disclosures to provide context on company exposure to methane emissions in its operations and supply chain.[a]
    2. Details on methane reduction strategies to explain concrete actions the company will take, the implementation timeline for actions, and expected methane reductions.
    3. Other considerations such as barriers and challenges, as well as information on implementing a just transition.
    4. Annual progress disclosure for companies to report on progress against their plans to address methane emissions.[a]
    5. Framework for improving a corporate DMAP over time through broader, deeper, and more transparent disclosures.
- **An evaluation of methane mitigation solutions** to help companies identify which existing and emerging solutions are best suited to their business based on a range of criteria from farm type and region, to solution readiness and GHG reduction potential. While this list is not exhaustive, it is meant to guide companies on how to evaluate different solutions based on distinct farm and intervention characteristics.
- **A DMAP template** and **example DMAP** in the Appendix to demonstrate what companies should disclose in their DMAPs, how to organize their DMAPs, and how to recognize leading DMAP disclosures.

[a] This guide covers key dairy methane disclosures and annual progress disclosure at a high level. Please refer to the DMAA Dairy Methane Disclosure guide for more details on public reporting.

FIGURE 4
DMAA initiative trajectory



Stage 1 of the DMAA initiative outlines how companies can measure their dairy methane emissions, while Stage 2 identifies best practices for publicly disclosing these emissions. This third stage (and guide) aims to help companies formulate a methane action plan that lays out the steps needed to achieve methane emissions reductions and make progress in the near term (5-10 years). Companies may optionally choose to review these plans every 1-3 years and disclose any necessary changes to the plan. DMAPs can help orient companies around climate priorities and showcase industry leadership by publicly disclosing these plans. In alignment with the DMAA initiative trajectory summarized in Figure 1, this DMAP guide is accompanied by a guide exploring best practices for engaging stakeholders on these dairy methane reduction efforts (Stage 4).

DAIRY METHANE ACTION PLAN (DMAP)

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DMAP components

This section describes criteria for companies to use when developing their DMAP. Appendix 1 of this guide includes a blank version of the DMAP template, and Appendix 2 includes a completed example template for reference.

Companies that want to lead on methane action should develop DMAPs in line with the guidance below, adding additional details and reporting progress over time as they implement methane actions and refine GHG estimates. Companies should create their DMAPs in the first year of embarking on this work and report on progress in subsequent years. Where applicable, companies should integrate their DMAPs into more extensive CTAPs to embed agricultural methane reduction into a broader climate strategy.

FIGURE 5
Overview of DMAP components

1

Part 1: Key disclosures
- Annual methane emissions disclosure
- Emissions reduction targets
- Methane reduction target
- Qualitative and quantitative explanation of key sources of dairy methane in company's operations and supply chain

2

Part 2: Strategies to reduce dairy methane emissions
- Farmer and supplier engagement strategy
- Innovation strategy
- Public policy advocacy strategy
- Action items and key details for all strategies

3

Part 3: Additional considerations for DMAPs
- Barriers and systemic challenges related to DMAP implementation
- Just transition considerations
- Measurement and accountability mechanisms
- Synergies with other sustainability programs
- Disclosure of non-dairy methane emissions and plans to address them
- Long-term planning for dairy methane reduction

4

Part 4: Disclosure of progress (year 2 onwards)
- % change in Scope 1 and/or Scope 3 methane emissions from dairy supply chain from previous reporting year
- Qualitative explanation of progress

The high-level DMAP checklist in Figure 5 outlines the key components of a robust DMAP. These components are discussed in more detail in the sections that follow. Parts 1-4 include disclosures for companies to establish leadership and accelerate their progress toward reducing methane emissions across their business. As companies progress in their plans, they may disclose additional details, such as new investments in methane solutions, emissions reductions realized from these investments, longer-term plans that go beyond 2035, and more.

Part 1: Key disclosures

FIGURE 5.1
DMAP checklist for Part 1: Key disclosures

1

Part 1: Key disclosures

- Annual methane emissions disclosure
- Emissions reduction targets
- Qualitative and quantitative explanation of key sources of dairy methane in company's operations and supply chain
- Methane reduction target

Disclosing emissions from dairy sourcing will allow the company to identify methane hotspots and plan actions to address those sources accordingly. To demonstrate industry leadership, companies participating in DMAA have already committed to disclose full scope (Scopes 1-3) emissions, methane from their dairy supply chains, and how dairy methane emissions relate to their full scope emissions.

Including methane emissions disclosures in the DMAP provides context for why a methane action plan is necessary to achieve broader climate goals. It also highlights the hotspots companies should cover in their plans. While the checklist in Figure 5.1 and the bulleted list below outlines key methane disclosures necessary for developing a DMAP, detailed methane disclosure best practices are outlined in the DMAA Dairy Methane Disclosure guide. DMAA signatories can report methane emissions in a single platform to minimize duplication of effort. See Appendix 1 for a template for completing the key disclosures and Appendix 2 for an example of a completed disclosure for reference.

Companies should disclose the following:

- **Annual methane emissions disclosure:**
  - ✓ Methane disclosures relevant to company's mitigation plans using guidance outlined in the DMAA Dairy Methane Disclosure guide and, optionally, cite what methodologies the companies used to estimate emissions
- **Corporate emissions reduction targets:**
  - ✓ Target and baseline year for Scope 1 and Scope 3 emissions
- **Methane reduction target:**
  - ✓ Target and baseline year for methane emissions
- **Quantitative and qualitative explanation of company's dairy methane emissions**
  - ✓ Contribution of dairy methane to total corporate emissions and description of dairy methane hotspots

Companies are encouraged to set a methane-specific reduction target and disclose progress against it to ensure internal prioritization of actions to reduce methane emissions as a core part of the company's climate strategy. Having a specific methane reduction target can help prioritize methane action within a company, elevating methane as a key priority among the company's broader climate-related goals. For example, in addition to its Scope 1, 2, and 3 targets, which include a Science Based Targets initiative (SBTi) target to reduce Forest, Land, and Agriculture (FLAG) emissions, Danone also has a specific target to reduce methane from fresh milk used in its dairy products 30% by 2030 compared to a 2020 baseline. This target is in line with the ambitions of the Global Methane Pledge.

BOX 2

Example: Dairy methane disclosure

Danone reported that its 2020 Scope 1-3 baseline emissions were 21.9 Mt CO_2e, with 4 Mt CO_2e (18%) coming from dairy methane. In 2022, Danone also reported that 25% of its total and 42% of FLAG emissions came from methane. Fresh milk accounted for 70% of these methane emissions, while other dairy ingredients comprised the remaining 30%. To support agricultural GHG emissions reduction, Danone set an SBTi target to reduce absolute Scope 1 and 3 FLAG emissions by 30.3% by 2030 from a 2020 baseline.

Since Danone's public disclosures highlight that dairy methane disproportionately contributes to its corporate GHG footprint, outlining a clear and comprehensive DMAP is critical to meeting its FLAG emissions reduction target.

Part 2: Strategies to reduce dairy methane emissions

A DMAP should include the strategies and action items a company will implement to reduce methane emissions from dairy production. Since many CPGs do not directly own or operate farms, addressing dairy methane will help companies make progress on reducing Scope 3 emissions. For companies that operate farms, especially those maintaining dairy cows or other ruminant herds, addressing methane will be a crucial way to reduce operational Scope 1 emissions.

There are three key methane mitigation strategies companies can implement to address agricultural methane emissions:

1. A **farmer and supplier engagement strategy** that outlines how companies will accelerate the adoption of methane solutions at the farm level to reduce Scope 1 and/or Scope 3 GHG emissions.
2. An **innovation strategy** that outlines the near-term actions companies will take to support the development of next-generation methane-abating technologies.
3. A **public policy advocacy strategy** that outlines how companies will support public policies that promote actions to address methane.

BOX 3

DMAP terminology: strategies, solutions, and actions

Throughout this document, many terms are used to describe different ways companies can work to mitigate dairy methane emissions. Below are definitions for how these terms are used in the context of this guide to ensure all readers are aligned on these meanings.

- **Strategies** describe the highest-level, most general pathways companies can use to begin conceptualizing methane reductions. Methane mitigation strategies identified in this guide include farmer and supplier engagement, innovation, and policy advocacy. Within each strategy are more specific methane mitigation activities (solutions/interventions and actions), but strategies represent general ways to engage.
- **Actions** include concrete steps that deliver progress toward an overall strategy. When working on farmer and supplier engagement as a methane mitigation strategy, an example action would be piloting an enteric methane-mitigating feed additive on 10 supplier farms in North America and Europe.
- **Solutions** or **interventions** are the methane-reducing technologies and practices that can be adopted on the farm. When thinking about farmer and supplier engagement as a methane mitigation strategy and piloting an enteric methane-mitigating feed additive on test farms as a supporting action, the solution itself would be the feed additive as the mechanism that reduces enteric methane.

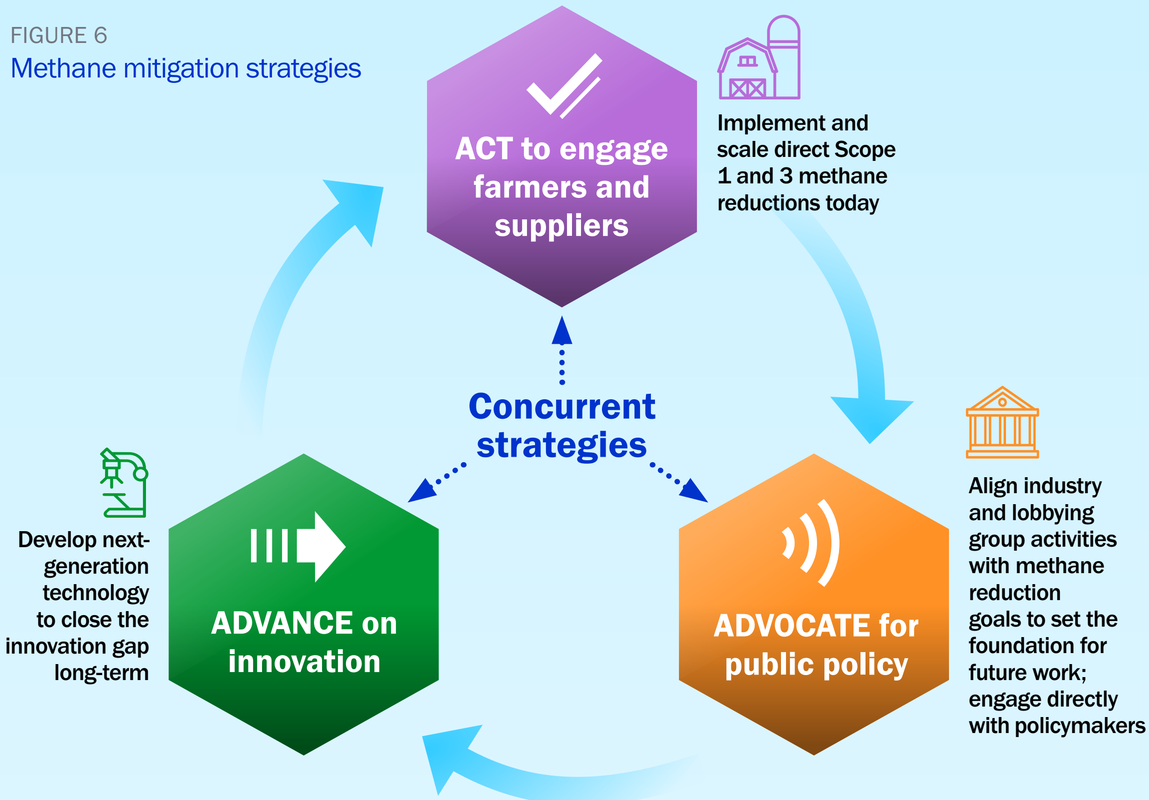
Example solutions and actions for key methane mitigation strategies can be found in the Methane Mitigation Solutions section of this guide.

BOX 4

Methane mitigation strategies

FIGURE 6

Methane mitigation strategies



All three strategy areas presented in this guide are critical for driving dairy methane reductions. Direct engagement with farmers and suppliers is necessary to promote on-farm adoption of ready-to-deploy methane solutions, research and innovation will help to improve upon existing solutions and accelerate the development of emerging ones, and beneficial public policies and programs bolster both approaches—providing additional support for the adoption of low-methane solutions and complementing private-sector research and innovation activities.

Companies should work on projects across different strategies in tandem to ensure they are not only acting on methane now but also investing in future, more substantial methane mitigation technologies, projects, and policies. While some solutions may require public policy, innovation, and farm-level interventions to realize methane reductions, others may only require interventions across one or two strategies. The strategies needed to successfully implement a methane-mitigating solution depend on existing solution readiness, implementation burden, and other factors.

Figure 6 shows how each methane mitigation strategy works to support direct methane reduction activities. This builds on the Act, Advocate, Advance framework presented in EDF's Strategic Roadmaps for SBTi Forest, Land, & Agriculture Targets: Prioritizing Action for Impact Report.

Strategy: Farmer and supplier engagement

Companies should complete the information in the checklists below (Figures 5.2A-C) for each methane mitigation strategy, including supplier engagement, innovation, and public policy advocacy.

FIGURE 5.2A

DMAP checklist for Part 2: Farmer and supplier engagement strategy

2

Part 2: Strategies to reduce dairy methane emissions

Farmer and supplier engagement strategy

- **Dairy methane emissions addressed**
- **Context for strategy implementation**
  - ✓ Key business changes from strategy implementation
  - ✓ Material physical and transition climate-related risks addressed
  - ✓ Scope, scale, and coverage across business
  - ✓ Business units involved in implementation
  - ✓ Industry, government, trade, and/or NGO groups engaged
  - ✓ Current status of strategy (ongoing, planned, etc.)
- **Action items and implementation timeline**
  - ✓ Concrete actions to implement and advance strategy, including the following for each action item:
    - Regions where interventions will be implemented
    - Expected start and completion date
    - Interim milestones and/or key performance indicators (KPIs)
    - Estimated emissions reductions for individual interventions
    - Investments and capital expenditure alignment

Methane related to dairy production is largely emitted at the farm level from enteric fermentation and manure management. For companies that source dairy products, addressing methane in their supply chain through robust and thoughtful farmer and supplier engagement is critical to meeting their Scope 3 emissions reduction target(s). For companies that own and operate farms, engaging farmers and farmworkers to ensure they understand and are trained to implement methane-mitigating actions will still be crucial. A comprehensive methane action plan should identify the main sources of methane emissions in a company's supply chain (e.g., enteric/manure, geography, business unit, supplier) and include specific actions a company will take to address these emissions through farmer and supplier engagement strategies.

Tactics to engage farmers and suppliers and advance the adoption of dairy methane solutions may include:

- Piloting new solutions on farms before scaling solutions in the broader supply chain
- Financially incentivizing dairy producers to adopt new solutions through compensation mechanisms
- Providing technical assistance to support the adoption of solutions
- Partnering with peers or customers (e.g., CPG partnering with a retailer) to co-invest in farm-level projects to drive larger adoption of methane solutions
- De-risking the transition by adopting a yield-gap guarantee in the price paid for dairy products
- Implementing procurement policies, such as guaranteeing a certain volume of dairy that will be purchased from dairy producers that implement these solutions
- Identifying federal or other government programs to share the cost of implementing climate-smart practices (including methane mitigation solutions) with farmers

Refer to this guide's Methane Mitigation Solutions section for more information on the solutions set for methane reduction and how companies can prioritize these different solutions.

Dairy-sourcing companies should plan to thoughtfully implement and scale actions in their supply chains. In their plans, companies should provide the overarching context of their farmer and supplier engagement strategy, including what climate-related risks the strategy will address, what business functions will be involved, any necessary changes to their business model or procurement strategy, and the regions in which they will implement interventions. Since supplier engagement actions may require collaboration across business units (e.g., between procurement and sustainability teams), it is critical that there is buy-in from different parts of the company from the start. DMAPs can be a valuable tool for catalyzing the near-term work to engage farmers and suppliers in reducing dairy methane. However, DMAPs can also be instrumental in helping shape the critical long-term strategies companies need to support continued adoption and engagement at the farm level. To ensure that companies have plans to scale actions, they should also identify either the proportion of farmers/suppliers or the volume of dairy products the company sources that will be covered by this strategy.

Companies may also provide the estimated emissions reductions listed by intervention and include capital or operational expenses needed to implement their farmer and supplier engagement strategy. Companies must gather emissions mitigation data from the interventions they implement across their operations and supply chains. This can help ensure that a DMAP will deliver the emissions reductions needed for companies to achieve broader climate-related goals. As the industry better understands the mitigation potential of different solutions over time, companies can use this data to supplement their DMAPs with the estimated emissions reductions from the actions they implement. This can help companies better understand whether planned actions can achieve their broader climate goals or whether more investment is needed.

Companies can also explain how investment in this strategy aligns with their corporate climate targets. As companies advance their dairy methane action planning, it is important that they sufficiently budget for investments needed to implement key strategies. In addition to investing in actions included in the DMAP, companies can explain how other business investments align with their overarching methane reduction target. This may include capital planning for investments that offer alternatives to products with a high methane footprint, such as plant-based alternatives. Companies can also use this information to secure additional funding sources for methane solutions, such as sustainability-linked bonds and loans from financial institutions.

See Appendix 1 for a template for completing the farmer and supplier engagement strategy and Appendix 2 for an example of a completed strategy.

BOX 5

Example: Companies expanding supply chain adoption of methane solutions

Bel Group, in partnership with dsm-firmenich and Institute de l'Elevage (Idele), piloted the feed additive Bovaer® on two farms in Slovakia in 2022, and with five dairy farmers in France between January and March of 2023. Bovaer® is a feed supplement developed by dsm-firmenich to reduce methane emissions from enteric fermentation in cattle. The purpose of the pilot was to understand the practical feasibility of feeding Bovaer® to dairy cows under real farm conditions. In France, the pilot showed that under optimal conditions, the feed additive reduced methane emissions by 29% to 42%, depending on the farm. Not only did this pilot help provide additional evidence on the efficacy of this feed additive, but it also helped the company build the business case for continuing to roll out the feed additive with farmers in its supply chain.

In May 2023, Bel Group announced that it would begin rolling out Bovaer® to farms in its Slovak dairy basin, which supplies a processing plant that produces Babybel® cheeses for consumers in the UK, Germany, the Czech Republic, and Slovakia. In mid-2024 Bel Group also made Bovaer® available for the French dairy basin, which produces iconic Bel products like Babybel®, Kiri®, Boursin®, and Cousteron®. In 2024, Bel Group, together with the French producers' organization Bel West Producers Association (APBO), built an incentive program "Mon BB Lait® durable" to accelerate GHG reduction and lever implementation, particularly through increased farmer deployment of Bovaer®. The new program will start in June 2025.

In the future, Bel Group could continue to strengthen its engagement by disclosing:

- *How it plans to roll this out over the next 1-5 years throughout its supply sheds*
- *The percentage of suppliers using the feed additive or the volume of milk produced using the feed additive*
- *The expected completion date for the rollout of the feed additive in its supply sheds*

The company could also share any plans to develop an incentive program for farms implementing this strategy.

Strategy: Innovation

FIGURE 5.2B
DMAP checklist for Part 2: Innovation strategy

2

Part 2: Strategies to reduce dairy methane emissions
Innovation strategy

- **Dairy methane emissions addressed**
- **Context for strategy implementation**
  - ✓ Key business changes from strategy implementation
  - ✓ Material physical and transition climate-related risks addressed
  - ✓ Scope, scale, and coverage across business
  - ✓ Business units involved in implementation
  - ✓ Industry, government, trade, and/or NGO groups engaged
  - ✓ Current status of strategy (ongoing, planned, etc.)
- **Action items and implementation timeline**
  - ✓ Concrete actions to advance strategy, including the following for each action item:
    - Regions where interventions will be implemented
    - Interim milestones and/or KPIs or expected outcomes
    - Investments and capital expenditure alignment

Today, companies can engage dairy farmers and suppliers to implement several existing methane-reducing technologies and practices in their operations and/or supply chains. However, in many cases, these technologies alone do not meet the level of emissions reduction needed to avoid the worst impacts of climate change and mitigate the climate-related risks facing the dairy industry. Further innovation of emerging and novel solutions will help accelerate the pace and increase the scale of methane reductions in agriculture. In addition, advancements in measuring, monitoring, reporting, and verification (MMRV) for methane, including making it easier for farmers to use MMRV solutions, could help further identify methane hotspots and simplify how companies prioritize actions and disclose progress. To address these opportunities, a methane action plan should include an innovation strategy that articulates how a company will support the development of new technology to further drive methane reductions.

Companies can accelerate innovation in this space through:

- Participating in public-private partnerships that fund methane abatement research
- Investing venture capital in methane-abating technologies
- Supporting commercial trials to advance research
- Supporting pilot testing and development of methane MMRV infrastructure to facilitate streamlined farmer use
- Considering the role of plant-based and alternative protein products in a diversified product portfolio to further mitigate the company's exposure to dairy methane

When evaluating innovative methane mitigation opportunities, it is also important to assess potential social and environmental trade-offs. For example, innovations should be less methane-intensive than the existing technology and not result in negative social impacts or other unintended consequences. Part 3 of the DMAP outlines how companies can incorporate just transition considerations into their planning.

See Appendix 1 for a template for completing the key disclosures and Appendix 2 for an example of a completed disclosure.

BOX 6

Example: Investing in methane innovation

As part of its Climate Transition Plan, **Danone** estimates that it can reduce 0.25 Mt CO_2e across its GHG inventory by accelerating and implementing methane innovations, including those that can reduce methane from enteric fermentation. To this end, in 2023, Danone became the first corporate funder of the Global Methane Hub's Enteric Fermentation Research & Development (R&D) Accelerator, which is the largest global coordinated research effort on enteric methane. The Accelerator has pledged to invest at least $200 million in developing and implementing practical solutions aimed at reducing methane emissions 30% by 2030. This commitment aims to foster new, scalable, and practical solutions to help dairy farmers significantly reduce methane emissions.

To strengthen its disclosure, Danone could also publish interim KPIs that would indicate success (e.g., volume of dairy produced with enteric-fermentation-mitigating technologies by year 20XX).

BOX 7

Product innovation

As dairy-sourcing companies strive to reduce the climate impact and financial risks associated with their dairy ingredients, they must also find solutions to feed a growing population while meeting evolving consumer dietary needs and preferences. Expanding product lines with plant-based ingredients and products is a key innovation strategy to do just that. This type of product innovation also addresses the gap where on-farm interventions will not meet existing climate and/or methane reduction targets.

Actions such as incorporating plant-based ingredients into existing products to reduce some milk purchasing, developing new plant-based products, investing in plant-based products and novel ingredient processing, and conducting R&D to improve consumer acceptability of plant-based ingredients and products all support this type of innovation. For example, Hershey worked to replace milk solids with roasted grain flour to improve its dairy-free chocolate, given growing consumer preferences for vegan and plant-based options. Danone's Manifesto Ventures invests in and supports innovative companies bringing emerging concepts to market, including plant-based products.

Strategy: Public policy advocacy

FIGURE 5.2C

DMAP checklist for Part 2: Public policy advocacy strategy

2

Part 2: Strategies to reduce dairy methane emissions
Public policy advocacy strategy

- **Dairy methane emissions addressed**
- **Context for strategy implementation**
  - ✓ Material physical and transition climate-related risks addressed
  - ✓ Industry, government, trade, and/or NGO groups engaged
  - ✓ Current status of strategy (ongoing, planned, etc.)
- **Action items and implementation timeline**
  - ✓ Concrete actions to advance strategy, including the following for each action item:
    - Regions where interventions will be implemented
    - Specific policies supported
    - Participation in regulatory process

Reducing global dairy GHG emissions will require collaboration between both the private and public sectors. Companies and their suppliers, as well as federal, state, and local governments, will need to collaborate to create a regulatory environment that enables transformative action. A policy advocacy strategy is important for a company to leverage government support and influence legislation to remove roadblocks and unlock solutions that can accelerate progress. As part of their policy advocacy strategy, companies can encourage industry and trade groups to align with methane reduction goals, lobby governments directly, and participate in public-private partnerships.

Specific actions companies can take to advance a policy advocacy strategy may include:

- Supporting policy initiatives that advance the development of methane MMRV
- Advocating for policies and programs that provide financial and technical support for implementing methane solutions
- Advocating for increased public R&D funding to support basic research and early-stage innovation
- Supporting regulatory reform to streamline the approval process for feed additives and other methane solutions and ensure an efficient and safe regulatory process
- Engaging trade associations and industry groups to conduct lobbying activities aligned with methane reduction goals
- Support policy incentives that not only support farmer adoption of methane mitigation solutions but also production-linked incentives for startups to scale solutions

Companies can advocate for programs and policies to accelerate research on agricultural methane across several global avenues. In the U.S., companies can advocate for Farm Bill measures that incentivize farm-level methane reduction and the protection of Inflation Reduction Act (IRA) provisions that help promote climate-smart agriculture. In the EU, the Common Agricultural Policy (CAP) requires Member States to draw up Strategic Plans to tailor the implementation of agricultural policies and channel financial farm support according to national contexts to meet the EU's targets and increase their own climate ambition. Companies can advocate for the CAP to fund innovative methane-reducing technologies and practices. Countries increasingly feature livestock emissions in their Paris Agreement Nationally Determined Contributions (NDCs), which are plans to cut emissions and adapt to climate impacts.

There are also opportunities for companies to support individual regulations to help accelerate the adoption of agricultural methane solutions. For example, many food companies in the U.S. supported the Innovative Feed Enhancement and Economic Development Act of 2023 (Innovative FEED Act), which is intended to streamline and expedite the approval process of methane-reducing feed products. Though not yet passed at time of publication, the legislation has bipartisan sponsors in the U.S. House of Representatives and Senate.

BOX 8

Example: Policies accelerating the adoption of methane solutions

Companies can support R&D of methane solutions by supporting public policies, such as the Enteric Methane Innovation Tools for Lower Emissions and Sustainable Stock (EMIT LESS) Act, introduced in March 2024. This legislation would expand U.S. Department of Agriculture (USDA) research on agricultural methane solutions and create voluntary incentives through conservation programs to accelerate on-farm adoption if enacted. Several companies and organizations, including Dairy Farmers of America, Danone North America, and McDonald’s, have publicly supported this bill.

Part 3: Additional considerations for DMAPs

FIGURE 5.3
DMAP checklist for Part 3: Additional considerations for DMAPs

3

Part 3: Additional considerations for DMAPs
- Barriers and systemic challenges related to DMAP implementation
- Just transition considerations
- Measurement and accountability mechanisms
- Synergies with other sustainability programs
- Disclosure of non-dairy methane emissions and plans to address them
- Long-term planning for dairy methane reduction

In addition to the key strategies companies will implement to reduce emissions, they should also include other considerations that will inform their DMAP. Compared to other parts of the methane action plan, the information in this section may be more fluid, and companies may opt to update this section more frequently than other sections as new barriers are uncovered or as best practices for a just transition in the dairy sector evolve.

Additional information companies should provide in this section include:

- **Barriers** that prevent farmers and suppliers in the company's supply chain from adopting the near-term methane mitigation solutions identified in the company's DMAP, along with the actions the company will take to help overcome these barriers
- **Systemic challenges** that currently limit the company's scope of methane mitigation in the near term (e.g., technology too nascent for corporate adoption or investment) and the company's intent to monitor for future planning
- Considerations to ensure the company's transition to lower emissions dairy procurement and production is aligned with a **just transition**, including but not limited to:
  - ✓ Actions taken or that will be taken to ensure a just transition and address transition risks to suppliers, including farmers and farmworkers
  - ✓ Activities to support the company's existing workforce, vulnerable customers, and at-risk communities during the transition
    - This may include sharing the cost of transitioning to low-methane practices, considering food affordability, and ensuring equitable access to low-methane dairy.
  - ✓ Actions to consult and implement feedback from your workforce, suppliers, impacted communities, and NGOs
- **Measurement and accountability** mechanisms in place to ensure the company continues to make progress over time
- **Synergies** between the company's DMAP and other sustainability initiatives, such as water, nature, and communities, and how this work may support progress in these areas

- **Sources of non-dairy methane** emissions and plans to address them
- Plans to reduce dairy methane emissions in the **long term** to help achieve a net-zero future by 2050

While this guide focuses on how dairy-producing and -sourcing companies can address dairy emissions, companies may also emit methane from other sources across their operations and supply chains. Examples include sourcing beef, pork, or rice products and disposing of and treating waste on- or off-site. Companies developing DMAPs may choose to include these other sources of methane in their plans.

A DMAP should identify actions a company will take in the near term (5-10 years). However, companies are encouraged to plan for the long term, looking ahead to 2050 and beyond if appropriate for the business. This could include aligning current investments with the company's vision for the long-term resilience and value of its future operations. While companies consider near-term reductions, they should ensure all reductions are aligned with science-based pathways. For example, the SBTi FLAG Guidance requires downstream dairy buyers to set absolute emissions reduction targets for land-based emissions, including methane from livestock production.

BOX 9

Just transition in the dairy industry

Supporting smallholders in developing markets

To advance systemic and sustainable local dairy production in Nigeria, FrieslandCampina partnered with URUS (a global leader in dairy cattle genetics), Barenbrug (a leading grass and forage seed company), and Agrifirm (a global animal nutrition and farming business) to form the Value4Dairy Consortium. The goal of this consortium is to provide a pathway towards a self-sufficient, competitive, climate-smart, and locally managed dairy sector in Nigeria.

Establishing labor standards for dairy farmworkers

Ben & Jerry's Caring Dairy program aims to support sustainable dairy practices that benefit farmers, farmworkers, cows, and the environment. To that end, Ben & Jerry's partnered with Migrant Justice to become the first company to adopt and implement the Milk with Dignity Program, a farmworker-led organization that established labor standards to ensure dignified labor conditions on dairy farms. These standards include adequate breaks, time off, paid sick time, safe working conditions, and worker education and advocacy. Participating farms are paid a premium for their milk to support wage increases for farmworkers. The Milk with Dignity program covers 100% of the farms supplying fresh milk to Ben & Jerry's.

Part 4: DMAP progress disclosure

FIGURE 5.4

DMAP checklist for Part 4: DMAP progress disclosure

4

Part 4: Disclosure of progress (year 2 onwards)

- % change in Scope 1 and/or Scope 3 methane emissions from dairy supply chain from previous reporting year
- Qualitative explanation of changes

Companies should report annual progress toward their DMAP, absolute changes in dairy methane emissions, and updates on implementing key strategies. Companies may also optionally report dairy methane changes on an intensity basis to indicate changes per unit of sourced or produced dairy.

TABLE 1

Methane emissions from dairy supply chain (Mt CH_4/year)

	Baseline [year]	Current [year]	% Change from previous year	% Change from baseline
Scope 1 emissions				
Scope 3 emissions				

Annual qualitative DMAP progress disclosure may include:

- Qualitative explanation of changes in dairy methane emissions and progress towards goals from the previous year
- Update on the status of implementing strategies articulated in the dairy methane action plan, including progress on milestones and KPIs related to the supply chain engagement, innovation, and public policy advocacy strategies
- Explanation of any changes to the business or external factors that may have resulted in emissions changes unrelated to the company's methane abatement strategies (e.g., mergers and acquisitions, divestments, unrelated changes to dairy procurement and sales)
- New strategies or technologies that can be added to the DMAP to improve performance (e.g., increase emissions reduction, meet target reduction faster, reduce cost, improve ease of use)
- Strategies or technologies that were not successful or practical to apply and whether they will be removed from the DMAP

See Appendix 1 for a template for completing the annual progress disclosure and Appendix 2 for an example of a completed disclosure.

DMAP improvement over time

Developing and publishing a DMAP is a substantial first step to defining strategic priorities and driving corporate accountability on dairy methane. As companies and the international community make progress on agricultural methane reduction, companies may seek to refine, adapt, and augment their DMAPs. Companies that improve the depth, breadth, and transparency of their DMAPs over time can better plan and track their methane action and demonstrate leadership.

Companies embarking on dairy methane planning at different stages of their journeys may have varied information available to disclose in their DMAPs. The figure below uses a "good-better-best" framework to outline the spectrum of DMAP disclosure, from a starting point of "good", to leading disclosures that fall under the "best" category. Note that in order to develop a "best" or leading DMAP, all "good" and "better" elements must also be included. This framework provides companies with the foundation to begin their work on dairy methane while demonstrating how to bolster their strategies over time.

Companies can make progress on their DMAPs to build a more robust methane strategy by setting methane targets, incorporating just transition considerations, and planning for the long term, among other actions. These additional elements can help external stakeholders ensure companies are on track to achieve their emissions reduction targets. These details can also help companies prioritize actions and investments and ensure they have sufficient internal support and understanding to drive further methane reductions. Every 1 to 3 years, companies may choose to review all strategies and assess whether to adjust their DMAPs. This could include new technologies, existing projects reaching completion, entry into new markets or product categories, mergers and acquisitions, divestments in operations, and other updates.

FIGURE 7

DMAP “good-better-best” disclosure improvement framework

	1 **Part 1: Key disclosures**	2 **Part 2: Strategies to reduce dairy methane emissions**	3 **Part 3: Additional considerations for DMAP**	4 **Part 4: Annual DMAP progress disclosure (in year 2 and beyond)**
GOOD	• Annual dairy methane emissions disclosure • Emissions reduction target • Qualitative and quantitative explanation of key dairy methane sources in operations and supply chain	**Farmer and supplier engagement** strategy: • Dairy methane sources addressed • Context for strategy implementation • Concrete action items to advance strategy	• Barriers and systemic challenges related to DMAP implementation • Synergies with other sustainability programs	• Dairy methane emissions disclosure reported annually • Quantitative and qualitative explanation of changes reported annually
BETTER	+ • Methodology for dairy methane emissions calculations	+ For each **farmer and supplier engagement** strategy action item: • Timelines, milestones, and KPIs to evaluate success • Estimated emissions reductions **Innovation** OR **public policy policy advocacy** strategy: • Dairy methane sources addressed • Context for strategy implementation • Timelines, milestones, and KPIs to evaluate success • Estimated emissions reductions	+ • Just transition considerations - Address risks of transition to farmers, suppliers, customers, employees, and communities - Activities to support key stakeholders • Long-term planning for dairy methane reduction (high-level) • Measurement and accountability mechanisms	+ • Update on DMAP strategies outlined in part 2 • Explanation of business or external factors causing emissions changes unrelated to methane abatement strategies • New strategies or technologies to add to DMAP to improve performance • Strategies or technologies not successful or practical to apply and whether they will be removed from DMAP
BEST	+ • Methane reduction target	+ All **planning details for all three** strategies (now also including investments and capital expenditure alignment)	+ • Just transition considerations - Ongoing stakeholder engagement and feedback consultation - Long-term actions • Non-dairy methane emissions and plans to address them • Detailed long-term planning for dairy methane reduction (2050 and beyond)	+ • DMAP reviewed and updated every 1–3 years with detailed analysis of progress

METHANE MITIGATION SOLUTIONS

METHANE MITIGATION SOLUTIONS

Overview

This section of the guide provides an overview of available and upcoming methane mitigation solutions. Key solutions are evaluated using a set of 13 different criteria. Given the number of solutions for methane mitigation, emerging and novel solutions that are less well studied are not fully evaluated but are outlined in Appendix 4. Appendix 5 includes further information on dairy processing improvements that can reduce methane emissions from dairy waste. While the lists of solutions presented throughout this guide are a comprehensive look at dairy-methane-reducing interventions, they are not exhaustive of all solutions in the marketplace.

This section first presents all identified solutions in Table 2. Evaluation criteria for key solutions are then defined and used to rank or categorize each solution by the different criteria parameters, highlighting which solutions are most accessible and ready for implementation, among other characteristics. Presenting different mitigation solution types can help companies identify which solutions best fit their operations and supply chains and estimate methane reductions associated with different strategies and actions. It is important to note that companies must still perform their own due diligence to understand how applicable each solution is to their own operations and supply chains and whether they can maintain the solution over time to realize the benefits in the long term.

TABLE 2

List of methane mitigation solutions

EDF and Ceres do not endorse specific solutions or the research associated with each solution.

Mitigation pathway	Mitigation solution	Solution description	Table in report
Enteric emissions reductions	3-NOP (e.g., Bovaer®)	A synthetic compound added to feed that acts as a methane inhibitor.[a]	Table 3. Full evaluation
Enteric emissions reductions	*Asparagopsis sp.* (e.g., Brominata®, Methane Tamer™, SeaFeed™, SeaGraze®, SeaStock)	A bromoform-containing red seaweed feed additive that acts as a methane inhibitor.[a]	Table 3. Full evaluation
Enteric emissions reductions	Breeding/genetics improvements for CH_4 (e.g., Semex®)	Selective breeding for methane efficiency traits.	Table 3. Full evaluation
Enteric emissions reductions	Diet optimization	Employing a variety of techniques to optimize the proper mix of forage and grain, such as selection of feed type and quality, introduction of legumes and tannin-rich plants, balance of starch, and phase feeding.	Table 3. Full evaluation
Enteric emissions reductions	Essential oils (e.g., Agolin®, Mootral Enterix™)	A feed additive made from an essential oil blend that acts as a rumen modifier.[a]	Table 3. Full evaluation
Enteric emissions reductions	Feed storage/quality	Implementing the proper storage of feed to retain feed quality and improve feed digestibility.	Table 3. Full evaluation
Enteric emissions reductions	Lipid supplementation	Supplementing feed with additional plant oils, such as olive, sunflower, and linseed oils, or tallow.	Table 3. Full evaluation

Mitigation pathway	Mitigation solution	Solution description	Table in report
Enteric emissions reductions	Methane capture headpiece (e.g., ZELP)	A CH_4-oxidizing device that converts CH_4 to CO_2 and water. The device also tracks animal health and wellness and is being piloted as an enteric methane measurement tool.	Table 3. Full evaluation
Enteric emissions reductions	Methane vaccines (e.g., ArkeaBio™, Lucidome Bio)	Vaccine to reduce ruminant methane emissions.	Table 3. Full evaluation
Manure management	Anaerobic digesters	Airtight structure that breaks down manure in the absence of oxygen and allows for the capture of biogas.[3]	Table 3. Full evaluation
Manure management	Composting	The aerobic decomposition of manure by microorganisms in a managed system, which can be achieved by a variety of composting methods, including compost bedded packs. Methane reduction occurs when compost is routinely and continuously turned over.[2]	Table 3. Full evaluation
Manure management	Daily spread	Removing manure from the barn and applying it to cropland or pasture daily.[2] This requires soil testing to ensure nutrients are not being over applied and manure is not being applied near water bodies.	Table 3. Full evaluation
Manure management	Manure additives: Acidification	Treating manure piles or lagoons with acid, most commonly sulfuric acid. There are emerging studies on the use of bio-acids such as sucrose, glucose, and whey. The acidic environment reduces net GHGs and ammonia emissions.	Table 3. Full evaluation
Manure management	Manure cover and flare systems	Airtight covers that collect biogas and flare it off as CO_2. This includes primary lagoons and secondary lagoons where anaerobic digestate is stored.	Table 3. Full evaluation
Manure management	Manure operational improvements	Employing a variety of techniques to optimize manure management, such as leak prevention, regular removal, and timing and method of manure application.	Table 3. Full evaluation
Manure management	Manure separators	Solid-liquid separation of manure: solids to bedding or compost, liquids to anaerobic digester or (preferably covered) storage lagoon.	Table 3. Full evaluation
Manure management	N2 Applied	The plasma treatment of manure reduces ammonia and methane while producing nitrogen-rich organic material.	Table 3. Full evaluation
Manure management	Pasture-based management	Incorporate pasture-based management as a strategy for manure management, including practices such as rotational grazing, adjusting grazing timing based on grass maturity, and optimizing stocking rates to evenly distribute manure on pasture and enhance nutrient cycling.	Table 3. Full evaluation
Productivity optimization and milk intensity reduction	Activity trackers	Automated health monitoring systems and the use of AI and computer monitoring to track and improve animal health.	Table 3. Full evaluation
Productivity optimization and milk intensity reduction	Animal health improvements	Use of animal health solutions for the prevention, treatment, and control of animal conditions to enhance productivity, improve animal welfare, and increase longevity.	Table 3. Full evaluation
Productivity optimization and milk intensity reduction	Breeding/genetics improvements for yield	Selective breeding to improve productivity and yield.	Table 3. Full evaluation
Productivity optimization and milk intensity reduction	Herd management/stocking density	Controlling barn stocking density for an optimal ratio of cows to stalls or cows to pasture. Too high of stocking density can lead to animal health concerns, while too low of stocking density may not maximize productivity.	Table 3. Full evaluation
Productivity optimization and milk intensity reduction	Herd management/young stock optimization	Focused management of early rearing of calves to optimize health and growth rate, reducing time to optimum weight for first calving.	Table 3. Full evaluation
Productivity optimization and milk intensity reduction	Robotic milking	Robotic or automatic milking systems allow for voluntary milking of cows, which increases productivity. These systems can also track robust data on milking frequency and milk quality.	Table 3. Full evaluation
Enteric emissions reductions	Acetic-acid-producing bacteria	Emerging research to replace the methane-producing microbes in the rumen with an acetic-acid-producing bacteria found in baby kangaroo feces.[4]	Table 5. Emerging solutions

Mitigation pathway	Mitigation solution	Solution description	Table in report
Enteric emissions reductions	Bioengineered feed additives (e.g., Lumen Bioscience, Elysia Bio)	Early-stage research on feed additives made from bioengineered products, such as spirulina (algae), corn grain, rye grass, and sorghum.	Table 5. Emerging solutions
Enteric emissions reductions	Clustered Regularly Interspaced Short Palindromic Repeats (CRISPR)	Early-stage research to apply CRISPR genome-editing technology to methane-producing microbes.	Table 5. Emerging solutions
Enteric emissions reductions	Macroalgae (excluding *Asparagopsis sp.*)	Feed additives derived from non-bromoform-containing seaweeds, such as the phlorotannin-containing brown seaweeds.[5]	Table 5. Emerging solutions
Enteric emissions reductions	Nitrates	Supplementing feed with nitrate, which serves as a hydrogen sink in the rumen, reducing methane production. Further studies are needed to ensure that increased ammonia production does not outweigh the benefits of added nitrates.	Table 5. Emerging solutions
Enteric emissions reductions	Polyphenols (e.g., Polygain™)	Supplementing feed with naturally occurring polyphenols, such as tannins found in plants.	Table 5. Emerging solutions
Enteric emissions reductions	Probiotics (e.g., Hoofprint Biome)	Probiotics and natural enzymes as a feed additive.	Table 5. Emerging solutions
Enteric emissions reductions	Synthetic bromoform (e.g., Rumin8)	Synthetically-derived bromoform feed additive with the same active compound found in *Asparagopsis sp.* (tribromomethane/bromoform), acting as a methane inhibitor.	Table 5. Emerging solutions
Enteric emissions reductions	Yeast cultures (e.g., Yea-Sacc®)	A feed additive derived from yeast cultures that acts as a rumen modifier, while enhancing yield and promoting animal health.	Table 5. Emerging solutions
Manure management	Manure additives: *Asparagopsis sp.*	Application of *Asparagopsis sp.* to manure piles.	Table 5. Emerging solutions
Manure management	Manure additives: Biochar application	Application of biochar to manure piles.	Table 5. Emerging solutions
Manure management	Manure additives: SOP Lagoon	A powdered additive, primarily composed of gypsum, used in the treatment of liquid manure management systems.	Table 5. Emerging solutions
Manure management	Manure additives: Tannins	Application of naturally occurring tannins found in plants to manure piles.	Table 5. Emerging solutions
Manure management	Manure drying	Drying of manure through solar drying or in closed drying systems.	Table 5. Emerging solutions
Manure management	Manure pasteurization	Raising the temperature of liquid manure in storage to greater than 70 °C to reduce biological activity of microbes.	Table 5. Emerging solutions
Manure management	Pyrolysis	Heating of manure in oxygen-limited environment to convert into carbon-rich biochar.	Table 5. Emerging solutions
Manure management	Vermicomposting for manure management	The use of vermiculture (worms) to break down organic matter.	Table 5. Emerging solutions
Dairy processing improvements	Manufacturing optimization	Optimizing manufacturing to reduce dairy waste.	Table 6. Dairy waste solutions
Dairy processing improvements	Ultra-pasteurization	Ultra-pasteurizing milk to extend the shelf life of dairy products.	Table 6. Dairy waste solutions
Dairy processing improvements	Waste diversion	Diverting dairy waste from landfills to alternate waste streams, such as composting, animal feed, or anaerobic digestion.	Table 6. Dairy waste solutions

[a] Feed additives are often classified as either methane inhibitors or rumen modifiers. Methane inhibitors directly block the methanogenesis process, inhibiting the formation of methane. Rumen modifiers alter the rumen environment to suppress methane production.

Solution evaluation criteria

Table 3 evaluates each solution at a high level using 13 different criteria, which are defined below. Appendix 3 outlines specific definitions (and sources, where applicable) for each evaluation criteria category. While these criteria can help companies compile a list of relevant solutions, more research on each solution is needed to inform a company's decision-making. Below are key considerations companies should reflect on when using this analysis to evaluate methane mitigation solutions.

1. **Regional regulatory applicability** evaluates the regions where it is possible to implement each solution based on regulatory restrictions. While many solutions are applicable to all regions from a regulatory perspective, this criterion is most relevant for feed additives.
2. **Climate applicability** evaluates the climate zones where the solution will have the most significant impact. Climate definitions are derived from IPCC climate zone mapping.[6] This criterion is most relevant for manure management solutions, where emissions can increase in warmer climates depending on management practices.
3. **Farm type** evaluates the type of farm for which the solution is most applicable, including intensive (dry lot or freestall), pastoral, and smallholder. Many solutions apply to multiple farm types.
4. **Farm size** evaluates the farm size for which the solution is most applicable. Farm size definitions are based on animal count and loosely derived from Thoma et al.[7] Many solutions apply to multiple farm sizes.
5. **Implementation stage** evaluates the stage at which the solution is ready for implementation, noting whether it is commercially available, undergoing research or pilot testing, or in need of public policy or advocacy before it can be considered a viable solution.
6. **Solution readiness** evaluates the degree to which the solution is ready to be deployed by companies and integrated into their supply chains. Solution readiness can range from high (widely available) to medium (becoming available) to low (not yet commercially available) to nascent (in research and development).
7. **Implementation burden** evaluates the level of difficulty required to implement and maintain the solution. Implementation burden can range from high (large-scale infrastructure changes or modifications to farming practices) to medium (moderate equipment investments, changes to farming practices, and training) to low (minimal changes and routine maintenance).
8. **Cost range** evaluates each solution's implementation cost, which can range from high (requiring third-party investments) to medium (requiring some financing) to low (minimal implementation costs).
9. **Cost type** evaluates whether the solution requires capital expenditure (CapEx), operational expenditure (OpEx), or both.
10. **GHG reduction potential** evaluates the magnitude of GHG reductions based on the intervention category. Given the variability in reduction potentials by mitigation pathway, this criterion groups solutions into a specific reduction range, with different high, medium, and low designations for enteric, manure management, and productivity optimization solutions. See Appendix 3 for specific reduction ranges.
11. **Technology level** evaluates the level of technology required to implement and maintain the solution for the average user. Technology level can range from high (advanced technology and training) to medium (average technology and training) to low (easily implemented at scale and requires minimal training).

12. **Alignment with GHG Protocols and standards** evaluates the level to which the solution is aligned with the GHG Protocol and can be readily integrated as reductions in a company's GHG inventory. This can range from high (verified to an industry standard) to medium (peer reviewed studies have demonstrated alignment) to low (few industry or university studies have demonstrated promising results) to unknown (minimal studies available to determine alignment).

13. **Level of MMRV required** evaluates the ease of measuring, monitoring, reporting, and verifying the reductions for each solution. This is categorized as high, medium, and low. Solutions with a higher reduction potential often have wider variability and require a high level of robust and manual monitoring, while solutions that can automate MMRV using technology require a low level of MMRV.

This list of solutions is not exhaustive, nor does it reference all applicable studies related to each solution. Instead, this list is meant to serve as a starting point for companies to assess mitigation options at a high level. Climate science is rapidly evolving, with new research constantly delivering new insights and informing the adoption of various solutions. Given the speed of the industry, some emerging solutions may quickly become commercially available, while others may prove to be less effective or have unintended effects. Further research in this field is needed even on commercially available solutions to determine each solution's effectiveness and impact in varying conditions and to better understand their risks and limitations.

Adopting different methane solutions can both positively and negatively impact several factors, such as water quality, soil quality, GHG emissions, biodiversity, animal health, and farm worker safety. For example, while spreading manure on pasture may reduce emissions compared with lagoon storage, too much manure may lead to the over-application of nutrients, causing eutrophication and water quality issues. Some solutions may also produce beneficial co-products, such as the biogas produced from anaerobic digestion or the nutrient-rich soil amendments from composting manure. Each solution's positive and negative impacts can vary widely depending on how each solution is implemented, as well as the regional and climatic conditions. Companies must assess these tradeoffs and co-benefits before implementing solutions within their supply chain, ensuring that the benefits outweigh the tradeoffs.

The 13 selected evaluation criteria are also not meant to provide a comprehensive assessment of each solution, but rather, to serve as high-level guidance and categorization based on existing research. Note that the evaluation of each solution is informed by the current landscape at the time of publication. Rankings within each category may change as new research emerges. Regional and farm-specific characteristics may also impact a site-specific evaluation of each solution. Specifically, GHG reduction estimates are highly variable for many solutions, either because long-term peer-reviewed studies have yet to establish sufficient consistency or because reductions depend on on-the-ground environmental conditions and farm management practices. In these cases, this guide recommends a higher level of MMRV until the variability can be reduced or better understood.

EDF and Ceres do not endorse specific solutions or the research associated with each solution. Companies should evaluate solutions before adoption, as their applicability can vary widely depending on each company's unique supply chain.

Methane mitigation solutions evaluation

TABLE 3

Methane mitigation solutions evaluation

EDF and Ceres do not endorse specific solutions or the research associated with each solution. Companies should evaluate solutions before adoption, as their applicability can vary widely depending on each company's unique supply chain.

INTERVENTIONS AND SOLUTIONS		FARM CHARACTERISTICS				SOLUTION CHARACTERISTICS								
Intervention pathway	**Mitigation solution**	**Regional regulatory applicability**	**Climate applicability**	**Farm type applicability**	**Farm size applicability**	**Implementation stage**	**Solution readiness**	**Implementation burden**	**Cost range**	**Cost type**	**GHG reduction potential**	**Technology level**	**Alignment with existing protocols/ standards**	**Level of MMRV required**
Enteric reductions	3-NOP (e.g., Bovaer®)	Commercially available and approved for intended use of methane reduction[8, a]	All	Favors intensive[b]	All	Commercial solution	High	Low/med	Med/high[9]	OpEx	Med/high[10, 11, 12]	Low	Med	Med
Enteric reductions	*Asparagopsis sp.*[c] (e.g., Brominata®, Methane Tamer™, SeaFeed™, SeaGraze®, SeaStock) (O)	Commercially available in Europe, Australia[d]	All	Favors intensive[b]	All	Commercial solution/ research/ advocacy depending on region	Low/med	Low/med	Med/high[13]	OpEx	High[e, 14, 15]	Low	Med	Med/ high
Enteric reductions	Breeding/genetics improvements for CH_4 (e.g., Semex®) (O)	All	All	All	All	Research/ limited commercial solution	Med	Low	Unknown/ low	OpEx	Med[g, 16, 17]	Med	Med	Med
Enteric reductions	Diet optimization (O)	All	All	All	All	Commercial solution	High	Low	Low	OpEx	Low[22]	Low	Med	Med
Enteric reductions	Essential oils (e.g., Agolin®, Mootral Enterix™) (O)	Commercially available in North America, Europe, Asia[18]	All	Favors intensive[b]	All	Commercial solution	High	Low/med	Low[19]	OpEx	Low[20]	Low	Med	Med
Enteric reductions	Feed storage/ quality (O)	All	Warm[h]	All	All	Commercial solution	High	Med	Med	Both	Low[21, 22]	Low	Med	Med
Enteric reductions	Lipid supplementation (O)	All	All	Favors intensive[b]	All	Commercial solution	High	Low/med	Low	OpEx	Low[23]	Low	Med	Med
Enteric reductions	Methane capture headpiece (e.g., ZELP)	Limited (piloting in Europe)	All	All	All	Research	Low	Med	Med[24]	Both	High[25]	High	High	Low

INTERVENTIONS AND SOLUTIONS		FARM CHARACTERISTICS				SOLUTION CHARACTERISTICS								
Intervention pathway	**Mitigation solution**	**Regional regulatory applicability**	**Climate applicability**	**Farm type applicability**	**Farm size applicability**	**Implementation stage**	**Solution readiness**	**Implementation burden**	**Cost range**	**Cost type**	**GHG reduction potential**	**Technology level**	**Alignment with existing protocols/ standards**	**Level of MMRV required**
Enteric reductions	Methane vaccines (e.g., ArkeaBio™, Lucidome Bio) (0)	None	All	All	All	Research/ advocacy	Low	Low	Unknown	OpEx	Unknown (likely low/ med)[26]	Unknown	Unknown	Unknown
Manure management	Anaerobic digesters[i, j] (0)	All	Warm[h]	Intensive	Large	Commercial solution	High	High	High	Both	High[27, 28]	High	High	High
Manure management	Composting[i] (0)	All	Warm[h]	All (favors smallholders and intensive dry lot)	All (favors small/ med)	Commercial solution	High	Med/high	Low	OpEx	High[29]	Low	High	Med
Manure management	Daily spread (0)	All	Warm/ temperate	All (favors intensive dry lot)	Small/ med	Commercial solution	High	Low/med	Med	Both	High[37]	Low	High	Low
Manure management	Manure additive: Acidification (0*)	All	Warm[h]	All	All	Commercial solution/ research	Low/med	Low	Low[42]	OpEx	High[30,31]	Low/med	Low/med	Med/ high
Manure management	Manure cover and flare systems (0)	All	Warm[h]	Intensive	Med/large	Commercial solution	High	Low	High[32]	Both	Med/high[33]	High	Med	Med
Manure management	Manure operational improvements (0)	All	Warm[h]	All	All	Commercial solution	High	Low/med	Low	OpEx	Varies	Low	Low/med	Med
Manure management	Manure separators[i] (0)	All	Warm[h]	Intensive	Med/large	Commercial solution	High	Med	Med	Both	Med/high[34, 35, 36]	Med/high	Med	Med
Manure management	N2 Applied (0)	Commercially available in Europe	Warm[h]	Intensive	Med/large	Commercial solution/ research	Med	Med	High	Both	High[37]	High	Med	Med
Manure management	Pasture-based management (0)	All	Warm[h]	Pastoral or smallholder	All	Commercial solution	High	High	Med	OpEx	Med[2, k]	Low	Med	High
Productivity optimization	Activity trackers (0)	All	All	All	All (tech solutions favor med/ large)	Commercial solution	High	Med	Med[38]	Both	Varies[39,40]	Varies	High	Low
Productivity optimization	Animal health improvements	All	All	All	All	Commercial solution	High	Low	Low	OpEx	Varies[41]	Low	High	Low
Productivity optimization	Breeding/ genetics improvements for yield (0)	All	All	All	All	Commercial solution	High	Low	Low[42]	OpEx	Varies[43]	Low	High	Low
Productivity optimization	Herd management/ stocking density (0)	All	All	All	All	Commercial solution	High	Low	Low	OpEx	High[44]	Low	High	Low

INTERVENTIONS AND SOLUTIONS		FARM CHARACTERISTICS				SOLUTION CHARACTERISTICS								
Intervention pathway	**Mitigation solution**	**Regional regulatory applicability**	**Climate applicability**	**Farm type applicability**	**Farm size applicability**	**Implementation stage**	**Solution readiness**	**Implementation burden**	**Cost range**	**Cost type**	**GHG reduction potential**	**Technology level**	**Alignment with existing protocols/ standards**	**Level of MMRV required**
Productivity optimization	Herd management/ young stock optimization (O)	All	All	All	All	Commercial solution	High	Low	Low	OpEx	Low/med[45]	Low	High	Low
Productivity optimization	Robotic milking (O)	All	All	Intensive or pastoral	Med/large	Commercial solution	High	High	High[46]	CapEx	High[47,48]	High	High	Low

(O) Indicates the solution can be used in certified organic farming systems

(O*) Organic acids (e.g., citric acid, acetic acid) can be used in organic farming systems. Further research is needed to determine if using sulfuric acid would violate organic standards and what (if any) long-term effects might exist from continued application of sulfur-treated manure on soil and forage.

Table 3 Footnotes:

[a] After safety and efficacy review, Elanco has received FDA permission to market 3-NOP for this intended use in the United States.

[b] More easily adopted in intensive or non-pastoral smallholder systems, as it is easier to continuously supplement and control feed. This solution can still be applied in pastoral systems but with more difficulty.

[c] Further research is needed to better understand the impact that feeding *Asparagopsis sp.* has on animal health and the toxicological risks associated with bromoform residues in milk.

[d] In North America, various federal regulations make transit problematic to transport milk across state lines without approval from the FDA. The use of *Asparagopsis sp.* is allowed within states with the submission of an uncontested GRAS application.

[e] The range of reductions is generally based on dosage. Planned dosage levels demonstrate reductions of around 60%, which categorizes this solution as having a high GHG reduction potential.

[f] While the cost of Rumensin is currently low, the manufacturer is attempting to monetize the carbon savings which could drive up the price.

[g] The methane reduction potential estimates are over 25-30 years, so considerably less over the near term of a 2030 or 2035 corporate goal.

[h] This solution is applicable to all climates but is most impactful in warm climates.

[i] This solution includes multiple solution technologies which may have varying methane reduction potentials.

[j] A critical design and maintenance consideration for anaerobic digesters is ensuring they remain airtight throughout their lifetime operation. Even a small leak in the methane path to the generator or pipeline can release methane directly into the atmosphere and negate much of the digester's reduction potential.

[k] Pasture-based systems can impact all intervention pathways. Manure methane is expected to decrease, while enteric emissions may increase or decrease depending on forage quality. Further, depending on how well the grazing is managed, carbon can either be sequestered or released from the soil.

CONCLUSION

CONCLUSION

Developing DMAPs is essential as the dairy industry works to reduce its global methane impact and mitigate its exposure to climate risks. Publishing a DMAP helps companies prioritize plans and secure both internal and external buy-in against a critical part of the climate puzzle. DMAPs also demonstrate industry leadership, sending the market signal that methane reduction across the dairy and livestock sectors should be a global priority to ensure resilience and long-term profitability. Finally, DMAPs increase transparency to meet the needs of regulators, investors, and consumers to hold dairy-producing and -sourcing companies accountable for implementing their plans and progressing work across supplier engagement, innovation, and advocacy.

When developing their DMAPs, companies should carefully consider which solutions are most appropriate for their operations and supply chains based on both farm and solution characteristics. As such, this guide outlines a streamlined DMAP template and solution evaluation criteria to support company methane reduction planning and progress disclosure. DMAPs should be regularly reviewed to ensure solutions and strategies to reduce methane are up to date.

Publicly disclosing a methane reduction plan also sets the stage for how companies will implement this work through active stakeholder engagement. In addition to DMAA's work catalyzing corporate dairy methane reduction, many other organizations and initiatives are working to address methane emissions through cross-sector and value chain collaboration. The fourth and final guide of the DMAA initiative, Dairy Methane Stakeholder Engagement, helps companies operationalize their DMAPs, outlining best practices for engaging stakeholders, such as farmers, suppliers, customers, and other organizations in the methane reduction journey. This guide also identifies key initiatives, resources, and tools addressing dairy methane. Together, the DMAP and Stakeholder Engagement guides provide the framework and strategies to address dairy methane emissions across dairy supply chains in the near term.

APPENDICES

APPENDICES

Appendix 1: Dairy methane action plan (DMAP) template

Companies can use the template below to communicate their dairy methane action plan.

1 Part 1: Key disclosures

Annual methane emissions disclosure for the past three years

Methane emissions from dairy supply chain (Mt CH_4/year)

	Baseline [year]	2021	2022	2023	Current [year]	% Change from previous year	% Change from baseline
Total emissions							
Scope 1 emissions							
Scope 2 emissions							
Scope 3 emissions							

Total GHG emissions (Mt CO_2e/year)

	Baseline [year]	2021	2022	2023	Current [year]	% Change from previous year	% Change from baseline
Total emissions							
Scope 1 emissions							
Scope 2 emissions							
Scope 3 emissions							

Dairy methane as % of total emissions

	Baseline [year]	2021	2022	2023	Current [year]	% Change from previous year	% Change from baseline
Scope 1 emissions							
Scope 2 emissions							
Scope 3 emissions							

Emissions reduction targets

Company's total GHG emissions reduction target:

- **Target:** *[e.g., 30% reduction of 2020 emissions by 2030]*
- **Year target was set:**

Company's methane emissions reduction target:

- **Target:** *[e.g., 30% reduction of 2020 emissions by 2030]*
- **Year target was set:**

Qualitative explanation of key sources of dairy methane in company's operations and supply chain

Part 2: Strategies to reduce dairy methane emissions

FARMER AND SUPPLIER ENGAGEMENT STRATEGY
Dairy methane sources addressed
Context for strategy implementation
✓ Key business changes from strategy implementation
✓ How this strategy will address material climate-related physical and transition risks to the company
✓ Scope, scale, and coverage across business
✓ Business units involved

✓ Industry, government, trade, and/or NGO groups engaged
✓ Current status of strategy
Action items and key details For each action item, complete the information below.
✓ Concrete actions to advance strategy
• Regions where interventions will be implemented
• Expected start and completion dates
• Key performance indicators (KPIs) to indicate success or failure
• Estimated emissions reductions for individual interventions

- Investments and capital expenditure alignment

INNOVATION STRATEGY

Dairy methane sources addressed

Context for strategy implementation

✓ Key business changes from strategy implementation

✓ How this strategy will address material climate-related physical and transition risks to the company

✓ Scope, scale, and coverage across business

✓ Business units involved

✓ Industry, government, trade, and/or NGO groups engaged

✓ Current status of strategy

Action items and key details
For each action item, complete the information below.

✓ Concrete actions to advance strategy

- Regions where interventions will be implemented

- Key performance indicators (KPIs) to indicate success or failure

- Investments and capital expenditure alignment

PUBLIC POLICY ADVOCACY STRATEGY

Dairy methane sources addressed

Context for strategy implementation
✓ How this strategy will address material climate-related physical and transition risks to the company
✓ Industry, government, trade, and/or NGO groups engaged
✓ Current status of strategy
Action items and key details For each action item, complete the information below.
✓ Concrete actions to advance strategy
• Regions where interventions will be implemented
• Specific policies supported
• Participation in regulatory processes

3 Part 3: Additional considerations for DMAPs

Barriers and systemic challenges related to DMAP implementation
✓ Barriers that prevent farmers and suppliers from adopting near-term methane mitigation solutions and how the company will address these barriers
✓ Systemic challenges that limit scope of methane mitigation and intent to monitor
Just transition considerations
✓ Actions taken or that will be taken to ensure a just transition and to address risks of transition to suppliers, including farmers and farmworkers
✓ Activities to support the company's existing workforce, vulnerable customers, and at-risk communities during transition *(e.g., Sharing the cost of transition to low methane practices, considering food affordability)*
✓ Actions to consult and implement feedback from the company's workforce, suppliers, impacted communities, and NGOs

Measurement and accountability mechanisms in place
Synergies of the DMAP with other sustainability goals and programs
Disclosure of non-dairy methane emissions and plans to address them
Long-term planning for dairy methane reduction (beyond 5-10 years)

4 Part 4: Annual DMAP progress disclosure

Scope 1 and 3 dairy methane progress

Methane emissions from dairy supply chain (Mt CH_4/year)

	Baseline [year]	Current [year]	% Change from previous year	% Change from baseline
Scope 1 emissions				
Scope 3 emissions				

Qualitative explanation of changes in dairy methane emissions and progress towards goals from previous year

✓ Update on status of implementing strategies articulated in the DMAP

✓ Explanation of any changes to the business or external factors that may have resulted in changes in emissions unrelated to the company's methane abatement strategies
(e.g., mergers and acquisitions, divestments, unrelated changes to dairy procurement and sales)

✓ New strategies or technologies that can be added to the DMAP to improve performance
(e.g. increase emission reduction, meet target reduction faster, reduce cost, ease of use)

✓ Strategies or technologies that were not successful or practical to apply and whether or not they will be removed from the DMAP

Appendix 2: Example dairy methane action plan (DMAP)

See below for an example of a methane action plan for a hypothetical company planning to reduce methane emissions.

1 Part 1: Key disclosures

Annual methane emissions disclosure for the past three years

Methane emissions from dairy supply chain (Mt CH_4/year)

	Baseline (2020)	2021	2022	2023	Current (2024)	% Change from previous year	% Change from baseline
Total emissions	0.89	0.85	0.83	0.80	0.77	3.3%	13.5%
Scope 1 emissions	-	-	-	-	-	-	-
Scope 2 emissions	-	-	-	-	-	-	-
Scope 3 emissions	0.89	0.85	0.83	0.80	0.77	3.3%	13.5%

Total GHG emissions (Mt CO_2e/year)

	Baseline (2020)	2021	2022	2023	Current (2024)	% Change from previous year	% Change from baseline
Total emissions	91	90	88	85	79	7.1%	13.2%
Scope 1 emissions	3.6	3.6	3.5	3.4	3.2	5.9%	11%
Scope 2 emissions	10.2	10.2	10.0	9.9	9.5	4.0%	6.9%
Scope 3 emissions	86.6	85	82	78	73.6	5.6%	15%

Dairy methane as % of total emissions

	Baseline (2020)	2021	2022	2023	Current (2024)	% Change from previous year	% Change from baseline
Scope 1 emissions	-	-	-	-	-	-	-
Scope 2 emissions	-	-	-	-	-	-	-
Scope 3 emissions	25	25	24	23	21	8.7%	16%

Emissions reduction targets

Company's total GHG emissions reduction target:

- **Target:** 30% reduction in full scope 2020 emissions by 2030
- **Year target was set:** 2020

Company's methane emissions reduction target:

- **Target:** 30% reduction in methane from dairy supply chain by 2030
- **Year target was set:** 2020

Qualitative explanation of key sources of dairy methane in company's operations and supply chain

The dairy supply chain contributes the largest source of methane, primarily from enteric fermentation (72%) and manure storage on farm (28%). Methane contributes 25% of full scope emissions across the company. The company has a target to reduce full scope emissions by 30% by 2030, including a 30% reduction in methane from the dairy supply chain, compared to 2020 baseline.

2 Part 2: Strategies to reduce dairy methane emissions

FARMER AND SUPPLIER ENGAGEMENT STRATEGY

Dairy methane sources addressed

Methane from enteric fermentation and manure for fluid milk sourced from North America and Europe for our cheese processing business.

Context for strategy implementation

✓ Key changes the strategy will entail to existing business

Working with suppliers to reduce methane emissions from procured dairy through on-farm practice implementation.

✓ How this strategy will address material climate-related physical and transition risks to the company

Reducing methane in the supply chain will address the systemic effect of climate change on operations (e.g., productivity impacts from heat stress and drought, feed availability disruptions) and the market and reputational risk of failing to act on emissions and climate change.

✓ Scope, scale, and coverage across business

Farmer and supplier engagement strategy to reduce methane emissions will include the company's supply chain sourcing raw milk for the next 5 years, aiming to cover at least 75% of the supply chain.

✓ Business units involved

Sustainability and procurement teams work directly with suppliers and farmers. R&D identifies ready-to-deploy mitigation options. Finance and sales determine incentive and compensation structure, which the executive team then approves.

✓ Industry, government, trade, and/or NGO groups engaged

- Industry: DMI
- Government: Local NRCS chapters of sourcing geographies in U.S.
- NGO: EDF, Ceres, SAI platform

✓ Current status of strategy

In progress

Action items and key details
For each action item, complete the information below.

ACTION 1
✓ Concrete actions to advance strategy
Pilot test an enteric-methane-mitigating feed additive on 10 supplier farms in North America and Europe. If successful, phase in supplier farms in each region to reach at least 75% of supplier farms in the next 2 years. This will cover 50% of the milk supply. Incentivize farms to implement the feed additive by paying 50% of the cost of the feed additive.
• Regions where interventions will be implemented
North America and Europe
• Expected start and completion dates
Start date: Q2 2025 **Expected completion date:** Q1 2026 for pilot, 2026-2028 for full implementation
• Key Performance Indicators (KPIs) to indicate success or failure
Success: • All pilot farms successfully adopt feed additive after pilot test • After 1 year, 50% of supplier farms adopt technology • After 2 years, 75% of supplier farms adopt technology
• Estimated emissions reductions for individual interventions
We expect a 15-30% absolute reduction in enteric methane, 10-20% reduction in overall dairy methane emissions if this intervention is successful.
• Investments and capital expenditure alignment
We anticipate spending $75 per cow per year on the feed additive intervention (equating to 50% of the total cost of implementation).

ACTION 2
✓ Concrete actions to advance strategy
Pilot test cover and flare systems to reduce manure storage methane emissions on 5 supplier farms in North America. If successful, phase in supplier farms in North America over the next 2 years to reach at least 50% of supplier farms. This will cover 25% of the milk supply.
• Expected start and completion dates
Start date: Q2 2025 **Expected completion date:** Q1 2027 for pilot, 2027-2029 for full implementation
• Key Performance Indicators (KPIs) to indicate success or failure
Success: • Expected response: 40-50% reduction in methane • Ease of use • No negative impact on handling and fertilizer value of manure

• Estimated emissions reductions for interventions
We expect a 40-50% reduction in manure methane, 10-15% reduction in dairy methane emissions.
• Investments and capital expenditure alignment
The first year of the pilot will cost an anticipated $175,000 to $500,000, with expansion of the program costing an additional $1-2 million per year.

INNOVATION STRATEGY
Dairy methane sources addressed
Methane from enteric fermentation and manure for fluid milk sourced from South America, Oceania, North America, and Europe for our cheese processing business.
Context for strategy implementation
✓ Key changes the strategy will entail to existing business
Future R&D and investments will be focused on next generation technology to reduce methane emissions. Allocation of funding to methane solution R&D will require near-term investments, with the goal of expanding the solutions set for long-term practice change.
✓ How this strategy will address material climate-related physical and transition risks to the company
Reducing methane in the supply chain will address the systemic effect of climate change on operations (e.g., productivity impacts from heat stress and drought, feed availability disruptions) and the market and reputational risk of failing to act on emissions and climate change.
✓ Scope, scale, and coverage across business
Innovation strategy to invest in next generation methane-reduction technology will include investments over the next 5 years. The aim is to invest in technology that can be used across at least 75% of our fluid milk supply chain.
✓ Business units involved
R&D and sustainability teams will partner on identifying external research opportunities to support and engage with. Executive leadership team will approve investment allocations.
✓ Industry, government, trade, and/or NGO groups engaged
• Industry: Innovation Center for U.S. Dairy • Government: Agricultural European Innovation Partnership (EIP-AGRI) • NGO: Foundation for Food and Agriculture Research
✓ Current status of strategy
Planning

Action items and key details
For each action item, complete the information below.

ACTION 1

✓ Concrete actions to advance strategy

Fund external R&D of feed additive delivery for grazing cattle

• Regions where interventions will be implemented

South America, Oceania, North America, Europe

• Key Performance Indicators (KPIs) to indicate success or failure

Success:
- 20-30% reduction in enteric methane
- Prove implementation success and efficacy of feed additive
- Neutral or positive impact on animal production and health
- Adequate protection of feed additive from weather
- Easy and convenient to use on farm
- Acceptable to cattle

• Investments and capital expenditure alignment

We pledge to commit $2 million to external research in this area.

ACTION 2

✓ Concrete actions to advance strategy

Participation in precompetitive collaboration with industry partners, such as FFAR

✓ Regions where interventions will be implemented

South America, Oceania, North America, Europe

• Key Performance Indicators (KPIs) to indicate success or failure

Success:
- Pooled funding for R&D of early-stage technology
- Identification of common challenges and bottlenecks and solutions to address

PUBLIC POLICY ADVOCACY STRATEGY

Context for strategy implementation

✓ How this strategy will address material climate-related physical and transition risks to the company

Advocating for public policy aimed at accelerating methane-mitigating solution adoption and regulatory approval will accelerate our company's efforts to reduce methane and full scope emissions, thereby mitigating regulatory and market risks of failing to address emissions as well as making strides toward greater industry resilience.

✓ Industry, government, trade, and/or NGO groups engaged
• International Dairy Foods Association • National Milk Producers Federation
✓ Current status of strategy
In progress
Action items and key details For each action item, complete the information below.
ACTION 1
✓ Concrete actions to advance strategy
Advocate for policies and programs that increase public funding for agricultural methane solutions. Through public statement or letter, publicly voice support for Innovative FEED Act as paving a clearer regulatory pathway for methane-reducing feed additives.
• Regions where interventions will be implemented
United States
• Specific policies supported
• Innovative FEED Act • EMIT LESS bill • Farm Bill – EQIP and CSP
• Participation in regulatory processes
Support for USDA/FDA reform to streamline regulatory process to approve feed additives to reduce methane Innovative FEED Act. Publicly advocate for and join working groups to strategize regulatory opportunities to scale adoption of on-farm methane-reducing technologies through incentives and cost-sharing.

Part 3: Additional considerations for DMAPs

Barriers and systemic challenges related to DMAP implementation

✓ Barriers that prevent farmers and suppliers from adopting near-term methane mitigation solutions and how the company will address these barriers

Difficulty in getting farmer buy-in for technology adoption and lack of familiarity with or awareness of how to implement such technology. We plan to provide education and technical support by partnering with local technical assistance providers to support farmers in their transition as well as financial incentives such as loans, grants, and cost-sharing to de-risk investment in new technology.

✓ Systemic challenges that limit scope of methane mitigation and intent to monitor

There is a new vaccine that claims it can reduce methane emissions without impacting animal health and nutrition, but there are several regulatory barriers as well as concerns from our consumer base that we are not yet able to address in our plans. We are therefore not pursuing further avenues to support investment in that technology yet, but as studies become more conclusive about the impacts of the vaccine on methane emissions, animal health and wellbeing, and impacts to human health, we will reconsider inclusion of this solution in our plan.

Just transition considerations

✓ Actions taken or that will be taken to ensure a just transition and to address risks of transition to suppliers, including farmers and farmworkers

To mitigate adoption costs, we are covering half of the cost of the feed additive solution for participants of our pilot program to reduce enteric methane emissions in Year 1, and in subsequent years we plan to offer a premium on top of the market price for dairy for any volume of dairy produced using the feed additive. We are also planning to implement a yield-gap guarantee to cover any potential losses in dairy production due to unexpected effects to animal productivity.

✓ Activities to support the company's existing workforce, vulnerable customers, and at-risk communities during transition

Proposed actions will not increase food costs more than inflation, but we intend to continue to seek solutions that can be implemented cost-effectively and support farmers in finding co-funding options through government programs.

✓ Actions to consult and implement feedback from the company's workforce, suppliers, impacted communities, and NGOs

Among our pilot participants, we are conducting a survey that includes questions pertaining to additional labor demands for farmworkers associated with the adoption of the new methane solutions and will use the results to determine whether increases in premium prices should be adjusted and whether other technical support could be provided. We also sought feedback from a partner environmental justice group and will continue to consult this and other stakeholder groups on the evolution of this action plan.

Measurement and accountability mechanisms

✓ Measurement and accountability mechanisms in place

All emissions reductions from farm-level interventions will be verified by SustainCert. We will disclose progress on our DMAP annually, updating the full action plan every two years. Finally, we will continue gathering feedback from farmers, farmworkers, and other key stakeholders to ensure they are supported in this transition.

Synergies with other sustainability goals and programs

We are viewing methane within our overall sustainability goals, of which water and animal welfare are other pillars. We expect co-benefits between certain sustainability pillars. For example, the manure management solutions we plan to fund and implement with farmers in the Midwest next year will help us achieve our targets for reducing water pollution impacts in our sourcing region while also reducing methane emissions.

Disclosure of non-dairy methane emissions and plans to address them

Our non-dairy methane emissions were 0.04 Mt CH_4 in 2024, primarily from food waste, rice production, and wastewater. We recently launched a food waste reduction campaign among our supplier network (beyond dairy) and are in the process of developing a rice methane mitigation roadmap.

Long-term planning for dairy methane reduction (beyond 5-10 years)

The company will continue to invest in innovation and R&D to reduce methane emissions from dairy. Following achievement of 30% reduction in in methane from dairy supply by 2030, the company will assess new targets based on current status of new technology to further reduce methane emissions. We will also continue to explore opportunities to improve long-term financial access for farmer implementation of methane-mitigating technologies through cost-sharing and other means.

4 Part 4: Annual DMAP Progress Disclosure

Since part 4 of the DMAP is not completed in year 1, this section would be completed by the company in the subsequent year (year 2).

Scope 1 and 3 dairy methane progress

Methane emissions from dairy supply chain (Mt CH_4/year)

	Baseline (2020)	Current (2024)	% Change from previous year	% Change from baseline
Total emissions	0.89	0.77	3.3%	13.5%
Scope 1 emissions	-	-	-	-
Scope 3 emissions	0.89	0.77	3.3%	13.5%

Qualitative explanation of changes in dairy methane emissions and progress towards goals from previous year

We have seen overall reductions in our Scope 3 methane emissions compared to the previous year. These were largely driven by promising results from our feed additive pilots as well as divestment of our ice cream business.

✓ Update on status of implementing strategies articulated in the methane action plan
Actions proposed in transition action plan are still in progress. For our feed additive pilot in year 1, we successfully engaged 45% of our supplier dairy farms to adopt the feed additive, which is 5% short of our goal for Year 1 (50% adoption). We plan to take year 1 learnings to adapt our program and to accelerate adoption such that we can meet our goal to have 75% of our suppliers adopt the feed additive by year 2. We were able to pilot cover and flare systems to reduce manure storage methane emissions on 4 supplier farms in North America, 1 farm short of our goal. We will engage farmers that participated to encourage their peers to adopt practices, as the farms on which the practices were implemented saw reductions in methane with no impact on the value of manure sold as fertilizer. We hope to continue seeking ways to ensure adoption across 25% of milk supply in the next year. We continue to look out for new policy advocacy opportunities, and in the meantime have invested $3 million towards the Greener Cattle Initiative to support ongoing R&D in agricultural methane solutions.
✓ Explanation of any changes to the business or external factors that may have resulted in changes in emissions unrelated to the company’s methane abatement strategies *(e.g., mergers and acquisitions, divestments, unrelated changes to dairy procurement and sales)*
Our methane emissions decreased in part due to slower sales of dairy in Q2 and Q3 compared to previous years. We acquired a new yogurt brand and divested our ice cream business and therefore recalculated our emissions accordingly.
✓ New strategies or technologies that can be added to the DMAP to improve performance *(e.g. increase emission reduction, meet target reduction faster, reduce cost, ease of use)*
New technology has been identified from innovation pipeline and will be implemented within the next year.
✓ Strategies or technologies that were not successful or practical to apply and whether or not they will be removed from the DMAP
Adoption of manure storage technology to reduce methane was not successful due to failure to adopt at farm level. We will be reevaluating use of that technology and potentially implementing a different technology to reduce methane from manure storage.

Appendix 3: Methane mitigation solutions evaluation criteria definitions

TABLE 4
Methane mitigation solutions evaluation criteria definitions

Evaluation criteria	Categories	Definitions
Regional regulatory applicability	N/A	List of countries/regions in which the solution is currently applicable
Climate applicability[49]	Cool	- Cool climate zones include cool temperate moist, cool temperate dry, boreal moist, boreal dry - Annual average temperatures <10 degrees C
	Temperate	- Temperate climate zones include warm temperate moist, warm temperate dry - Annual average temperatures 10-18 degrees C
	Warm	- Warm climate zones include tropical montane, tropical wet, tropical moist, tropical dry - Annual average temperatures >18 degrees C
Farm type	Smallholder	- Small scale farming systems with <10 milking cows
	Pastoral	- Farming systems in which milking cows graze on pasture for at least some period of the year
	Intensive	- Farming system aimed to maximize productivity, often large scale - Milking cows remain in barns and do not graze on pasture
Farm size[50]	Small	- Less than 50 head
	Medium	- Between 50-500 head
	Large	- Greater than 500 head
Implementation stage	Commercial solution	- Commercially available for companies to adopt and integrate across their supply chain
	Research	- Not yet commercially available but undergoing pilot research either on farm or in labs
	Advocacy	- Regulatory barriers that must be addressed through public policy or advocacy before it can be implemented within a company's supply chain
Solution readiness	High	- Widely available - Currently being contracted for and implemented
	Medium	- Not widely available - Farmers need help navigating procurement and or implementation - Becoming more available, may need some special training
	Low	- Not yet ready for commercial farming - Appropriate for farm pilots or university research farms - Regulatory barriers to implementation are unresolved
	Nascent	- Prototype versions being developed, but not yet piloted
Implementation burden	High	- Requires large infrastructure changes or significant changes to farming practices - May also require regular routine maintenance
	Medium	- Requires some equipment investments or changes to farming practices and farmer training
	Low	- Simple and can be easily implemented by the farmer with minimal changes to standard farming practices - Minimal or no routine maintenance

Evaluation criteria	Categories	Definitions
Cost range	High	- Requires extensive 3rd party investment
	Medium	- Requires financing or some investment to ramp up or maintain over time
	Low	- Requires minimal cost or positive financial return of investment
Cost type	Capital expenditure (CapEx)	- Requires a capital expenditure to implement
	Operational expenditure (OpEx)	- Requires increased operational expenses
	Both	- Requires both a capital expenditure and operational expense
GHG reduction potential	High	- Greater than 30% of enteric CH_4 - Greater than 60% of manure management emissions - Greater than 5% yield improvement
	Medium	- Greater than 15% of enteric CH_4 - Greater than 30% of manure management emissions - Greater than 2.5% yield improvement
	Low	- Greater than 1% of enteric CH_4 - Greater than 2% of manure management emissions - Less than 2.5% yield improvement
	Negligible	- Less than 1% of enteric CH_4 - Less than 2% of manure management emissions - Negligible yield improvement
Technology level	High	- Advanced and innovative technology that has not been widely used at scale - Requires a high level of training and assistance for the average user to implement
	Medium	- Average technology that is more established than advanced technologies - May require some level of training or assistance for the average user to implement
	Low	- Technology that has been well tested and implemented at scale - Requires minimal or no training for the average user to implement
Alignment with GHG protocols and standards	High	- Verified to an industry-standard protocol to follow GHG Protocol Land Sector and Removals guidance
	Medium	- Peer reviewed results showing performance under very similar farming conditions with documented processes and assumptions demonstrating compliance with GHG Protocol Land Sector and Removals guidance
	Low	- Industry or University results from more than one independent source showing promising results
	Unknown	- Results only of internal business testing, or external testing with only one promising set of performance results published
Level of MMRV required	High	- High GHG reduction potential that has a wide variability in emissions reductions - Requires extensive monitoring to assess reduction potential
	Medium	- Some variability in GHG reduction potential - Requires some monitoring to assess reduction potential
	Low	- Little to no variability in GHG reduction potential - Requires little additional monitoring to assess reduction potential or MMRV is automated using tech

Appendix 4: Emerging methane mitigation solutions

Given the number of possible interventions for methane reduction, not all possible interventions were fully evaluated. Below is a list of other emerging solutions. EDF and Ceres do not endorse specific solutions or the research associated with each solution. Companies should evaluate solutions before adoption, as their applicability can vary widely depending on each company's unique supply chain.

TABLE 5

Emerging methane mitigation solutions

Intervention pathway	Emerging solution	Solution notes
Enteric reductions	Acetic-acid-producing bacteria	- Emerging research to replace the methane producing microbes in the rumen with an acetic-acid-producing bacteria found in marsupial feces.[51, 52] - In-vitro studies in a simulated rumen have demonstrated promising results.[53]
Enteric reductions	Bioengineered feed additives (e.g., Elysia Bio, Lumen Bioscience)	- Elysia Bio is developing a feed additive made by engineering animal feed crops to suppress methane emissions. Crops include corn grain, rye grass, and sorghum. - Lumen Bioscience is developing a feed additive made from genetically engineered spirulina (algae), which has shown to reduce methanogens in in vitro studies.
Enteric reductions	Clustered Regularly Interspaced Short Palindromic Repeats (CRISPR)	- The Innovative Genomics Institute (IGI) at UC Berkeley is researching how to apply CRISPR genome-editing technology to methane-producing microbes. - Received $70M in funding from TED's Audacious Project.
Enteric reductions	Macroalgae (excluding *Asparagopsis sp.*)	- Multiple macroalgae strains are being studied for their impact on methane emissions in ruminants.[54] - Non-bromoform-containing seaweeds, such as the phlolorotannin-containing brown seaweeds have shown more inconsistent results as compared to red seaweed (*Asparagopsis sp.*).
Enteric reductions	Nitrates	- Supplementary nitrate as a feed additive has been shown to reduce enteric methane emissions.[55] - Increases in ammonia and nitrous oxide emissions from manure may result. - Nitrate supplementation must be gradually introduced to reduce the risk of toxicity.
Enteric reductions	Polyphenols (e.g., Polygain™)	- Some naturally occurring tannins, a type of polyphenols found in plants, have anti-methanogenic compounds that have been shown to reduce enteric methane emissions.[56] - Polygain™ has developed a polyphenol blend for dairy cows that demonstrated a 35% reduction in methane on an Austrailian Dairy Farm.[57]
Enteric reductions	Probiotics (e.g., Hoofprint Biome)	- Hoofprint Biome is developing probiotics and natural enzymes to reduce methane while improving cow health. - A meta-analysis on probiotics in beef cattle have shown variable results, but specific strains have proven to be more impactful on methane emissions than others.[58]

Intervention pathway	Emerging solution	Solution notes
Enteric reductions	Synthetic bromoform (e.g., Rumin8)	- Rumin8 is a synthetically derived bromoform producing the same active compound that is found in *Asparagopsis sp.* (tribromomethane/bromoform). - Reported productivity gains of up to 9% and methane reduction of 50–90% in grain-fed cattle and 24–50% in grass-fed cattle.
Enteric reductions	Yeast cultures (e.g., Yea-Sacc®)	- Yea-Sacc® is a feed additive derived from yeast cultures that acts as a rumen modifier, enhances yield, and promotes animal health. - Laboratory studies of yeast cultures as a feed additive have demonstrated CH_4 mitigation, but animal studies have yielded varying results in dairy cows.[59]
Manure management	Manure additive: *Asparagopsis sp.*	- The addition of *Asparagopsis sp.* to fresh manure piles has been shown to reduce methane emissions by 44% in pilot studies.[60] - The use of *Asparagopsis sp.* in fresh manure piles demonstrates the potential for application to manure lagoons.
Manure management	Manure additive: Biochar application	- Application of biochar to compost piles has been shown to reduce methane emissions by 58-79% as compared to composting without biochar in pilot studies.[61] - This solution is only applicable for farms already composting or with stockpiled solids.
Manure management	Manure additive: SOP Lagoon	- Adding the commercial SOP Lagoon product to liquid manure management systems can reduce CO_2, CH_4, and N_2O emissions. - In a recent study, CH_4 emissions were reduced by up to 80% and CO_2 emissions by 75%.[62]
Manure management	Manure additive: Tannins	- Adding tannins to manure can reduce both N_2O and CH_4 emissions. - Currently limited to in-vitro studies, but have shown to reduce CH_4 emissions by up to 68.2%.[63]
Manure management	Manure drying	- Drying of manure through solar drying or closed drying systems to acheive a solids content of 13% or more has been shown to reduce methane emissions. However N_2O emissions may increase.[2]
Manure management	Manure pasteurization	- Raising the temperature of liquid manure to greater than 70°C in storage to reduce biological activity of microbes is commonly done prior to anaerobic digestion. - In swine manure, methane emissions from storage of manure prior to anaerobic digestion were reduced by >95% with methane potential of anaerobic digestion enhanced by 16-35%.[64] - Minimal studies in dairy.
Manure management	Pyrolysis	- The pyrolysis of dairy manure solids creates biochar, a carbon-rich soil amendment. - This must be done in conjunction with either solid-liquid separation or anaerobic digestion.[65]
Manure management	Vermicomposting	- Vermicomposting can break down organic matter very rapidly, resulting in a high-quality compost and has been shown to reduce emissions from manure management.[66] - May be a more viable option for smallholders.

Appendix 5: Methane mitigation from food waste reduction

Dairy processing improvements to mitigate dairy waste are important levers companies can pull to reduce methane emissions. These solutions are listed in a separate table since agricultural methane is the focus of this guide.

TABLE 6

Dairy waste methane mitigation solutions

Intervention pathway	Mitigation solution	Solution description
Dairy processing improvements	Manufacturing optimization	Optimize manufacturing batch management by: - Implementing a waste management plan - Conduct regular waste audits - Reducing cleanout waste from product switchover
Dairy processing improvements	Ultra-pasteurization	Ultra-pasteurization to prolong shelf life of dairy products and reduce risk of spoilage. The shelf life of ultra-pasteurized milk is 30-90 days refrigerated, as compared to 10-21 days for pasteurized milk.[67]
Dairy processing improvements	Waste diversion	Divert dairy ingredient waste from food processing away from landfills or manure lagoons to reduce methane emissions. Alternative disposal options include composting, anaerobic digestion, or waste to animal feed.

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