INNOVATION CENTER FOR U.S. DAIRY®

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2025 U.S. Dairy Materiality Assessment Report

MAY 2025

Contents

This report was produced by the Innovation Center for U.S. Dairy. Founded by Dairy Management Inc. (DMI), the Innovation Center for U.S. Dairy is an organization that works with leaders from across the dairy value chain to align on pre-competitive priorities, drive progress and speak with one voice. DMI and its related organizations work to increase sales and demand for dairy through research, education and innovation, and to maintain confidence in dairy foods, farms and businesses. DMI manages the dairy checkoff which was created by American dairy farmers and is funded by the nation's dairy farm families and those that import dairy into the U.S. DMI, the Innovation Center for U.S. Dairy and its related organizations cannot and do not seek to influence governmental policy or action.

Executive Summary

The U.S. dairy community has a long-standing commitment to building a healthy and sustainable future for the dairy community, the animals in its care, the people it serves and the planet we all share. This dedication to sustainability supports the long-term health of farmers' businesses and land, and helps the U.S. dairy sector as well as food and beverage manufacturers, retailers and foodservice companies worldwide to capitalize on the growing demand for more nutritious and delicious products made from socially, environmentally and economically responsible sources.

In 2008, U.S. dairy farmers founded the Innovation Center for U.S. Dairy ("Innovation Center") and continue to support and fund its mission to collaborate to advance solutions for a more sustainable world and thriving U.S. dairy community. The Innovation Center works across the dairy value chain to foster collaboration and progress to build a healthy and sustainable future.

The Innovation Center was one of the first organizations to conduct a national materiality assessment on behalf of an agricultural industry in 2018. The Innovation Center continues to be on the frontier of adopting industry best practices. Building from the second materiality assessment conducted in 2021, the 2025 U.S. Dairy Materiality Assessment adopted the approach of double materiality for the first time, incorporating materiality guidance from sustainability standards. The double materiality approach expanded the assessment to consider U.S. dairy's impact (often referred to as the "inside-out" perspective) as well as the financial risks and opportunities (often referred to as the "outside-in" perspective). Like the previous materiality assessments, the 2025 U.S. Dairy Materiality Assessment engaged stakeholders both within and outside the U.S. dairy value chain to further develop a comprehensive understanding of U.S. dairy's impacts, risk and opportunities.

The results of these industry-wide, national materiality assessments are leveraged to inform strategy and guide industry efforts, including those driven by the Innovation Center. As a useful resource, the results also support U.S. dairy companies when conducting their own assessments.

Key Takeaways

- This assessment reinforced the topics that U.S. dairy has prioritized for decades, while deepening the understanding of other topics and their associated impacts, risks and opportunities.
- The incorporation of assessing financial risks and opportunities emphasized the significance of existing topics and elevated topics new to this assessment. For example, the topic of Economic Viability and Resilience underscored how foundational the viability and resilience of U.S. dairy farms and companies is to dairy farmers and workers across the supply chain, the nation's food supply and people around the world who consume and rely on U.S. dairy products.
- The prioritization of the topics closely aligns with how stakeholders, inside and outside of the dairy value chain, ranked the topics by importance on average (*Appendix B*).

Background

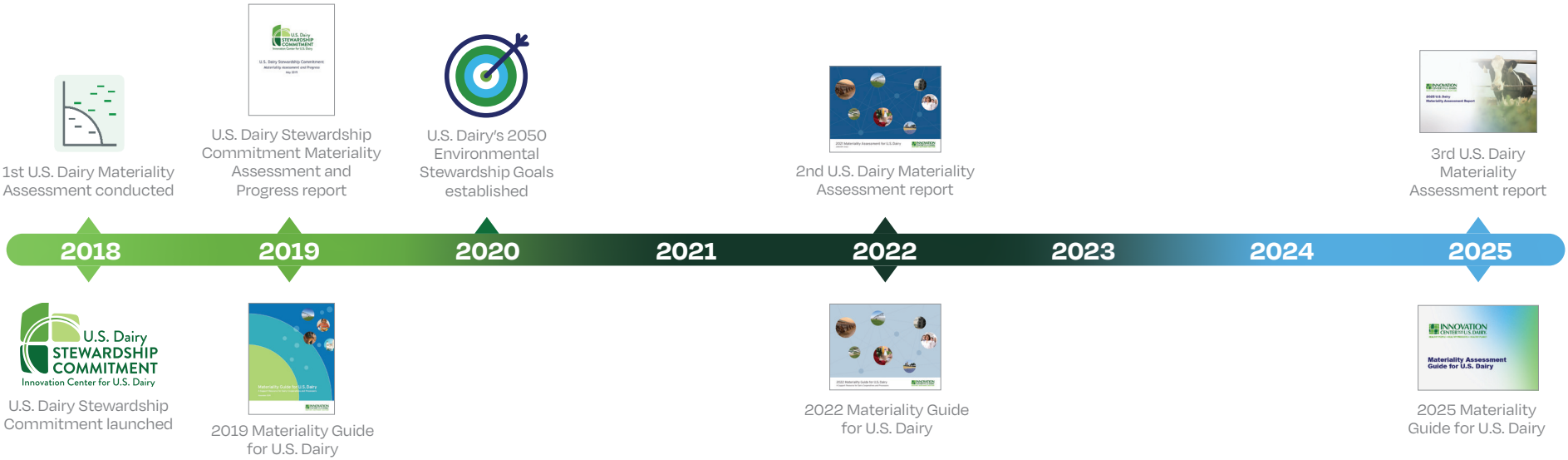
Since 2008, the Innovation Center for U.S. Dairy ("Innovation Center") has led national efforts as a pre-competitive forum to support the dairy community's understanding and management of impacts, risks and opportunities across social responsibility and sustainability matters. The mission of the Innovation Center is to collaborate to advance solutions for a more sustainable world and a thriving U.S. dairy community.

In 2018, the Innovation Center conducted the first national materiality assessment for U.S. dairy to help substantiate industry-wide priorities and inform actions. This assessment was among the first in the agricultural industry at a national level. The results were published in 2019 along with a Materiality Assessment Guide for U.S. Dairy, which was designed to aid dairy companies in conducting their own assessments. In 2021, the Innovation Center conducted a refresh of the original assessment, reflecting stakeholder and industry changes. The results were published in 2022 along with an updated version of the guide. The materiality assessments have since seen broad use, received recognition from within and outside of the dairy community and demonstrated value, such as shaping the industry's priorities and reporting as demonstrated in the 2021-2022 U.S. Dairy Sustainability Report.

The results have also guided the focus areas in the U.S. Dairy Stewardship Commitment – a voluntary pledge that empowers and equips the U.S. dairy community to demonstrate sustainability progress through aligned action and reporting as an industry. Dairy cooperatives and processors, representing more than 77% of U.S. milk production, have adopted the Stewardship Commitment as of March 2025. As part of their adoption, these companies agree to a set of terms related to material topics like animal care, food safety and traceability, greenhouse gas (GHG) emissions and more. One of these terms requires adopting companies to conduct their own materiality assessments or incorporate the national assessment into their organizational priorities.

The assessment results, which prioritized the most pressing areas of environmental sustainability, also led to the development of industry-wide environmental goals. By 2050, U.S. dairy collectively commits to achieve GHG neutrality, optimize water usage and improve water quality. Learn more about how U.S. dairy is collaborating to identify economically viable pathways for collectively reaching these goals at usdairy.com.

Timeline of Materiality Assessment Developments & Sustainability Initiatives



Purpose

A materiality assessment is a process through which an entity identifies, assesses and prioritizes sustainability topics. While traditionally undertaken by individual companies, the purpose of this assessment is to support in the identification, assessment and prioritization of sustainability topics across the U.S. dairy industry.

Assessment results are not intended to designate any sustainability topic as unimportant, but rather are leveraged to identify and drive further discussion about opportunities where the industry has the strongest potential to amplify positive impacts and demonstrate progress.

The results of the assessment serve to:

- Strengthen credibility and provide a consistent voice around sustainability topics and action for U.S. dairy,
- Aid U.S. dairy companies in conducting their own assessment by providing nationally relevant findings,
- Inform strategic planning by identifying areas where the industry has the most potential for positive impact, and
- Bolster positioning of sustainability priorities and leadership in the marketplace and global stage.

Scope

The scope of this assessment is limited to dairy feed and milk production and dairy processing and packaging within the United States, which will be referred to throughout this report as "U.S. dairy." While the primary focus was from "field to processor gate," the assessment considered activities and relationships along the full dairy value chain along with their associated impacts, risks and opportunities. Refer to the *Phase 1: Identification* section for additional information.

External Guidance & Standards

The 2025 U.S. Dairy Materiality Assessment implemented a "double materiality" approach that harmonizes leading materiality standards to systematically consider both financial and impact materiality. The concept of "double materiality" instructs entities to consider the impacts imposed on the environment, society and economy ("impact materiality") as well as the sustainability-related risks and opportunities that might affect their financial performance ("financial materiality").

Process Guidance

To ensure a robust, evidence-based assessment, the process undertaken to determine topics material to the U.S. dairy industry applied the following guidance and incorporated materiality requirements from sustainability standards, as applicable for an industry-wide national assessment (collectively "referenced guidance"):

- GRI 3. Material Topics 2021, 1. Guidance to determine material topics
- European Financial Reporting Advisory Group (EFRAG) IG1: Materiality Assessment Implementation Guidance (IG1)

The process also applied the AccountAbility's AA1000 Core Principle of Materiality, which outlines that decision makers should identify and be clear about the sustainability topics that matter.

Reporting Standards

This report follows the disclosure requirements within GRI 3. Material Topics 2021: 2. Disclosures on material topics.

- Disclosure 3-1 Process to determine material topics (*Process* section beginning on *page 5*)
- Disclosure 3-2 List of material topics (*Materiality Matrix* section on *page 10*)
- Disclosure 3-3 Management of material topics, items 3-3a and 3-3b (*Overview of Topics & Key IROs* beginning on *page 11*)
  - Topic descriptions are summarized at the national level and not comprehensive of all activities and business relationships across U.S. dairy.
  - Reporting on the other requirements under Disclosure 3-3 occurs at the industry-level through various sources, such as the biennial U.S. Dairy Sustainability Report.

External Verification

The Innovation Center sought external verification that the process undertaken followed the referenced guidance described in the *External Guidance & Standards* section on the previous page and that the reporting meets the referenced GRI disclosure requirements, as applicable for a national assessment. The verification process also confirmed how the use of this assessment can help dairy companies partially or fully meet requirements for conducting a materiality assessment within the Sustainable Agriculture Initiative Platform's Sustainable Dairy Partnership (SDP). The third-party verification statement is included in *Appendix D* on *page 29*.

Application

The Innovation Center will continue to share and disseminate these results with the U.S. dairy community, its stakeholders and the broader ecosystem as appropriate. The assessment will continue to be leveraged as a tool to help direct focus and resources to support the Innovation Center's mission of advancing social responsibility and a thriving U.S. dairy community. The Innovation Center Board of Directors will continue to apply the assessment's results, insights and learnings to inform strategic planning, reporting and communications as well as stakeholder engagement efforts as appropriate.

While this assessment provides a national perspective, it is further intended to inform and be leveraged as a resource for U.S. dairy companies' individual assessments. The Innovation Center has updated its Materiality Assessment Guide for U.S. Dairy to support companies conducting an organizational materiality assessment. The guidance incorporates the results of this national assessment and other Innovation Center resources, while integrating organization-specific considerations and insights.

Ongoing Monitoring

The Innovation Center intends to reassess materiality at least every four years and reserves the right to refresh the results on an as-needed basis. The Innovation Center will continue to monitor emerging trends, shifts in stakeholder interests and expectations, and updates to the latest available science and standards. As data availability and quality improves, the Innovation Center will update the sourced evidence as necessary. Future assessments will continue to build on the analysis and results of the former, while incorporating the insights derived from continuous monitoring and stakeholder engagement.

Process

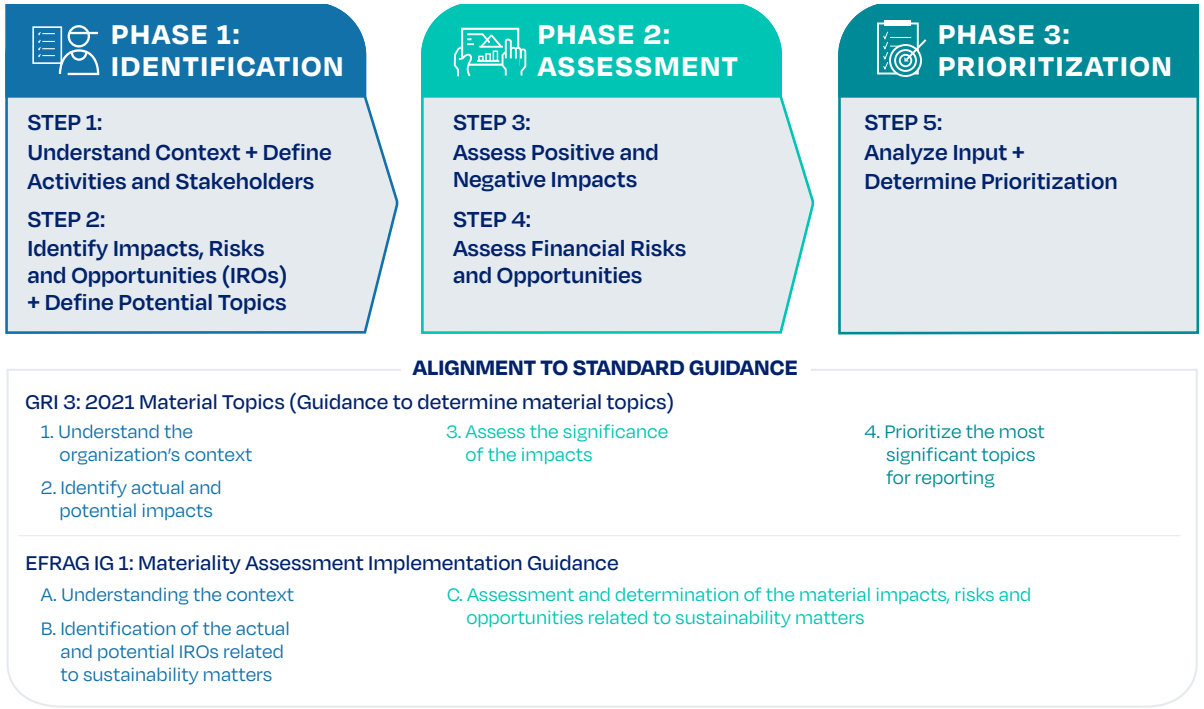
The Innovation Center for U.S. Dairy is committed to conducting robust sustainability materiality assessments that are guided by international standards and best practices.

As noted on *page 3*, the assessment followed the guidance of the GRI Standards (GRI 3. Material Topics 2021) and incorporated the EFRAG's Implementation Guidance on Materiality Assessment (IG 1), as appropriate for an industry-wide assessment. IG-1 is currently the only guidance for double materiality within sustainability reporting standards. Aligning to this standard along with GRI also supports U.S. dairy companies being required to report in accordance to these standards.

Given the unique nature of this assessment—covering feed and milk production as well as dairy processing and packaging at an industry-level across the United States—aspects of the referenced guidance required adaptation to fit the needs of the assessment and to address limitations. The U.S. Dairy Materiality Assessment Process diagram to the right highlights the alignment of these approaches.

The assessment process was led by the Senior Vice President, Social Responsibility at the Innovation Center, who engaged with Innovation Center staff, committees and board members and a wide range of stakeholders and experts (see *page 8*). To incorporate external expertise, the assessment lead collaborated with a third-party sustainability consulting firm with dairy industry experience and materiality expertise to support the overall process, topic analysis and report development.

Figure 1. 2025 U.S. Dairy Materiality Assessment Process Alignment to Standards



Phase 1: Identification

Step 1: Understand Context and Define Activities & Stakeholders

The first step focused on setting context about U.S. dairy's activities, business relationships, and the stakeholders that participate, influence and/or are affected by U.S. dairy's activities. Recognizing the industry's dynamics are complex and vary widely, this analysis focused on the most common set of activities, business relationships and key affected stakeholders.

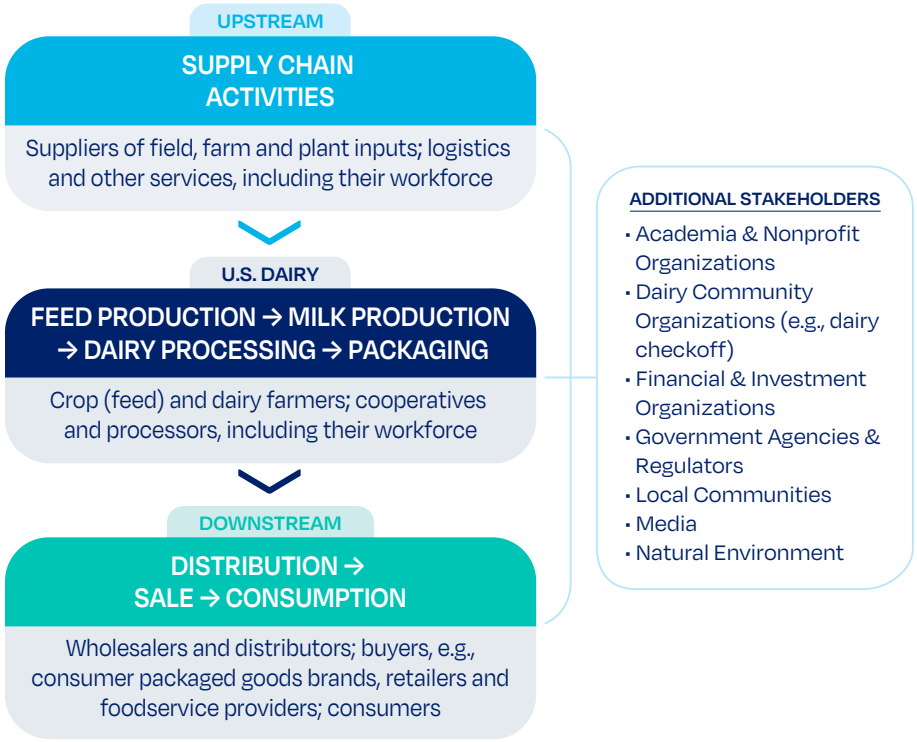
The analysis primarily focused on feed production, milk production and dairy processing and packaging, along with support activities, such as human resource management and procurement. It is recognized that many U.S. dairy companies, including dairy cooperatives and processors, directly manage multiple activities in the dairy value chain, such as milk transportation, packaging and/or distribution. Similarly, approximately 25% of U.S. dairy feed is produced by dairy farmers on a per cost basis.[31]

The most common activities in the dairy value chain were mapped with an overlay of where the identified stakeholders would most likely fit and/or be affected. This analysis informed the next step of identifying relevant impacts, risks and opportunities, in addition to the stakeholders targeted for engagement during Phase 2.

Step 2: Identify Impacts, Risks & Opportunities and Define Potential Topics

Environmental, social and economic topics along with the most common impacts, risks and opportunities (IROs) associated were identified by scanning and inventorying standards, frameworks and other sources, in addition to leveraging past materiality assessments. Sector-specific standards, such as GRI 13: Agriculture, Aquaculture and Fishing Sectors 2022 and the SASB Standards for Meat, Poultry and Dairy and Processed Foods, were incorporated. Additionally, the experts and stakeholders engaged throughout the assessment were consulted to help identify and refine the main IROs associated with the industry's activities.

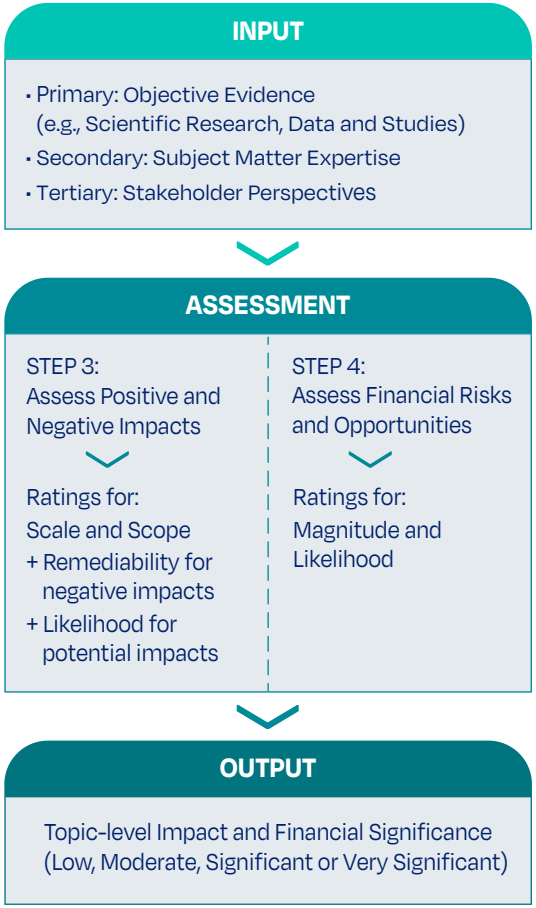
Figure 2. Main Activities & Stakeholders within U.S. Dairy Value Chain



Phase 2: Assessment

The next phase involved evaluating the impacts, risks and opportunities associated with each topic identified in Phase 1. The types of input into the assessment, described further on the next page, were intentionally prioritized to support a sound and credible evaluation of IROs, prioritizing objective evidence as the primary input to inform the assessment for Steps 3 and 4 (Figure 3).

Figure 3. Overview of Phase 2



Step 3: Assess the Actual and Potential Impacts Related to Sustainability Topics

During this step, the significance of economic, environmental and social impacts associated with the topics identified during Phase 1 were assessed. Impacts include those that are positive or negative, intended or unintended as well as actual (meaning already occurring) or potential.

The relevant time horizons (short-, medium- and long-term) of each impact were considered, alongside U.S. dairy's level of influence. For example, U.S. dairy's activities can cause, contribute to or be directly linked to impacts.

Focusing on the main impacts associated with each topic, the objective evidence, subject matter expertise and stakeholder perspectives, described on the next page, were prioritized in that order to inform the assessment of the significance of these impacts. Following the referenced guidance, the significance was evaluated based on the following criteria and ratings:

- Scale: The magnitude of the impact, i.e., how detrimental/damaging (negative) or beneficial (positive) an impact is
- Scope: How widespread the negative or positive impacts are
- Remediability (only for negative impacts): The extent to which negative impacts can be addressed, remedied or reversed
- Likelihood (only for potential impacts): The likelihood of the impact occurring

Step 4: Assess Financial Risks and Opportunities Related to Sustainability Topics

This step examined the financial significance of risks and opportunities associated with each topic. Incorporating the referenced guidance, specifically EFRAG's IG1: Materiality Assessment Implementation Guidance, the criteria used to assess the financial significance of risks and opportunities is their likelihood of occurrence and the potential magnitude of their financial effects in the short-, medium- and long-term. The magnitude was characterized by the potential effects that the risks and opportunities could pose on U.S. dairy's business development, financial position, financial performance, cash flows and access to and cost of capital, to the extent possible.

The objective evidence, subject matter expertise and stakeholder perspectives, as described on the next page, were prioritized in that order to inform the ratings for magnitude and likelihood for the main risks and opportunities identified.

Types of Input

Primary Input: *Objective Evidence, i.e., Scientific Research, Data & Studies*
To gain an independent perspective on U.S. dairy's impact, the sustainability experts at the consulting firm undertook the primary evaluation, which required a comprehensive desktop review and research. Information was sourced from a range of objective, unbiased sources (refer to the summary in *Appendix A*). The review of resources first focused on leveraging credible sources specifically about the U.S. dairy industry to inform the assessment. When quantitative information was available for specific activities along the dairy value chain, such as with life cycle assessment findings, the review assessed the IROs associated with each activity. When national-level scientific research and data were not available, other sources such as regional- and state-level research, publications from U.S. dairy companies, and global dairy examples were examined.

Some of the resources used to establish relevance during Phase 1 were also leveraged to inform the assessment of IROs during Phase 2, such as the SASB Standards. Additionally, an extensive review of key existing and forthcoming regulations in the U.S. and in key markets where U.S. dairy companies may have operations was conducted.

Secondary Input: *Subject Matter Expertise*
To supplement the evidence-based review, interviews with subject matter experts were conducted to gather deeper insights, valuable context and technical input. Experts shared their firsthand knowledge of industry trends and emerging risks, refining the assessment of the IROs associated with their respective topic(s) of expertise. Moreover, expert interviews helped to validate and/or refine initial findings, strengthening the robustness and credibility of the assessment of IROs. Subject matter experts were engaged throughout the assessment process to help identify IROs and assess the criteria selected for IROs.

Tertiary Input: *Stakeholder Perspectives*
Stakeholder perspectives were collected to support a comprehensive assessment of IROs by providing further context, background and deeper understanding of situational factors. Stakeholder experiences, expectations and views were gathered to inform a sound understanding of how U.S. dairy's activities may impact stakeholders. Stakeholders from inside and outside of the value chain were engaged to help further identify and provide context into the IROs. Stakeholders that provided input by survey or interview also ranked the topics identified during Phase 1 by importance.

Stakeholder perspectives were also collected and examined from a variety of sources, including but not limited to: previous U.S. dairy materiality assessments, for which extensive stakeholder engagement took place in 2018 and 2021; ongoing engagement methods at the Innovation Center; consumer perception studies; and reports, surveys and articles that incorporated the voices and experiences of affected stakeholders such as dairy farm workers (both native- and foreign-born individuals) as well as perspectives on nature and wildlife.

Expert & Stakeholder Engagement

Over 550 stakeholders were invited to participate in the assessment process through surveys, interviews, workshops and webinars. Direct input was collected from more than 150 stakeholders representing more than 100 organizations to identify additional topics, provide further context, rank topics and, if expertise applied, assess the significance of impacts, risks and opportunities.

The following methods of engagement were used during the assessment:

- More than 60 stakeholders, including subject matter experts, completed materiality surveys.
- More than 25 stakeholders, including subject matters experts, were interviewed.
- In addition to two webinars held with the Dairy Sustainability Alliance®, more than 120 stakeholders provided feedback on the assessment's preliminary findings in a Discussion and Input session at the Dairy Sustainability Alliance® fall meeting.
- The Innovation Center Board of Directors, with representation from 25 U.S. dairy companies, and the Innovation Center's committees were engaged throughout the assessment.
- The Dairy Management Inc. Board, comprised of more than 80 dairy farmers, and its Sustainability Committee were engaged throughout the assessment, bringing a farmer-focused perspective.

Participation by Stakeholder Group

72% of stakeholders directly engaged were within the dairy value chain:

- 55% Farmers, Cooperatives & Processors
- 11% Food Chain Organizations
- 6% Industry Suppliers

28% represented entities outside the dairy value chain:

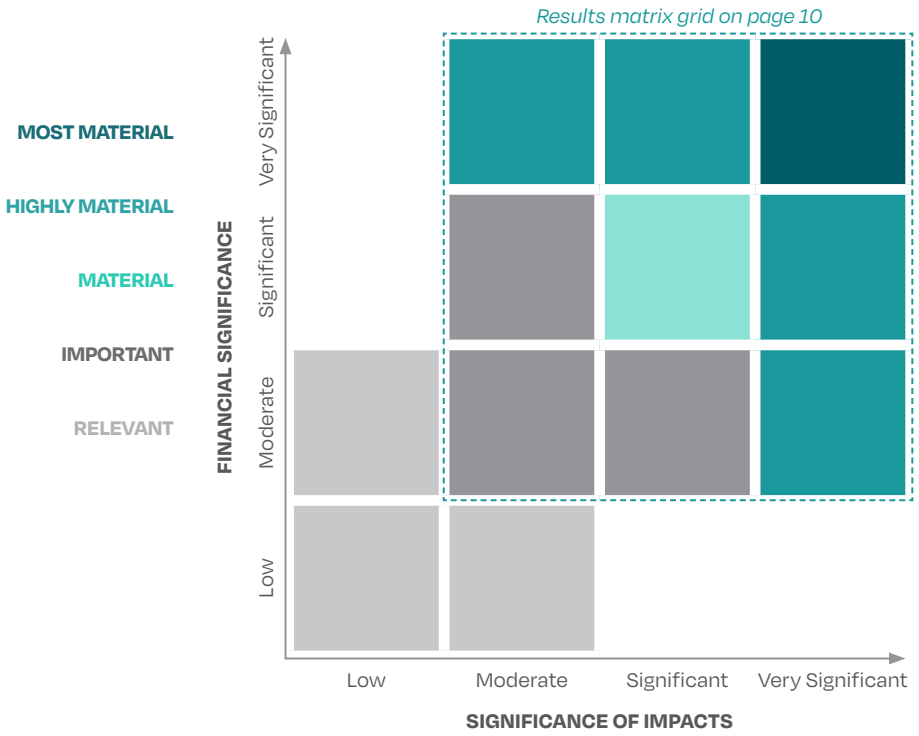
- 20% Dairy Community Organizations
- 5% Non-Profits & Academic Organizations
- 3% Financial & Investment Organizations

To learn more about how stakeholders ranked topics by importance and the input received during the Dairy Sustainability Alliance® meeting, please refer to *Appendix B.*

Phase 3: Prioritization

This phase consolidated the IRO-level assessments from Phase 2 for topic-level prioritization and the establishment of a materiality threshold.

Figure 4. Prioritization: Materiality Tiers



Notes:

- The assessment did not result in any topics being placed in the empty grids in the matrix. For example, no topics were assessed as having low significance of impacts with financial significance in the significant-to-very significant range, and vice versa.
- For topics categorized as Important and Relevant, it is critical to note that U.S. dairy companies may still be responsible for addressing the associated IROs in line with applicable laws, regulations or authoritative intergovernmental instruments. The topics assessed with low-to-moderate financial and impact significance at the national level for U.S. dairy are summarized in *Appendix A* under the Relevant Topics heading. U.S. dairy companies are encouraged to include these topics in their own materiality assessments.

Step 5: Analyze Input and Determine Prioritization

Topic Organization & Categorization

To facilitate prioritization, the IROs were grouped and organized at the most appropriate topic level. Driven by the input and feedback received throughout Phase 2, some topics were integrated into previously stand-alone topics or renamed. For example, industry leaders, experts and stakeholders at large recommended combining "GHG Emissions" and "Energy" to form an updated topic labeled GHG Emissions & Energy.

Based on the criteria results in Phase 2, the significance of impacts and financial significance of risks and opportunities associated with each topic were initially categorized as Low, Moderate, Significant or Very Significant. In this categorization, if a topic is associated with both negative and positive impacts, the significance of negative impacts was prioritized over the significance of positive impacts in accordance with standard guidance.

Materiality Threshold & Preliminary Matrix

The Innovation Center's Board of Directors reviewed the preliminary findings and the topics in relation to one another. During this review, the Board provided input on the financial and impact significance of topics and also discussed the threshold between material, important and relevant topics. This discussion informed the established threshold for materiality, as shown in Figure 4.

Incorporating the Board's input and guidance, the topics were placed on a preliminary matrix. The preliminary matrix supported further evaluation and refinement, resulting in adjustments based on expert input, supporting evidence and relative comparisons. For example, guidance and validation of the identification, assessment and prioritization of topics were collected from the Innovation Center's Stewardship Commitment Committee and the Environmental Stewardship Committee.

The preliminary matrix was also distributed to attendees at the fall meeting of the Dairy Sustainability Alliance®, and more than 120 stakeholders provided feedback during a dedicated Discussion and Input session.

Informed by the feedback collected, the Innovation Center's Stewardship Commitment Committee and DMI's Sustainability Committee reviewed and validated the topics' organization and prioritization before the results were shared with the Innovation Center's Board of Directors for a final review.

Final Matrix & Approval

The Innovation Center's Board of Directors reviewed the report and formally approved the matrix in early 2025. The approved matrix in the Results section presents the topics in the Most Material to Important categories.

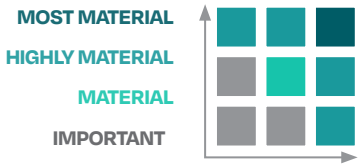
Materiality Matrix

The double materiality matrix below presents the final prioritization of the topics within the following tiers: Important, Material, Highly Material and Most Material.

Figure 5. Materiality Matrix

MATRIX KEY

Topics are listed in alphabetical order within the grids associated with their prioritization tier.



Appendices

Appendix A. Overview of Topics & Key IROs

The following pages provide a summary of the topics included in the assessment and their associated impacts, risks and opportunities, as well as the main considerations that informed the basis of their significance ratings and prioritization. This overview does not represent all actions undertaken, resources leveraged or input received during the assessment process.

The topics are listed in alphabetical order within their associated materiality tier, beginning with the most material topics and ending with the those that remain relevant. The topic summaries include the following information:

General Description: Short overview of the topic, including any topics that were incorporated into the main topic during the assessment

Main Interconnections: List of key interrelated topics

Assessment Summary

- **Key Impacts | Significance Rating:** Brief description of the associated impacts and affected stakeholders along with key aspects from the impact review
- **Key Risks & Opportunities | Significance Rating:** Brief description of the associated risks and opportunities along with key aspects from the review of their financial implications
- **Supporting Evidence:** Summary of the assessment review of evidence, including input from subject matter experts and other stakeholders

Changes Since the 2021 Materiality Assessment

While the 2025 Materiality Assessment cannot be directly compared to the 2021 Materiality Assessment due to the incorporation of a "double materiality" approach, the most material topics remained consistent with the previous national materiality assessment. The following new topics were included or separately identified from previously assessed topics:

- *Air Quality*
- *Climate Resilience*
- *Cybersecurity & Data Protection*
- *Economic Viability & Resilience*
- *Responsible Marketing & Product Labeling*
- *Working Conditions & Labor Practices*

ANIMAL CARE

General Description: Animal care refers to the care towards an animal's physical and mental state in relation to the conditions in which it lives and dies. The 'Five Freedoms' and the 'Five Domains' are internationally recognized standards and frameworks that outline the meaning of animal welfare. The domains include nutrition, environment, health, behavior and mental state. This topic also incorporates the IROs linked to Antibiotic Use in Food Animal Production and Biosecurity.

Main Interconnections: *Climate Resilience, Food Safety & Product Quality* and *Worker Health, Safety & Well-Being*

Assessment Summary

- **Key Impacts | Very Significant:** The impacts related to animal care can include adverse or beneficial effects on animal health, well-being and productivity and on worker and public health. Dairy farmers have direct operational control over the treatment of their animals, while dairy processors and other downstream actors can contribute to or are linked to associated impacts. U.S. dairy's FARM Animal Care Program establishes welfare management guidelines, which are verified by both second- and third-party evaluators and, though voluntary, is adopted by companies representing 99% of U.S. milk production.[15]
- **Key Risks & Opportunities | Very Significant:** Dairy customers and consumers place a high value on humane animal care. Striving to meet U.S. dairy's high standards of animal care is not only a socially responsible obligation but also critical to the farm's profitability. Cows that are healthy and well cared for produce a higher volume of milk making them more profitable for a farmer. This links animal care directly to revenue, in addition to customer and consumer trust, all of which can have very significant financial implications. U.S. dairy also has programs in place to manage and mitigate other risks that may pose operational, financial and even public health risks, such as those associated with antibiotic residues in milk and threats of diseases. For example, since 2011, zero retail-ready milk products have tested positive for traces of antibiotics. All milk is screened for antibiotics and any load that tests positive for drug residue is discarded and never sold.
- **Supporting Evidence:** The topic is a longstanding priority for U.S. dairy and is widely recognized as a highly significant sustainability topic within sector-specific sustainability frameworks and standards (*Appendix C*). Dedicated programs to promote best practices such as FARM Animal Care, Antibiotic Stewardship and Biosecurity reinforce the significance of associated IROs and underscore the industry's shared commitment. While there is a low frequency of actual negative impacts,[15,21] animal care management carries very significant reputational and financial implications, contributing to the topic's prioritization at the most material level. Expert and stakeholder input reinforced the analysis and prioritization of this topic.

FOOD SAFETY & PRODUCT QUALITY

General Description: Food safety is the handling of food and feed products in a way that prevents food contamination and foodborne illness, while product quality refers to the degree to which a product meets or exceeds customer expectations, is fit for its intended purpose and meets industry standards. The topic also incorporates traceability, which is the ability to follow and trace back the movement of a food product and its ingredients through all steps in the supply chain.

Main Interconnections: *Animal Care*, *Materials & Packaging*, *Responsible Sourcing* and *Worker Health, Safety & Well-Being*

Assessment Summary

- **Key Impacts | Very Significant:** Dairy farmers and processors have direct operational control to ensure the quality and safety of their products, and they contribute to or are linked to up- and downstream activities that affect food safety. Stringent food standards and regulation, including those enforced by the U.S. Food and Drug Administration (FDA), reinforce the severity of actual and potential negative impacts associated with incidents of foodborne illnesses or contamination, which include mild to severe illness, and in rare cases, death. Stakeholders at higher risk include children, pregnant women, the elderly and those with compromised immune systems and those who consume unpasteurized milk.[43] U.S. dairy is proactive in protecting consumers. Initiatives such as through the Innovation Center promote excellence by convening U.S. dairy companies to share world-class practices, publishing tools and guidance including the U.S. Dairy Traceability Guidelines, conducting training and advancing scientific research.
- **Key Risks & Opportunities | Very Significant:** While U.S. dairy has a strong food safety record,[46] the risk of a food safety or quality incident with all consumable products remains highly relevant. In addition to their potential impacts on human health, food safety incidents and outbreaks can trigger repercussions such as product recalls, regulatory penalties, legal action, increased insurance premiums, decreased market value, damage to brand/reputation and erosion of customer and consumer trust in the company and/or the dairy sector. The associated direct and indirect financial implications are very significant, and, in severe cases, incidents have resulted in business closure. Conversely, strong food safety, quality and traceability practices have the potential to improve company performance and expand market opportunities.
- **Supporting Evidence:** Food safety is widely recognized as an unwavering social responsibility and a critical component to the economic viability of dairy. The topic is consistently identified as a significant sustainability matter within sector-specific sustainability frameworks and standards (*Appendix C*). The topic's assessment and prioritization as a most material topic was supported by strong scientific consensus on the significance of food safety and quality, the existing regulatory and industry context and a review of objective evidence on the associated IROs, including statistics on dairy-related foodborne illnesses, tracking of product recalls and representative cases.[9,82] Expert and stakeholder input reinforced the analysis, incorporation of traceability and ultimately, the prioritization of the topic.

GHG EMISSIONS & ENERGY

General Description: Greenhouse gases (GHGs), such as carbon dioxide (CO2), methane (CH4) and nitrous oxide (N2O), are gases that trap heat in the Earth's atmosphere. Increasing levels of GHGs in the atmosphere lead to detrimental changes to the Earth's climate and weather patterns. This topic also covers energy use such as electricity, fossil fuels and/or alternative fuels, which can contribute to or mitigate environmental impacts resulting from GHG emissions.

Main Interconnections: *Biodiversity, Climate Resilience, Economic Viability & Resilience and Soil Health & Quality*

Assessment Summary

- **Key Impacts | Very Significant:** Underscoring one of the industry's priorities, U.S. dairy is working collaboratively to achieve GHG neutrality at the field, farm and processor levels by balancing GHG emissions with reductions and removals. The main sources of GHG emissions in the dairy value chain include feed production, which is the major source of nitrous oxide emissions in dairy production[35] as well as enteric fermentation and manure storage, which are sources of methane emissions.[67] All steps in the dairy value chain require energy.[37] The dairy industry has achieved notable efficiency gains over the last few decades, lowering GHG emissions per liter of milk, as the milk production per cow has grown.[28] The industry is leveraging new research, technologies and practices to support environmental stewardship and progress towards the GHG neutrality goal in an economically viable way that positions the industry to thrive for generations to come.
- **Key Risks & Opportunities | Very Significant:** The U.S. dairy value chain faces risks and opportunities related to energy use and GHG emissions. Beyond climate-related risks outlined on *page 16*, others include increased regulatory developments limiting emissions or mandating climate-related disclosures,[84] operational risks like increasing energy costs,[72] and reputational risks related to stakeholder demands.[28] Opportunities to improve energy efficiency and use renewable energy exist across the value chain, while approaches for feed efficiency improvements[38] and use of anaerobic digesters[78] offer examples of on-farm options. These activities, in addition to carbon sequestration, can create opportunities for U.S. dairy farmers and companies to participate in carbon markets, which can potentially offer another revenue stream.
- **Supporting Evidence:** This topic is widely recognized as a significant sustainability topic within sector-specific sustainability frameworks and standards (*Appendix C*). The scale of the industry's GHG footprint and the associated industry-wide risks reconfirmed the highest priority rating, as was established in the past two national assessments. The analysis and prioritization were validated and substantiated through the insights of experts and stakeholders.

HEALTH & NUTRITION

General Description: Nutrition is the process of consuming, absorbing and using nutrients from food that are necessary for growth, development and maintenance of life and human health.

Main Interconnections: *Food/Nutrition Security & Accessibility* and *Responsible Marketing & Product Labeling*

Assessment Summary

- **Key Impacts | Very Significant:** Milk and dairy foods and ingredients nourish people and communities around the world. The nutritional and health contributions of milk and dairy products at each stage of life are well recognized, both nationally and globally.[27] Milk contains 13 essential nutrients in every serving, and dairy foods like cheese and yogurt provide high-quality protein, calcium, vitamins and more.[27] The benefits from dairy occur at the point of consumption as well as over time, as health effects can play out over a lifetime. A growing number of studies indicate that eating dairy foods is associated with reduced risk of chronic disease, including a lower risk for type 2 diabetes and cardiovascular disease, reduced blood pressure, neutral to lower levels of inflammation and improved bone health.[27,56,58,69]
- **Key Risks & Opportunities | Very Significant:** The role of dairy as a source of nutritious food that positively contributes to human health and development is foundational to its contribution to sustainable food systems and its market position. Changes in perceptions of nutritional and health aspects of dairy and consumer food preferences could affect demand, presenting both risks and opportunities. For example, interest in food-first, precision/personalized nutrition and food as medicine approaches to health and wellness continue to rise among consumers, creating greater opportunities for the dairy community. In fact, a recent health and wellness landscape study points to significant consumer spending against top health and wellness benefits today, yet consumers acknowledge that more than 50% of the spending is not meeting their health needs.[12]
- **Supporting Evidence:** In addition to being identified as a material topic in past materiality assessments for U.S. dairy, Health & Nutrition is widely recognized as significant within sector-specific sustainability frameworks and standards (*Appendix C*). The review integrated the solid body of evidence on the nutritional and health contributions of milk and certain dairy products. The basis of this topic's prioritization is also underscored by dairy's role in healthy eating patterns recommended by the Dietary Guidelines for Americans (DGA). Consideration of nondairy ingredients was beyond the scope of this assessment but might be associated with additional impacts and/or pose other risks or opportunities for individual dairy companies. Expert and stakeholder input reinforced the analysis and prioritization of this topic.

WATER QUALITY & NUTRIENT MANAGEMENT

General Description: Water quality refers to the chemical, physical and biological characteristics of water with respect to its suitability for a particular purpose or process. This topic includes water quality management practices such as the management of nutrients and soil amendments. It also covers other practices such as pesticide use and related impacts on water quality.

Main Interconnections: *Biodiversity*, *Climate Resilience*, *GHG Emissions & Energy*, *Soil Health & Quality* and *Water Use & Availability*

Assessment Summary

- **Key Impacts | Very Significant:** Actively managing water quality can positively impact U.S. dairy, surrounding communities and the general public. Dairy-related impacts on water quality can occur during feed production, milk production and dairy processing. Feed production can potentially lead to nutrient leaching into groundwater or runoff into surface waters.[36] While dairy farmers have limited influence over field-specific practices for feeds grown by suppliers, dairy farms have direct operational control over feeds they grow and use nutrient management plans and other practices to protect air, soil and water quality.[32,36] Dairy processors implement policies, procedures or monitoring systems to ensure compliance with related standards and regulations.
- **Key Risks & Opportunities | Very Significant:** Dairy companies can face a range of risks arising from actual and potential noncompliance with laws and permitting requirements, which can result in penalties, legal action and reputational damage with customers, consumers and local communities. These risks can have very significant financial implications arising from potential fines, remediation costs, legal fees and loss of sales. Properly managed water quality practices are essential to meet and maintain regulatory requirements, demonstrate an ongoing commitment to industry goals, and strengthen community relations and license to operate. Effective nutrient and manure management supports water quality while delivering multiple co-benefits such as increasing water-holding capacity and organic carbon content of soil,[3] which can improve crop productivity.
- **Supporting Evidence:** This topic is considered a material sustainability topic across sector-specific frameworks (*Appendix C*). This review was informed by published literature, government reports, as well as specific incidents. The analysis and prioritization were validated by experts and stakeholders and underscored by the industry's 2050 goal to improve water quality by optimizing utilization of manure and nutrients.

WATER USE & AVAILABILITY

General Description: Water use and availability refers to the amount of water available for use and the amount withdrawn and consumed. This topic includes any efforts to conserve and improve water efficiency through recycling, reclamation and reuse.

Main Interconnections: *Animal Care*, *Climate Resilience* and *Water Quality & Nutrient Management*

Assessment Summary

- **Key Impacts | Very Significant:** Water use can potentially impact communities and ecosystems but has been found to be more significant in areas with higher water stress and scarcity, particularly in central and western regions of the country.[35] The dairy community manages water as a shared essential natural resource. U.S. dairy's blue water use accounts for approximately 3% of the nation's freshwater withdrawal.[35] While the full dairy value chain relies on water, approximately 97% of U.S. dairy's water use occurs during feed production.[35] The industry-wide goal to optimize water use by 2050 demonstrates the dairy community's commitment in this area, and research shows a decline in on-farm water consumption per liter of milk from 2007 to 2017.[28] Projections of freshwater use from climate scenarios indicate that the most arid regions of the nation may experience concurrent reductions in water availability and increased demand.[70]
- **Key Risks & Opportunities | Very Significant:** Customers, supply chain partners and communities prioritize water use as an issue, which, if not addressed, can pose reputational and commercial risks. Water scarcity can pose financial risks due to its critical role in the dairy value chain. Although there are regional disparities in water stress across the U.S., many areas where there are dairy operations are increasingly facing regulatory, operational and financial risks related to water. U.S. dairy's practices at the field, farm and processor levels to conserve water are examples of risk management.
- **Supporting Evidence:** This topic has long been a priority for the U.S. dairy industry and is widely recognized as a material sustainability topic across sector-specific frameworks, including GRI and SASB (*Appendix C*). Published life cycle assessments and research, national climate assessment reports, and government data supported the basis of the analysis and reconfirmed prior materiality assessments. The analysis and prioritization were validated by experts and stakeholders and underscored by the industry's 2050 goal to optimize water use while maximizing recycling.

WORKER HEALTH, SAFETY & WELL-BEING

General Description: Worker health, safety and well-being addresses the ability to create and maintain a safe and healthy workplace environment that is free of injuries, fatalities and illness. It further involves the prevention of physical and mental harm to workers and promotion of workers' health.

Main Interconnections: *Animal Care*, *Climate Resilience*, *Food Safety & Product Quality* and *Working Conditions & Labor Practices*

Assessment Summary

- **Key Impacts | Very Significant:** Workplace safety is a vital component for all activities across the dairy value chain. While there is a range of inherent workplace hazards and safety challenges, proactive and effective safety management can reduce the risk of worker injuries, illnesses and fatalities. Groups at greater risk or more vulnerable to adverse impacts can include agricultural workers, immigrant workers and youth workers.[18, 25, 27] Worker health, safety and well-being can be supported through employer-provided benefits, sufficient training and accessible resources. A survey of dairy farms indicated a vast majority offer on-the-job training that focus on safety and job-specific technical skills.[23] Dairy processors reporting through the Stewardship Commitment have indicated the use of leading indicators to measure and encourage safe worker behavior.[10] Initiatives such as FARM Workforce Development produce industry resources including safety manuals to help enhance working environments.
- **Key Financial Risks & Opportunities | Very Significant:** Dairy companies can face a range of related, and often interconnected, risks arising from the actual and potential occurrence of worker safety incidents of noncompliance. When related issues arise, these can generate very significant financial implications as well as industry-wide repercussions. Fostering a safety culture, strengthening management approaches and expanding on regular training can improve safety, which can lead to stronger operational and financial performance.
- **Supporting Evidence:** The topic has long been prioritized by the U.S. dairy industry and is widely recognized as a significant topic within sector-specific sustainability frameworks and standards (*Appendix C*). Worker safety is highly regulated at the federal and state levels and often included in customers' supplier management programs. While "agriculture, forestry, fishing and hunting" often ranks among the most hazardous industrial sectors in terms of worker injuries and fatalities, the dairy industry has improved its safety incident rates. U.S. dairy farms have improved the incidence rate of non-fatal injuries or illnesses by over 44% from 2017 to 2023.[23] In addition to expert and stakeholder input substantiating the analysis, the assessment of actual impacts and the significance of potential impacts and risks contributed to the topic's prioritization as one of the most material topics.

Photo credit: Stephen Kennedy

CLIMATE RESILIENCE

General Description: Climate resilience refers to adjustments made to current and anticipated climate-related impacts and the capacity built to withstand and mitigate such risks. This includes increasing resilience to physical (e.g., severe weather events, shifts in climate patterns) and transitional climate-related risks (e.g., increasing climate regulations).

Main Interconnections: *Animal Care*, *Biodiversity*, *GHG Emissions & Energy*, *Water Use & Availability*, *Water Quality & Nutrient Management* and *Worker Health, Safety & Well-Being*

Assessment Summary

- **Key Impacts | Significant:** Per the Fifth National Climate Assessment, the average temperature across the United States is likely to increase,[61] which could likely lead to greater associated impacts. These impacts can cause disruptions in operations, contribute increased health and safety impacts, and drive food insecurity. A range of stakeholders can be affected across the value chain including farmers, workers, suppliers, customers, and local communities, as well as animals. Participants along the dairy value chain play a role in contributing to climate resilience efforts. As seen on U.S. dairy farms and in dairy processing facilities, practices (e.g., upgrading equipment) are increasingly being deployed to help mitigate current and future risks and events.
- **Key Financial Risks & Opportunities | Very Significant:** The associated impacts pose multiple strategic, operational, regulatory and reputational risks, and is likely to continue to pose physical risks and, if unmitigated, these risks may include higher frequency of droughts, floods, fires and heat-stress impacts on animals, which can decrease milk production.[59] The dairy value chain may increasingly experience disruptions from extreme weather events. Furthermore, transition risks can pose financial effects; for example, an evolving landscape of regulatory requirements can require further investments from the dairy industry.
- **Supporting Evidence:** This topic is widely recognized as a significant sustainability topic within sector-specific sustainability frameworks and standards, including GRI and SASB (*Appendix C*). Published academic literature, government data as well case studies suggest that the types of IROs can vary significantly across the value chain and by geographic location. However, the evidence supports the conclusion that potential risks can pose very significant financial implications. Expert and stakeholder input reinforced the analysis and prioritization of this topic.

CYBERSECURITY & DATA PROTECTION

General Description: Cybersecurity encompasses the protective measures taken to prevent unauthorized access to information systems, malicious attacks and exploitation. Data privacy and protection is the right to control access to one's personal data and organizational data (as with a business customer) as well as the measures to protect one's data.

Main Interconnections: *Economic Viability & Resilience, Food Safety & Product Quality* and *Working Conditions & Labor Practices*

Assessment Summary

- **Key Impacts | Moderate:** The integration of technologies and data science has facilitated deeper operational insights, enabling informed decision-making and subsequent growth within the dairy industry. Though U.S. dairy has limited influence on technology development, the value chain is increasingly reliant on and adopting digital technologies to enable positive outcomes such as optimized feed management, livestock health, and resource utilization. The vulnerability of integrated systems has been underscored by cyberattacks and attempts across industries, elevating the importance for data security and privacy. Advanced cyberattacks on critical infrastructure in the dairy value chain can disrupt supply chains, potentially leading to food shortages, which can affect stakeholders including employees, business partners, customers and consumers.
- **Key Risks & Opportunities | Very Significant:** While digitalization can have a range of benefits from automation, fraud protection, physical security and real-time data monitoring, an increased adoption and reliance on technology can pose financial risks for U.S. dairy. More data is being generated, requested and collected from the dairy value chain, including but not limited to data about livestock, production processes, and consumer preferences. Without strong protections in place, this data can be vulnerable to misuse, breaches or attacks. These potential incidents can disrupt operations, leading to production losses and supply chain disruptions, as evidenced by incidents reported. The Food and Agriculture industry is subject to approximately 6.2% of the 1,193 ransomware incidents across 16 critical sectors.[77] Data and information breaches can compromise critical assets such as intellectual property, trade secrets, and sensitive personnel and customer data, potentially resulting in financial loss and legal repercussions.
- **Supporting Evidence:** Cybersecurity practices and breach disclosure may increasingly be subject to regulatory oversight. The review of IROs was informed by industry-specific incidents, and publicly available data on cybersecurity threats. With limited availability of data, expert and stakeholder input heavily assisted in the analysis and prioritization of this topic. Stakeholders of all types generally identified this topic as very significant from a financial risk lens.

ECONOMIC CONTRIBUTIONS

General Description: This topic refers to U.S. dairy's economic contributions and development, including the creation of direct and indirect economic value at local, state and national levels. Through employment opportunities, training programs and local engagement, U.S. dairy delivers significant economic benefits and growth especially in the communities where operations are present, which are often rural communities. The contribution to these economies can impact the overall resilience of the respective communities, especially in rural areas. Rural areas are defined in a number of ways but more commonly as open country and settlements with fewer than 5,000 residents.

Main Interconnections: *Community Impact & Engagement* and *Economic Viability & Resilience*

Assessment Summary

- **Key Impacts | Significant:** The U.S. dairy industry contributes significant direct and indirect economic value at the local, state and national levels by supporting millions of jobs and billions of dollars in wages. The economic impact totaled nearly $794 billion in 2023, representing approximately 3% of the U.S. gross domestic product (GDP).[6] Dairy production occurs in all 50 states, and much of the milk production and dairy processing occurs in rural communities. Beyond job creation and wage growth, U.S. dairy has contributed tens of billions to federal, state and local taxes. The income earned through dairy translates to investment in these communities, further contributing to the national economy.
- **Key Risks & Opportunities | Very Significant:** As U.S. dairy represents approximately 3% of U.S. GDP, it poses very significant opportunities and risks. While dairy farms, cooperatives and processors manage their financials, many external factors can also affect the overall economic impacts. For example, U.S. dairy exports have quadrupled since the early 2000s, representing over 18% of milk production and contributing over $9 billion in economic impact. Tariffs posed by other countries can cost the U.S. dairy industry millions in sales, market share and jobs.[7]
- **Supporting Evidence:** The analysis of this topic builds from past U.S. dairy materiality assessments, which identified the topic as material due to its high impact on communities, workers and other stakeholders. National and industry economic studies and market analysis research supported the conclusion that this topic is highly material. Expert input reinforced the analysis and prioritization of this topic. Stakeholders are generally interested in the economic contributions of the dairy industry and their connections to community impact as well as employment opportunities for millions of workers.

ECONOMIC VIABILITY & RESILIENCE

General Description: This topic refers to the economic viability and resilience of farmers and other participants in the dairy value chain. Transparent and effective markets as well as responsible sourcing practices can further help build and sustain economically viable businesses, provide access to economic opportunities and ultimately support the livelihoods of farmers and other participants in the value chain.

Main Interconnections: *Economic Contributions* and *Responsible Sourcing*

Assessment Summary

- **Key Impacts | Significant:** As a critical sector to national food security, it's especially important to ensure U.S. dairy maintains the ability to survive and grow. This resiliency is particularly essential during periods of short- and long-term changes and volatility. U.S. dairy companies and dairy organizations have launched initiatives with a focus on enhancing the access to markets and capital and programs focused on workforce development, which support the economic viability, productivity and resilience of the U.S. dairy value chain. The outcomes can contribute to greater food security, the livelihoods of farmers and workers as well as the viability of the local communities and economies that benefit from U.S. dairy.
- **Key Risks & Opportunities | Very Significant:** Economic viability and resilience can lead to a variety of benefits including strengthened partnerships and relationships, higher productivity and greater financial opportunities. Dairy prices are by nature volatile due to seasonal production in some regions and milk's perishability. Adding to these challenges, dairy farmers also navigate unpredictable weather, changing regulations and production costs. Total milk production costs increased nearly 20% in one year from 2021 to 2022.[26] While every herd size has economically viable farms, smaller farms can face a more challenging environment to withstand these factors, which can contribute to shifts in business strategies, consolidation, and in some cases, closure. Despite the decreasing number of dairy farms, production has grown significantly, resulting in the addition of 60,000 new jobs and an increase of $41 billion to the U.S. economy since 2021.[6]
- **Supporting Evidence:** This topic and its associated IROs are recognized as a significant sustainability matter within sector-specific sustainability frameworks and standards, including Economic Inclusion within the GRI Standards (*Appendix C*). The basis of this topic's analysis leveraged economic and industry reports and expert input. Expert input and stakeholder engagement with U.S. dairy reinforced the analysis and the topic's prioritization. This topic was rated among the most important by farmers and cooperatives.

FOOD/NUTRITION SECURITY & ACCESSIBILITY

General Description: Food and nutrition security means that all people have consistent and equal access to enough safe, nutritious, and affordable food for an active, healthy lifestyle and optimal well-being.

Main Interconnections: *Climate Resilience*, *Health & Nutrition* and *Community Impact & Engagement*

Assessment Summary

- **Key Impacts | Very Significant:** Freedom from hunger and consistent access to nutritious food are internationally recognized human rights and essential dimensions of sustainable development. U.S. dairy plays a strong role in national food security programs; for example, dairy is a major component of the nutrition assistance programs administrated by the USDA Food and Nutrition Service.[22] More broadly, the U.S. dairy community has made food/nutrition security a priority for collective action, with many companies building long-term relationships with food banks and other hunger-relief organizations. U.S. dairy has demonstrated the meaningful impact it has in helping address hunger in local communities and supporting nutritional needs. In 2024, Feeding America distributed 445 million pounds of dairy through its network, equivalent to 1.5 billion servings.[5] This marks a 9.6% increase compared to 2023, with dairy foods purchased and donated continuing to rise. In addition to participation in government programs and philanthropic efforts, dairy companies continue to develop affordable products specifically to address nutrition security and nutrient deficiencies around the world.
- **Key Risks & Opportunities | Significant:** With food insecurity rising in the U.S. in recent years,[91] U.S. dairy continues to collaborate to broaden access to nutritious, affordable dairy foods. Efforts in this area not only amplify the benefits of dairy but also enhance the reputation of individual companies and the industry overall. Conversely, perceptions of insufficient efforts in this area carry reputational risks, which can have financial implications.
- **Supporting Evidence:** The review built upon the assessment of Health & Nutrition within the context of global food insecurity and malnutrition. Food and agriculture industries are uniquely positioned to contribute to Sustainable Development Goal (SDG) 2, Zero Hunger, which aims to end hunger and all forms of malnutrition by 2030. Food security is recognized in food-sector benchmarks and indices, such as the Food and Agriculture Benchmark and the Access to Nutrition Index. Expert and stakeholder input reinforced the analysis and the topic's prioritization as highly material.

WORKFORCE ATTRACTION, DEVELOPMENT & RETENTION

General Description: This topic refers to workplace approaches to identify, attract, engage, and retain individuals who have the skills and abilities to help meet objectives. The topic also covers approaches to develop a highly skilled workforce through training, education and development opportunities, equipping an engaged workforce for the range of future work scenarios and to foster fair and equal workplaces. During Phase 3, this topic was renamed to reflect the integration of topics with strong associations with employee attraction and retention, such as learning and development as well as creating a work environment for equal opportunity and treatment for all.

Main Interconnections: *Worker Health, Safety & Well-Being* and *Working Conditions & Labor Practices*

Assessment Summary

- **Key Impacts | Significant:** The attraction, development and retention of skilled employees/workers is foundational to the success of the industry and contributes to an economically viable and socially responsible dairy community. Dairy organizations have a high level of control over their human capital management practices, with many striving to be an employer of choice as a strategic priority. While approaches vary across organizations, efforts at the industry level, such as National Dairy FARM Workforce Development and the International Dairy Foods Association's (IDFA) People Strategy, focus on providing resources on best practices for the industry to leverage.
- **Key Risks & Opportunities | Very Significant:** This topic involves interconnected risks and opportunities, which can have very significant operational and financial implications for dairy operations. Effectively attracting and retaining talent directly impacts a company's success, growth and overall performance.[87] Research has found that high levels of employee engagement can contribute to a range of beneficial individual, team and organizational outcomes, such as increased job satisfaction, productivity, reduced absenteeism and turnover, and higher rates of customer loyalty, which can lead to increased revenue, profitability and other positive financial results.[73,80]
- **Supporting Evidence:** The review built upon the results of the 2021 assessment, which recognized the strategic importance of the topic. Given the limited availability of aggregated dairy-specific information, the assessment relied on the body of organizational research findings and SASB's preliminary Human Capital Framework. Additionally, sources and expert input about dairy's recognized challenges in attracting and retaining employees,[3] especially given current labor market conditions in the U.S., informed the review. Expert and stakeholder input reinforced the analysis, integration of other topics and the topic's overall prioritization.

MATERIALS & PACKAGING

General Description: This topic refers to the journey of materials, including packaging, from inception and sourcing to end-of-life management with opportunities to reduce costs and environmental impacts. In management practice, it means appropriate material selection, prioritizing resource recovery, redesigning processes to optimize efficiency, and bolstering ecosystem services while generating economic returns.

Main Interconnections: *Food Safety & Product Quality*, *Waste & Resource Recovery* and *GHG Emissions & Energy*

Assessment Summary

- **Key Impacts | Significant:** Materials and packaging are increasingly viewed through the lenses of circularity and waste reduction, including a focus on plastic. Plastic use across the value chain from feed bags and silage wrap on farms to the plastic used in packaging of dairy products contributes to environmental impacts.[33,89] Though influence on downstream actions and impacts can be limited, U.S. dairy considers a variety of factors for packaging materials, including but not limited to food safety and product quality, cost, availability of materials, as well as customer and consumer requirements and preferences. Some materials, particularly plastics, have the potential to release chemicals, which can contribute to adverse health effects,[50] and have downstream environmental impacts. Because downstream impacts can be managed in part by upstream activities, U.S. dairy companies are collaborating with the packaging sector to reduce materials used in packaging, maximize recyclability and compostability of packaging and integrate recycled material.
- **Key Risks & Opportunities | Significant:** Growing interest in sustainable packaging can pose both risks and opportunities. Customers/buyers, including food service and retail, and U.S. dairy are increasingly prioritizing sustainable packaging options, driven by heightened consumer demands, national and state regulations, and increased understanding of associated impacts. Meeting a variety of buyer preferences for sustainable packaging, alongside food safety requirements, may pose challenges for dairy companies.[76] Additionally, regulatory developments, such as plastic pollution laws and Extended Producer Responsibility bills,[86] raise risks of noncompliance and increased costs, primarily for dairy processors and retail/food service companies.[83]
- **Supporting Evidence:** This topic is considered significant within sector-specific sustainability frameworks and standards (*Appendix C*). Published scientific research and reports from international organizations and government agencies paired with regulatory developments substantiated the prioritization. Expert and stakeholder input reinforced the analysis and prioritization of this topic.

SOIL HEALTH & QUALITY

General Description: Soil health and quality is the capacity of soil to function as a living ecosystem and to sustain plant and animal productivity, promote plant and animal health, and maintain or enhance water and air quality.

Main Interconnections: *Biodiversity*, *Climate Resilience*, *GHG Emissions & Energy*, *Water Quality & Nutrient Management* and *Water Use & Availability*

Assessment Summary

- **Key Impacts | Significant:** Aspects of soil health and quality include soil structure, organic matter content and water retention. Activities associated with feed and milk production can directly and indirectly impact soil health and quality, which are also affected by regional factors[62] and external variables such as climate and water availability. Beneficial practices like cover cropping, conservation tillage, appropriate manure application, and rotational grazing can improve soil structure, organic matter content and water retention, which help increase soil carbon, reduce erosion and improve water quality. Apart from dairy farmers, stakeholders impacted by this issue may encompass neighboring communities and the surrounding natural ecosystem.
- **Key Risks & Opportunities | Significant:** The role that healthy soil has in food systems, communities, economies and nature is well-documented,[62] underscoring the significance of the risks and opportunities associated with this topic. Soil health directly influences crop yields and economic returns, and the optimization of practices to enhance soil health and quality can reduce crop input costs. Climate-related risks such as drought, flooding and excessive heat can have a detrimental effect on soil health.[54] Soil erosion in the country causes significant productivity losses and water quality issues, estimated at tens of billions of dollars annually.[85] On the other hand, practices to improve soil health can increase the opportunity for carbon sequestration, offering a cost-effective option to reduce GHG emissions[54] and the opportunity for farmers to participate in carbon markets.[88]
- **Supporting Evidence:** This topic is recognized as a significant sustainability matter within sector-specific sustainability frameworks and standards, including GRI (*Appendix C*). While scientific research and national climate assessments indicate substantial variability in the significance of IROs associated with soil health and quality along the value chain and across regions, U.S. dairy's contributions to healthy soil and its well-recognized beneficial impacts informed the prioritization. Expert input reinforced the analysis and prioritization of this topic.

WASTE & RESOURCE RECOVERY

General Description: Waste refers to anything that is discarded, intended for discard, or required to be discarded. This topic includes food waste and non-food waste such as packaging waste. This topic also covers resource recovery, which is the selective extraction of disposed-of materials (waste) for a specific next use, such as production of new and/or recycled materials or energy.

Main Interconnections: *Community Impact & Engagement*, *Food Safety & Product Quality*, *GHG Emissions & Energy* and *Materials & Packaging*

Assessment Summary

- **Key Impacts | Significant:** Waste can have impacts on the environment and communities, which can extend beyond the locations where waste is generated and discarded. Within direct operational boundaries, dairy farms, cooperatives and processors have a high level of control in managing inputs to reduce the consumption of resources and generate the least amount of waste. Influence on waste generated downstream, particularly related to food and packaging waste at retail and consumer levels, is limited. U.S. dairy is reducing waste and improving resource recovery by using byproducts from food processing as animal feed and implementing waste management plans at processing plants. For example, in 2022, reporting adopters of the U.S. Dairy Stewardship Commitment, which represented over 75% of milk production at the time, collectively achieved a 95% waste diversion rate, sending only 5% of waste to landfills and incineration.[10] This success is supported by additional measures that are being implemented to lessen the impact of other sources of waste such as materials and packaging.
- **Key Risks & Opportunities | Significant:** Through waste minimization and opportunities for resource recovery, U.S. dairy is advancing a circular economy while obtaining new sources of revenue and cost savings through improved efficiencies. The U.S. dairy industry has effectively upcycled would-be food waste as animal feed, which can result in substantial environmental advantages and reduced operational expenses. Additionally, the industry can benefit from use of anaerobic digestion technology for managing organic waste (co-digestion). Co-digestion reduces greenhouse gas emissions compared to sending organic waste to landfill and facilitates the transformation of waste into renewable energy.
- **Supporting Evidence:** The topic is recognized as a sustainability matter within sector-specific sustainability frameworks and standards (*Appendix C*). The review was informed by data and research published by academic research institutions and government agencies, as well as data reported by U.S. dairy cooperatives and processors that have adopted the U.S. Dairy Stewardship Commitment. Expert and stakeholder input reinforced the analysis and prioritization of this topic.

WORKING CONDITIONS & LABOR PRACTICES

General Description: Working conditions and labor practices refer to the working environment and aspects of an employee's terms and conditions of employment beyond health and safety. This topic covers matters related to fair labor practices (e.g., compensation and benefits, work hours and work-life balance, and, when applicable, adequate housing) and relevant labor-related human rights (e.g., non-discrimination and equal opportunity, freedom of association and right to collective bargaining, child labor,[1] and forced or compulsory labor).[2]

Main Interconnections: *Workforce Attraction, Development & Retention*, *Responsible Sourcing* and *Worker Health, Safety & Well-Being*

Assessment Summary

- **Key Impacts | Significant:** Activities throughout the dairy value chain can cause and contribute to positive and negative impacts related to working conditions and labor practices for both formal and informal employment including migrant workers.[3,4] U.S. dairy continues to implement practices to safeguard workers, such as grievance procedures for pay issues and non-wage benefits like housing, health insurance and paid leave.[14] In recent years, U.S. dairy added nearly 60,000 new jobs, supporting 3.2 million total jobs and $49 billion in direct wages.[6] Efforts at the industry level, such as National Dairy FARM Workforce Development, focus on providing resources and tools to enhance practices.
- **Key Financial Risks & Opportunities | Significant:** Working conditions can improve or lower worker morale, affect productivity, and contribute to employee attraction and retention. This topic is associated with financially significant risks, such as inability to retain a talented workforce and failure to comply with regulations, which have operational and financial implications and can lead to reputational damage.
- **Supporting Evidence:** The topic is widely recognized as a significant sustainability matter within sector-specific sustainability frameworks and standards, such as the SASB Standards (*Appendix C*). Aspects of working conditions are highly regulated in the U.S. and included in many dairy customers' supplier management programs, underscoring the significance of the IROs. Workplace practices related to this topic can vary across dairy farms and companies. The review of adverse impacts on specifically labor-related human rights, such as child or forced labor violations, identified infrequent, isolated cases. While recognizing the potential range of impacts across the value chain, the IROs related to labor-related human rights are rated as relatively low. Expert and stakeholder input reinforced the analysis and prioritization of this topic along with its sub-topics. Stakeholders of all types generally rated fair labor practices as an important topic, while most stakeholders viewed labor-related human rights risks to be less relevant.

1 Child labor does not refer to youth employment or to children working; instead, this topic focuses on work that deprives children of their childhood, potential and overall development. The lawful employment of children or adolescents that does not negatively affect their health, personal and educational development is generally regarded as positive.

2 Please note the Innovation Center for U.S. Dairy cannot seek to influence governmental policy or action.

AIR QUALITY

General Description: Air pollutants, including particulate matter (PM), ozone (O3), sulfur dioxide (SO2), nitrogen oxides (e.g. NO), ammonia, and volatile organic compounds (VOCs), can have a negative impact on air quality.

Main Interconnections: *GHG Emissions & Energy*, *Water Quality & Nutrient Management* and *Worker Health, Safety & Well-Being*

Assessment Summary

- **Key Impacts | Significant:** Activities across the dairy value chain, such as feed and milk production, processing and transportation, can release air pollutants. For example, particulate matter, nitrogen oxides and ammonia, can be released from the use of fertilizers, manure storage and application, the operation of agricultural machinery, transportation and the production of electricity.[66] These emissions can impact air quality and potentially affect human and animal respiratory health, ecosystem health and visibility.[63] Aspects of air quality are regulated in the U.S. under the Clean Air Act and other laws.[90] Air quality management practices and technology such as air filtering systems help ensure operations meet requirements.
- **Key Risks & Opportunities | Moderate:** This topic is associated with operational, regulatory and reputational risks and opportunities, many of which are addressed through the management of related topics. Risks of noncompliance with air quality permits or standards can have operational, financial and reputational implications. Furthermore, research has found air pollution can adversely affect crop and dairy cow productivity, which carries financial risks.[71] Practices that reduce air pollutants, such as those designed to improve manure management, optimize fertilizer application or mitigate GHG emissions, can minimize related risks.
- **Supporting Evidence:** This topic is identified as a significant sustainability matter within sector-specific sustainability frameworks and standards (*Appendix C*), often in connection with other topics such as GHG emissions. While published academic literature and government reports suggest that the significance of associated IROs varies significantly across the dairy value chain and across geographic locations, there is scientific consensus on the potential effects, as underscored by the regulatory context. Expert and stakeholder input reinforced the analysis and prioritization of this topic.

BIODIVERSITY

General Description: Biodiversity is the variety and variability of all living things within an agricultural ecosystem.

Main Interconnections: *Climate Resilience*, *GHG Emissions & Energy*, *Land Use & Conversion*, *Soil Health & Quality* and *Water Quality & Nutrient Management*

Assessment Summary

- **Key Impacts | Moderate:** Globally, biodiversity has declined at a high rate, and preserving, restoring and enhancing the vast variety of plant and animal species is a key component to sustainable development. Numerous activities along the dairy value chain, particularly during crop production, have the potential to impact biodiversity. For example, when manure is properly applied, it provides essential nutrients for crop production, reducing the need for synthetic fertilizers. If not managed properly, harm to local plants, insects and animals can potentially result.[81] Impacts on biodiversity are intricately linked to other environmental matters, most notably, land use and conversion and GHG emissions, which can be key drivers of biodiversity loss.[60,70] Given the complexity and range of species in ecosystems, enhancing biodiversity often requires localized approaches.
- **Key Risks & Opportunities | Moderate:** The dairy industry's reliance upon natural resources and ecosystem services presents both risks and opportunities with financial implications. The Taskforce on Nature-related Financial Disclosures (TNFD) Framework reinforces the increasing understanding and concern about the consequences associated with biodiversity loss and their financial implications. Biodiversity conservation practices offer opportunities to improve farm productivity and resilience, reduce costs, benefit from government incentives and grants, and meet customer and consumer preferences, which can reduce operational, supply chain and reputational risks. U.S. dairy is continuously improving its management of associated risks. For example, the FARM Environmental Stewardship program has a voluntary Conservation Practice Questionnaire, which includes biodiversity metrics to capture on-farm practices that benefit biodiversity.
- **Supporting Evidence:** The topic is recognized as a sustainability matter within sector-specific sustainability frameworks and standards (*Appendix C*). However, the intricate web of interconnected issues underscores the dependence of biodiversity-related IROs on a wide range of factors. Although academic literature and case studies suggest that IROs vary significantly across geographic locations, the significance of the topic for food and agriculture systems is well established. Expert and stakeholder input verified the analysis and prioritization of this topic.

COMMUNITY IMPACT & ENGAGEMENT

General Description: This topic refers to community impact efforts such as philanthropic efforts, product donations and the investment of funds in the broader community where the target beneficiaries are considered external. The topic also covers community engagement, such as community consultation and grievance processes, to understand the concerns and vulnerabilities of local communities and how local communities may be affected by activities. The topic was expanded from Community Contributions, which was identified and assessed in previous U.S. dairy materiality assessments, to capture the activities related to community engagement as well.

Main Interconnections: *Economic Contributions*, *Economic Viability & Resilience* and *Food/Nutrition Security & Accessibility*

Assessment Summary

- **Key Impacts | Significant:** Beyond U.S. dairy's economic contributions (*page 17*), U.S. dairy farmers and companies regularly engage the communities in which they operate such as through community volunteering, sponsorship of local events, product donations, serving on local boards, and charitable giving. Many U.S. dairy companies have reported an expansion of efforts to strengthen community viability through grant and gift-matching programs as well as aid for disaster relief. Furthermore, food/nutrition security and accessibility (*page 18*) has long been a shared community commitment and an area of collective action such as through the Dairy Nourishes America initiative. These efforts impact a variety of stakeholders beyond local communities and help strengthen the perception and experiences of workers, customers and consumers.
- **Key Risks & Opportunities | Moderate:** Robust community engagement and consultation, especially related to development projects, can help minimize risks and bolster goodwill with local stakeholders.[49] U.S. dairy, alongside its partners and workforce, actively engages in its communities to help develop strong, thriving communities. Additionally, dairy companies often encourage their workforce to bring social purpose to their work and are provided opportunities to do so through donations and experiences to support locally. These activities often result in stronger relations with stakeholders in the community as well as increase morale and engagement with its workforce.
- **Supporting Evidence:** The scale and scope of these impact activities are difficult to accurately capture across the U.S. dairy industry. However, the efforts communicated by individual companies, associations and other dairy organizations, including those reported through the U.S. Dairy Stewardship Commitment, provided evidence of significance. Expert input reinforced the analysis of the financial value and implications that community impact and engagement can deliver for companies and the industry at large. Stakeholders value the dairy community's contributions, although to a lesser degree compared to many other topics.

LAND USE & CONVERSION

General Description: This topic refers to changing a natural ecosystem to another use, or a profound change in a natural ecosystem's species composition, structure or function. This includes activities such as land use conversions and deforestation, which can include the conversion of native grasslands, wetlands or woodlands to agriculture, as well as conversion to development activities, or severe and sustained degradation.

Main Interconnections: *Water Use & Availability*, *Soil Health & Quality*, *Biodiversity*, *GHG Emissions & Energy*, *Economic Viability & Resilience* and *Land & Resource Rights*

Assessment Summary

- **Key Impacts | Moderate:** While land use is associated with activities across the U.S. dairy value chain, feed production accounts for 95% of land use.[32] Impacts due to physical occupation of land by dairy farm buildings are considered negligible in comparison.[32] Research suggests that agriculture can be a driver of land use change, most specifically conversion of native grasslands; the agricultural sector in the U.S. has not been a primary driver of deforestation.[45] U.S. dairy has demonstrated a commitment to sustainability by reducing its land use per gallon of milk produced through the use of agricultural byproducts as feeds,[30] improved crop yields, and enhanced pest and disease control measures.[28]
- **Key Financial Risks & Opportunities | Moderate:** While U.S. dairy is not a primary driver of land-use change, growing competition for land currently in agricultural production, particularly from urban development, presents potential risks and challenges. While various factors influence land-use change, research highlights the prominent role of agricultural land conversion for urban development.[48] The precise financial implications for U.S. dairy are difficult to quantify due to the complexity of these land-use dynamics and depend on local context and land ownership matters.
- **Supporting Evidence:**[1] Published life cycle assessments, national studies and government data suggest that IROs vary significantly across the value chain and by geography. The topic was determined to be "important" for U.S. dairy to continue to monitor, track and manage. It is highly recommended for U.S. dairy companies to assess the associated IROs based on regional context and local data. Expert and stakeholder input reinforced the analysis and prioritization of this topic.

1 Scope of the assessment: The review of impacts for non-dairy ingredients or inputs other than feed was out of scope for this assessment. U.S. food and beverage companies, including dairy processors, may source other ingredients like cocoa and palm oil, which can have potential impacts such as deforestation or other land-use issues. U.S. dairy companies are advised to assess their own supply chain and evaluate the significance of IROs associated with this topic.

RESPONSIBLE MARKETING & PRODUCT LABELING

General Description: This topic covers product and service information, labeling and marketing communication. It includes approaches to ensure compliance with regulations and/or voluntary codes and access to accurate and adequate information about products and services.

Main Interconnections: *Food Safety & Product Quality* and *Health & Nutrition*

Assessment Summary

- **Key Impacts | Moderate:** Fair and responsible marketing communications, as well as access to information about the composition of products, and their proper use and disposal, can help consumers make informed choices. Aspects of this topic are regulated to protect human health and to prevent false or misleading health and advertising claims, including those related to sustainability-related characteristics. Dairy companies are responsible for adhering to these laws and regulations within the U.S. and, when applicable, those of the countries to which they export. While product labeling and marketing activities can occur at all steps in the dairy value chain, dairy processors have greater influence given their primary role in processing milk and dairy products for direct consumption by consumers or for use in the products of their customers.[94] The most significant impacts are directly associated with those addressed under *Food Safety & Product Quality*, which was determined to be a Most Material topic.
- **Key Risks & Opportunities | Moderate:** Dairy companies must comply with labeling requirements and claims about the nutrition and health contributions of their products or the ways in which they were produced. Risks of noncompliance are associated with regulatory penalties, potential legal action, reputational damage and reduced consumer trust, all of which can have financial implications. The rise in greenwashing litigation related to allegations of unsubstantiated or exaggerated environmental claims can increase risk for individual companies and the industry overall.[41]
- **Supporting Evidence:** This topic is recognized as a significant sustainability matter within sector-specific sustainability frameworks and standards, such as the SASB Standards, primarily for dairy processors and downstream actors (*Appendix C*). Given the limited availability of aggregated information, the basis for the topic's prioritization as important from an industry-wide perspective was informed by the regulatory context, the potential for adverse impacts and associated risks, and limited incidents of noncompliance and accusations of misleading claims. Expert and stakeholder input reinforced the analysis and the prioritization of this topic.

BUSINESS CONDUCT

Responsible, ethical business conduct is a foundational expectation across sectors. During the assessment, the review of IROs related to business conduct found the following two topics relevant but with insufficient evidence of adverse impacts or significant risks at the national, industry level for a higher rating. It is highly recommended that U.S. dairy companies assess these topics and their associated IROs further at an organizational level.

ANTI-COMPETITIVE BEHAVIOR

General Description: This topic refers to practices to identify and prevent collusion with potential competitors, abuse of dominant market position or exclusion of potential competitors, thereby limiting the effects of market competition. Anti-competitive behavior can include fixing prices or coordinating bids; creating market or output restrictions; imposing geographic quotas; and allocating customers, suppliers, geographic areas or product lines.

Main Interconnections: *Anti-Corruption* and *Economic Viability & Resilience*

Assessment Summary: Activities across the value chain can potentially result in or be associated with anti-competitive behavior or other abuses of market power. U.S. dairy companies use a range of practices to reduce risk of such behaviors. While isolated incidents and accusations of anti-competitive behavior were noted, the significance of the impacts and risks varied by a range of factors, such as market composition of dairy products, design of agreements and organizational structures. Within the broader context of shared progress, U.S. dairy has a long history of working together on pre-competitive sustainability matters, such as food safety, animal care and environmental stewardship. Expert and stakeholder input reinforced the analysis and prioritization of this topic.

ANTI-CORRUPTION

General Description: This topic refers to practices to identify and prevent corrupt behaviors such as bribery, facilitation payments, fraud, extortion, collusion, money laundering, or the offer or receipt of an inducement to do something dishonest or illegal.

Main Interconnections: This topic covers the potential for corruption to occur in relation to all other topics and is often linked to *Anti-Competitive Behavior* and *Responsible Sourcing*.

Assessment Summary: As in every industry, actors along the U.S. dairy value chain can be exposed to corruption and bribery risks, which can be detrimental to sustainable economic growth and social development. Publicly available information regarding incidents of corruption across the industry is limited. Expert and stakeholder input reinforced the analysis and prioritization of this topic.

OTHER HUMAN RIGHTS

Respect for and protection of internationally recognized human rights are foundational ethical and business responsibilities. Other topics assessed that have salient human rights dimensions include Worker Health, Safety & Well-Being, Working Conditions & Labor Practices, Food/Nutrition Security & Accessibility, and Cybersecurity & Data Protection.

The assessment of the remaining human rights topics found them relevant but with insufficient evidence of significant adverse impacts or risks at the national dairy level for a higher rating. Dairy companies are encouraged to assess these topics within their specific organizational context.

LAND & RESOURCE RIGHTS

General Description: This topic encompasses the rights to use, manage and control land, forests and other natural resources. Activities on land can impact the availability and accessibility of natural resources. Acquiring legal rights to land and its natural resources can be a complex process, and the forms of land and resource tenure vary from public, private, communal, collective, indigenous and customary tenure.

Main Interconnections: *Economic Viability & Resilience* and *Land Use & Conversion*

Assessment Summary: Land tenure is a relevant issue for agriculture in general, involving dual dimensions of the rights of owners and those with legal claims, such as tenants, and the public interest in how land is used.[79] Related challenges include access to land for new and beginning farmers, increasing amount of farmland owned by non-operators and matters of land transfer.[42] Aspects of resource rights are interconnected with other environmental topics, such as Water Use and Availability as disputes can occur in regions where water is a scarce resource. Expert and stakeholder input reinforced the analysis and prioritization of this topic. Stakeholders often noted the variability of the IROs associated with this topic, most notably by geographic region.

RIGHTS OF INDIGENOUS PEOPLES

General Description: Indigenous peoples have both collective and individual rights, as set out in the United Nations Declaration on the Rights of Indigenous Peoples and other authoritative international human rights instruments.

Main Interconnections: *Land & Resource Rights*

Assessment Summary: It is widely recognized that some of the land currently used for agriculture had been historically used, occupied or claimed by Native American tribes and Indigenous peoples. Expert and stakeholder input confirmed the review and prioritization of this topic.

RESPONSIBLE SOURCING

General Description: This topic covers procurement practices that reduce sourcing risks related to environmental and social factors and that promote responsible and sustainable sourcing. It also includes practices to screen, monitor and engage with suppliers on environmental and social topics and can include practices to actively source products and services based on sustainability criteria and performance.

Main Interconnections: All topics with impacts in the dairy supply chain

Assessment Summary: Through responsible supply chain management practices, companies can positively influence the environmental and social impacts of their suppliers. Procurement-related risks and opportunities can arise from social and environmental impacts caused within the supply chain.

Supply chain management issues related to labor and environmental practices, ethics or corruption can result in regulatory fines, operational costs and reputational damage. Conversely, responsible sourcing initiatives can deliver positive environmental and social impacts as well as financial and market opportunities.

U.S. dairy relies on a vast range of goods and services. Management practices used by dairy companies include supplier codes of conduct, use of third-party certifications as procurement criteria, social and environmental audits, and sustainable sourcing commitments. Many dairy companies share their approaches on their websites and within their sustainability reports.

The consideration and review of the associated IROs occurred within the assessments of associated topics, such as *Worker Health, Safety & Well-Being* and *GHG Emissions & Energy*. Given the management focus of this topic, and its cross-cutting nature with many of the assessed topics, its prioritization remained as a relevant topic from a national perspective. At the individual organization level, the topic is commonly prioritized for reporting and disclosure, such as to customers, regulators and/or consumers, to demonstrate effective risk management and responsible sourcing practices.[52] Expert and stakeholder input reinforced the analysis and prioritization of this topic.

TRANSPARENCY

GMO (GENETICALLY MODIFIED ORGANISM) MANAGEMENT

General Description: GMOs refer to plants, in which one or more changes have been made to the genome, typically using high-tech genetic engineering to attempt to alter the characteristics. This topic refers to management practices to assess and manage GMO-related IROs, including product labeling requirements. The topic was placed under Transparency based on the associated labeling requirements.

Main Interconnections: *Animal Care* and *Responsible Marketing & Product Labeling*

Assessment Summary: GMO crops have yielded multiple benefits including improving drought resistance as well as resistance to pests and diseases, requiring fewer pesticides.[93] More than 95% of animals used for meat and dairy in the United States eat GMO crops.[92] Food for animals is regulated by the U.S. FDA to ensure its safety and proper labeling. The assessment did not identify evidence of adverse GMO-related impacts on animals, the nutritional quality of their products or human health.[92] Based on the regulation of GMOs, limited availability of evidence of associated adverse impacts and the coverage under interconnected topics, the prioritization as relevant was determined to be appropriate.

Expert and stakeholder input aligned with the analysis, prioritization and the placement of the topic within the Transparency category.

PUBLIC POLICY

Please note the Innovation Center for U.S. Dairy cannot seek to influence governmental policy or action.

General Description: This topic was reviewed under Transparency, wherein the assessment considered public disclosures on policy positions, development and advocacy efforts such as engagement with regulatory authorities.

Main Interconnections: All topics that are subject to policy implications

Assessment Summary: Local, national or international policies concerning sustainability matters can be influenced by certain entities and groups. Industry groups such as NMPF and IDFA publicly share their policy priorities. Due to the variability of company-specific approaches and the extent to which existing policies have already been incorporated in topic analysis, public policy was determined to be more appropriate for assessment at an organizational level.

Appendix B. Topic Significance Ratings & Importance to Stakeholders

Key for significance categories (impact and financial) and importance to stakeholder ratings

Low	Moderate	Significant	Very Significant

	Topics by Materiality Tier	Significance of Impact	Financial Significance	Importance to Stakeholders[1]
MOST MATERIAL	Animal Care	■	■	■
	Food Safety & Product Quality	■	■	■
	GHG Emissions & Energy	■	■	■
	Health & Nutrition	■	■	■
	Water Quality & Nutrient Management	■	■	■
	Water Use & Availability	■	■	■
	Worker Health, Safety & Well-Being	■	■	■
HIGHLY MATERIAL	Climate Resilience	■	■	■
	Cybersecurity & Data Protection	■	■	■
	Economic Contributions	■	■	■
	Economic Viability & Resilience	■	■	■
	Food/Nutrition Security & Accessibility	■	■	■
	Workforce Attraction, Development & Retention	■	■	■[2]
MATERIAL	Materials & Packaging	■	■	■
	Soil Health & Quality	■	■	■
	Waste & Resource Recovery	■	■	■
	Working Conditions & Labor Practices	■	■	■[3]
IMPORTANT	Air Quality	■	■	■
	Biodiversity	■	■	■
	Community Impact & Engagement	■	■	■
	Land Use & Conversion	■	■	■
	Responsible Marketing & Product Labeling	■	■	■
RELEVANT	Business Conduct: Anti- Competitive Behavior	■	■	■
	Business Conduct: Anti- Corruption	■	■	■
	Other Human Rights: Land & Resource Rights	■	■	■
	Other Human Rights: Rights of Indigenous People	■	■	■
	Responsible Sourcing	■	■	■
	Transparency: Public Policy	■	■	■
	Transparency: GMO Management	■	■	■

1. Stakeholders represent those that provided direct input through a survey or during an interview
2. Due to low ranking of integrated sub-topics, e.g., Learning & Development
3. Due to low ranking of integrated sub-topics, e.g., Non-Discrimination

Stakeholder Perspectives from the Dairy Sustainability Alliance® 2024 Fall Meeting

The Innovation Center's Dairy Sustainability Alliance® is a multi-stakeholder group consisting of companies and organizations from across the dairy community and others who want to contribute to dairy's social responsibility journey. Through in-person meetings, webinars and newsletters, Dairy Sustainability Alliance® members share knowledge, collaborate on issues affecting the industry at large, accelerate progress toward common sustainability goals and contribute to the long-term viability of the U.S. dairy industry.

The Dairy Sustainability Alliance® provides a forum for stakeholder input that is essential as the Innovation Center takes its next steps to credibly measure, report on and support dairy social responsibility. During the fall meeting in 2024, over 120 stakeholders participated in a Discussion & Input session to review and provide feedback on the preliminary materiality matrix. Participants represented a wide range of stakeholder types including but not limited to farmers, processors, academia and nonprofit organizations.

Stakeholders confirmed and reinforced the placement of almost all topics on the preliminary matrix, with strong alignment on the most material and highly material topics. Two updates were made as a result of feedback, input and discussion that took place during the session. These changes were discussed and reviewed by the Innovation Center Stewardship Commitment Committee and DMI Sustainability Committee. The Innovation Center Board conducted the final review.

The two updates included:

1. *Cybersecurity & Data Protection* moved from being an important to highly material topic on the matrix. The majority of stakeholders during the session provided input that the potential risks associated with cybersecurity and data protection could have very significant financial implications on U.S. dairy companies.
2. *Responsible Marketing & Product Labeling* shifted from a relevant to important topic on the matrix. Stakeholders emphasized the magnitude of the potential risks associated with this topic and underscored that the likelihood of the risk occurring may increase in the short and near term.

Appendix C. Mapping to Initiatives, Standards & Frameworks

Topics in *italic* reflect partial alignment.

Topic	U.S. Dairy Stewardship Commitment	Dairy Sustainability Framework (DSF) Criteria	GRI Standards	SASB Standards	European Sustainability Reporting Standards (ESRS)
MOST MATERIAL TOPICS					
Animal Care	Animal Care	Animal Care	Animal Health & Welfare	Animal Care & Welfare; Antibiotic Use in Animal Production; *Environmental & Social Impacts of Animal Supply Chain*	Business Conduct
Food Safety & Product Quality	Product Safety & Quality	Product Safety and Quality	Food Safety; *Supply Chain Traceability*	Food Safety	Consumers and End-Users
GHG Emissions & Energy	GHG Emissions; Energy Use	Greenhouse Gas Emissions	Emissions	Greenhouse Gas Emissions; Energy Management	Climate Change
Health & Nutrition	*Product Contributions; Product Safety & Quality*		Healthy and Affordable Food	Health & Nutrition	Consumers and End-Users
Water Quality & Nutrient Management	Water Quality; Nutrient Management	Water Availability and Quality; Soil Nutrients	Water & Effluents	Water Management; Land Use & Ecological Impacts	Pollution; Water and Marine Resources
Water Use & Availability	Water Quantity	Water Availability and Quality	Water & Effluents	Water Management	Water and Marine Resources
Worker Health, Safety & Well-Being	Workforce Development	Working Conditions	Occupational Health & Safety	Workforce Health & Safety	Own Workforce; Workers in the Value Chain
HIGHLY MATERIAL TOPICS					
Climate Resilience			Climate Adaptation & Resilience	Animal & Feed Sourcing	Climate Change
Cybersecurity & Data Protection				Data Security	Business Conduct
Economic Contributions		Rural Economies	*Local Communities*		Affected Communities
Economic Viability & Resilience		Rural Economies; Market Development	Economic Inclusion		Affected Communities; Own Workforce
Food/Nutrition Security & Accessibility	Product Contributions		Food Security		Affected Communities; Consumers and End-Users
Workforce Attraction, Development & Retention	Workforce Development		Employment		Own Workforce; Workers in the Value Chain
MATERIAL TOPICS					
Materials & Packaging	Packaging; Resource Recovery		Materials	Packaging Lifecycle Management	Resource Use and Circular Economy
Soil Health & Quality	Nutrient Management; Land Use (within Feed Impact)	Soil Quality and Retention; Soil Nutrients	Soil Health; *Pesticides Use*		Biodiversity and Ecosystems
Waste & Resource Recovery	Resource Recovery, *Packaging*	Waste	Waste		Resource Use and Circular Economy
Working Conditions & Labor Practices	Workforce Development	Working Conditions	Employment Practices; Non-Discrimination & Equal Opportunity; Child Labor; Forced Labor; Freedom of Association & Collective Bargaining; *Living Income & Living Wage*		Own Workforce; Workers in the Value Chain

Appendix C: Mapping to Initiatives, Standards & Frameworks

Topic	U.S. Dairy Stewardship Commitment	Dairy Sustainability Framework (DSF) Criteria	GRI Standards	SASB Standards	European Sustainability Reporting Standards (ESRS)
IMPORTANT TOPICS					
Air Quality			Emissions	*Environmental & Social Impacts of Ingredient Supply Chain*	Pollution
Biodiversity	Biodiversity	Biodiversity	Biodiversity	*Environmental & Social Impacts of Ingredient Supply Chain*	Biodiversity and Ecosystems
Community Impact & Engagement	Community Contributions		Local Communities		Affected Communities
Land Use & Conversion	Land Use (within Feed Impact)		Natural Ecosystem Conversion	Land Use & Ecological Impacts	Biodiversity and Ecosystems
Responsible Marketing & Product Labeling			Marketing & Labeling	Product Labelling & Marketing	Consumers and End-Users
RELEVANT TOPICS					
Business Conduct: Anti-Competitive Behavior; Anti-Corruption			Anti-Competitive Behavior; Anti-Corruption; *Economic Inclusion*		Business Conduct
Other Human Rights: Rights of Indigenous Peoples; Land & Resource Rights			Rights of Indigenous Peoples; Land & Resource Rights		Affected Communities
Responsible Sourcing			Procurement Practices; Supplier Environmental Assessment; Supplier Social Assessment	Animal & Feed Sourcing; Environmental & Social Impacts of Animal Supply Chain	
Transparency: GMO Management; Public Policy			Public Policy		Consumers and End-Users

Appendix D. External Verification Statement

AVERUM

Innovation Center for US Dairy – Verification Statement Letter

1. Client Information	
Client Name:	**Innovation Center for US Dairy (ICUSD)**
Client Address:	10255 W. Higgins Rd. Suite 900, Rosemont, IL 60018-5616
Client Contact:	Emily Bishop
Verifier Body:	**Averum**
Verifier (Lead):	Matt Armstrong
Additional Verifiers:	Linnea Abel
Subject Matter Expert(s):	Matt Armstrong, Linnea Abel
Subject Matter Expertise:	Global Reporting Initiative (GRI) Standards and Principles, EFRAG Guidance, European Sustainability Reporting Standards (ESRS) requirements, Sustainability Dairy Partnership (SDP) Verification
Dates of verification:	12/9/2024 – 4/9/2025

2. Scope Information	
Verification Objective	The objective of Averum's verification was to provide ICUSD with an independent assessment regarding: • The conformance of ICUSD's materiality approach and assessment with the requirements of GRI Principles regarding materiality assessment. • The conformance of ICUSD's materiality approach and assessment with the guidance provided in EFRG Implementation Guidance (IG1) • A review of the utility provided by ICUSD's Materiality Assessment of Sustainable Dairy Partnership's Stage 3 regarding Materiality Assessments
Time period covered	Reporting as of March 28, 2025
Organizational Boundary	United States
Entities covered	Innovation Center for US Dairy
Significant entities excluded	None
Verification Scope	Verification that the processes and procedures employed by ICUSD in the preparation of their 2025 Materiality Assessment conform with: • GRI Principles of Reporting regarding Materiality Assessments • EFRAG Implementation Guidance (IG1) • Sustainable Dairy Partnership (SDP): Stage 3 regarding Materiality Assessments

AVERUM

Innovation Center for US Dairy – Verification Statement Letter

3. Verification Statement

Averum's Agreed Upon Deliverables to the Innovation Center for US Dairy included:

1. Project management and administrative time
2. External verification of the Innovation Center's materiality assessment to confirm the assessment followed appropriate guidance from GRI and EFRAG as applicable.
3. Assessment of the Innovation Center's "double materiality" approach for appropriate integration into the materiality assessment
4. Provide a verification statement letter to the Innovation Center confirming the successful completion of verification activities

We are pleased to provide this verification statement for the use of Innovation Center for US Dairy (ICUSD) and their collaborators, based on the verification activities conducted by Averum in 2025. Averum was engaged by ICUSD to provide an independent third-party verification of their draft 2025 Materiality Assessment's conformance with the implementation guidance provided by a number of external standard setters. Our verification was informed by the guidance provided by GRI, EFRAG, and the SDP. ICUSD's Materiality Assessment addresses the material topics, impacts, risks, and opportunities facing Dairy Producers in the United States.

Verification Objective

The objective of Averum's verification was to provide ICUSD with an independent assessment regarding:

- The conformance of ICUSD's materiality approach and assessment with the requirements of GRI Principles regarding materiality assessment.
- The conformance of ICUSD's materiality approach and assessment with the guidance provided in EFRG Implementation Guidance (IG1)
- A review of the utility provided by ICUSD's Materiality Assessment to Sustainable Dairy Partnership's Stage 3 regarding Materiality Assessments

Limits of our Verification

As the purpose of our engagement is to provide a verification of guidance implementation, the techniques, scope, and timing of our procedures are less than those required to obtain limited or reasonable assurance.

Our engagement does not provide any additional assessment of the relevance or appropriateness of the selections made by ICUSD regarding the selection of material topics, impacts, risk, or opportunities. Our verification does not include an assessment of any quantitative data relied upon in ICUSD's topic assessments.

Appendix D: External Verification Statement

AVERUM

Innovation Center for US Dairy – Verification Statement Letter

Our verification does allow us to express conclusions regarding ICUSD's process for assessment, analysis, and presentation of the selected topics included in the Materiality Assessment as they relate to the guidance and requirements of GRI, EFRAG, and the SDP as detailed in our verification objective.

Verification Activities

Our verification activities consisted of verifying the following:

- The processes defined and implemented by ICUSD to identify and assess the impacts, risks, and opportunities (IRO) relate to sustainability matters in accordance with implementation guidance provided by GRI and EFRAG.
- Additionally, the ranking and disclosure of selected material topics in ICUSD's Materiality Assessment are also in accordance with the implementation guidance provided by GRI and EFRAG.
- Supporting and constructive documentation allows ICUSD's Materiality Assessment to conform with implementation guidance provided by GRI and EFRAG.
- Stakeholder identification, outreach planning, surveys and interview notes are appropriately conducted in accordance with implementation guidance provided by GRI and EFRAG.
- Per topic analyses regarding impact and financial assessment have been conducted in accordance with implementation guidance provided by GRI and EFRAG.

Our verification consisted of activities to reinforce and support the findings of the verification team. Support activities included:

- Referencing and reviewing constructive materials from previous consultants, team members, responsible staff, and other stakeholders in the materiality assessment development process
- Reviewing additional external and objective evidence to determine if Innovation Center appropriately follows the guidance from GRI and EFRAG as applicable
- Reviewing the utility provided by the Innovation Center's materiality assessment to Sustainable Dairy Partnership members where appropriate and applicable
- Averum's verification team referred to the following documents as normative references:
  - GRI 3: Material Topics 2021
  - GRI's "Double materiality: The guiding principle for sustainability reporting"
  - EFRAG IG1: Materiality Assessment Implementation Guidance
  - ESRS 1: General Requirements & Application Requirements
  - ESRS 2: General Disclosures & Application Requirements
  - Sustainable Dairy Partnership (SDP) Requirement Document
  - SDP Annex A: Verification Guidelines

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AVERUM

Innovation Center for US Dairy – Verification Statement Letter

Conclusion

It is important to note that our engagement was limited to the criteria and procedures agreed upon and does not constitute an audit or review. Therefore, we do not express an opinion or assurance on the subject matter beyond the agreed upon criteria included.

Based on the procedures Averum performed during the verification engagement, we have not identified any material errors, omissions, or inconsistencies with the requirements and guidance provided by GRI and EFRAG in the processes and procedures conducted by Innovation Center for US Dairy's in preparing their 2025 Materiality Assessment.

Independence

Averum is an independent assurer of the specified information detailed in the scope of our engagement. Averum has not been responsible for the preparation of any part of the Materiality Assessment, nor have we undertaken any commissions that would conflict with our independence. Responsibility for producing the Materiality Assessment belongs to Innovation Center for US Dairy and their advisors.

We appreciate the collaboration and cooperation of the Innovation Center for US Dairy in providing access to the necessary information and resources for Averum to provide our Verification.

Matthew Armstrong
Verifier Name (Printed)

04/09/2025
Date (MM/DD/YYYY)

Matthew E. Armstrong
Verifier Signature

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Appendix E. Summary of Sources

The following lists highlights the types of information that informed the assessment and includes citations for those referenced within this report.

Dairy: National and regional/state level information

- **Past materiality assessment reports for U.S. dairy and resources referenced within them**
  1. Innovation Center for U.S. Dairy. (2019). U.S. Dairy Stewardship Commitment Materiality Assessment and Progress. https://www.usdairy.com/getmedia/9ae815f1-c547-4e93-91de-de1fa35baac5/U-S-Dairy-Stewardship-Commitment-Materiality-Assessment.pdf?ext=.pdf
  2. Innovation Center for U.S. Dairy. (2022). 2021 Materiality Assessment Report or U.S. Dairy. https://www.usdairy.com/getmedia/401760f2-2982-48ff-826a-e445799b947b/Materiality-Assessment-For-USDairy.pdf?ext=.pdf
- **U.S. dairy industry strategic priorities and commitments:** This information provides evidence of relative significance of topics.
- **U.S. dairy industry reports, resources and surveys**
  3. Bohnert, K. (2022). A Deep Dive into Workforce Issues Facing Dairy. Dairy Herd Management. https://www.dairyherd.com/news/labor/deep-dive-workforce-issues-facing-dairy
  4. Dairy Management Inc. (2024). Dairy Conservation Navigator. https://www.dairyconservation.org
  5. Feeding America. (2024). Dairy distribution in the Feeding America Network. Values are provided by Feeding America and reported during its fiscal year, July 1 to June 30, and they are published biennially in the U.S. Dairy Sustainability Reports.
  6. International Dairy Foods Association. (2023). U.S. Dairy Industry Adds 60K New Jobs and Higher Wages Driven by Growing Consumption and Immense Economic Returns to Local and Regional Communities. https://www.idfa.org/news/u-s-dairy-industry-adds-60k-new-jobs-and-higher-wages-driven-by-growing-consumption-and-immense-economic-returns-to-local-and-regional-communities
  7. International Dairy Foods Association. (2020). China Tariff Impact on U.S. Dairy. International Dairy Food Association. https://www.idfa.org/wordpress/wp-content/uploads/2020/03/china-tariff-impact-on-dairy.pdf
  8. International Dairy Foods Association. (2021). The economic impacts of dairy products. https://www.idfa.org/dairydelivers
  9. Innovation Center for U.S. Dairy. (2013). U.S. Dairy's Environmental Footprint. www.usdairy.com/getmedia/c9d3f013-c34c-42b4-9ee0-18885837bdc6/dairysenvironmentalfootprintbrochure%20july.pdf.pdf.aspx
  10. Innovation Center for U.S. Dairy. (2024). 2021-2022 U.S. Dairy Sustainability Report. https://2021-2022report.usdairy.com
  11. Innovation Center for U.S. Dairy. (2024). 2023 Processor Aggregate Data Report for the Stewardship Commitment for U.S. Dairy (internal). Results are publicly reported within the biennial U.S. Dairy Sustainability Report.
  12. Innovation Center for U.S. Dairy. (2024). Internal Health & Wellness report.
  13. National Dairy Council (2023). Dairy Nutrition Notebook. https://www.usdairy.com/getmedia/1ca923b5-3a02-48e7-871b-169c439f2994/Dairy-Nutrition-Notebook-2023.pdf?ext=.pdf
  14. National Milk Producers Federation. (2020). FARM Workforce Development Nationwide Labor Survey Report. https://nationaldairyfarm.com/wp-content/uploads/2020/07/Nationwide-Dairy-Labor-Survey_FARM-Workforce-Development.pdf
  15. National Milk Producers Federation. (2024). 2023 National Dairy FARM Program Year in Review. https://nationaldairyfarm.com/wp-content/uploads/2024/07/2023-YIR-Final-for-web.pdf
- **Legal and regulatory context:** The team reviewed the legal and regulatory context at the topic level, including impact/activity-level laws and regulations and mandatory disclosure rules within the U.S. (federal and state) and international markets for input on potential impacts, trends and implications on U.S. dairy exports.
  16. U.S. EPA. (2024). Regulatory and Guidance Information by Topic: Air. https://www.epa.gov/regulatory-information-topic/regulatory-and-guidance-information-topic-air
- **Federal government databases and reports:** Sources included those that aggregate by industry/sector (NAICS code) or product/food type. When the topic involved aspects that are regulated, reports of incidents of noncompliance and/or audit results were reviewed when available.
  17. Center for Dairy Research. (2024). College of Agricultural and Life Sciences, University of Wisconsin-Madison. 2024. Dairy Recall Tracker. https://www.cdr.wisc.edu/dairy-recall-tracker
  18. Centers for Disease Control and Prevention. (2010). Occupational injuries and deaths among younger workers-United States, 1998-2007. MMWR Morb Mortal Wkly Rep. 2010 Apr 23;59(15):449-55. PMID: 20414187
  19. Key, N., Sneeringer, S. and Marquardt, D. (2014). Climate change, heat stress, and US dairy production. USDA-ERS Economic Research Report, (175). https://ers.usda.gov/sites/default/files/_laserfiche/publications/45279/49164_err175.pdf?v=99511
  20. Rabbitt, M. P., Hales, L. J., Reed-Jones, M. (2024). The prevalence of food insecurity increased in 2023 compared with 2022. U.S. Department of Agriculture, Economic Research Service. https://www.ers.usda.gov/data-products/chart-gallery/chart-detail?chartId=58378
  21. University of Maryland, JIFSAN (2023). National Milk Drug Residue Database. Fiscal Year 2023 Annual Report (October 1, 2022 – September 30, 2023). https://www.nmdrd.com/fy-23.pdf
  22. USDA Food & Nutrition Services. (2024). FNS Nutrition Programs. https://www.fns.usda.gov/programs. Program reports available at the website were also reviewed.
  23. U.S. Bureau of Labor Statistics. (2024). Injuries, Illnesses, and Fatalities: Survey of Occupational Injuries and Illnesses Data. Survey of Occupational Injuries and Illnesses Data: U.S. Bureau of Labor Statistics. https://www.bls.gov/iif/nonfatal-injuries-and-illnesses-tables.htm. Review included Table 1. Incidence rates of nonfatal occupational injuries and illnesses by industry and case types, annual reports data by industry and Table A-1. Fatal occupational injuries by industry and event or exposure, all United States for Crop production/Oilseed and grain farming (1111), Dairy cattle and milk production (11212), Dairy product manufacturing (NAICS 311500).
  24. U.S. Bureau of Labor Statistics. (2023). Quarterly Census of Employment and Wages. Employment and Wages Data Viewer. https://data.bls.gov/cew/apps/data_views/data_views.htm#tab=Tables. Tables reviewed for 2023 annual averages, Private, All Counties, All establishment sizes, Industries: NAICS 3115 Dairy product manufacturing and NAICS 112120 Dairy cattle and milk production.
  25. U.S. Department of Agriculture, Economic Research Service. (2023). Cash receipts by state, commodity ranking and share of U.S. total, 2023 Nominal (current dollars). https://data.ers.usda.gov/reports.aspx?ID=17843
  26. U.S. Department of Agriculture, Economic Research Service. Milk Cost of Production data. https://www.ers.usda.gov/data-products/milk-cost-of-production-estimates. Calculation based on data from USDA, ERS and USDA, National Agricultural Statistics Service's Agricultural Resource Management Survey (ARMS) data. Survey base years are those in which a survey of producers was concluded. These years provide a baseline from which estimates in subsequent years are set. For further ARMS documentation, see USDA, ERS Commodity Costs and Returns Data Products website.

27. U.S. Department of Agriculture and U.S. Department of Health and Human Services. (2020). Dietary Guidelines for Americans, 2020-2025. 9th Edition. December 2020. https://www.dietaryguidelines.gov/sites/default/files/2021-03/Dietary_Guidelines_for_Americans-2020-2025.pdf

- **Scientific research publications, life cycle assessments and other studies**

28. Adams, C. et al. (2019). Five insights into the views and behaviors of the US dairy consumer. McKinsey & Company. https://www.mckinsey.com/industries/consumer-packaged-goods/our-insights/five-insights-into-the-views-and-behaviors-of-the-us-dairy-consumer
29. Capper, J. L., and R. A. Cady. (2020). The effects of improved performance in the U.S. dairy cattle industry on environmental impacts between 2007 and 2017. *Journal of Animal Science, Volume 98, Issue 1:1–14.* https://academic.oup.com/jas/article/98/1/skz291/5581976
30. de Ondarza, M.B. and J.M. Tricarico. (2021). A dataset of human-inedible byproduct feeds consumed by dairy cows in the United States, *Data in Brief*, Volume 38, 107358, ISSN 2352-3409. https://doi.org/10.1016/j.dib.2021.107358
31. Gillespie. J. (2023). Feed rations fed by US dairy producers. *J. Dairy Sci.* 106:8152–8168. https://doi.org/10.3168/jds.2023-23363
32. Henderson, A.D., Asselin-Balençon, A., Heller, M.C., Burek, J., Kim, D., Lessard, L., Margni, M., Saad, R., Matlock, M.D., Thoma, G. and Wang, Y. (2023). Spatialized life cycle assessment of fluid milk production and consumption in the United States. *Sustainability*, 15(3), p.1890
33. Nutter, D.W., Kim, D.S., Ulrich, R. and Thoma, G., (2013). Greenhouse gas emission analysis for USA fluid milk processing plants: Processing, packaging, and distribution. I*nternational Dairy Journal*, 31, pp.S57-S64
34. Panikkar, Bindu, and Mary-Kate Barrett. (2021). Precarious essential work, immigrant dairy farmworkers, and occupational health experiences in Vermont. International Journal of Environmental Research and Public Health, vol. 18, no. 7, Apr. 2021, p. 3675. https://doi.org/10.3390/ijerph18073675
35. Rotz, A., Stout, R., Leytem, A., Feyereisen, G., Waldrip, H., Thoma, G., Holly, M., Bjorneberg, D., Baker, J., Vadas, P. and Kleinman, P. (2021). Environmental assessment of United States dairy farms. *Journal of Cleaner Production*, 315, p.128153
36. Rotz, C.A., Beegle, D., Bernard, J.K., Leytem, A., Feyereisen, G., Hagevoort, R., Harrison, J., Aksland, G. and Thoma, G. (2024). Fifty years of environmental progress for United States dairy farms. *Journal of Dairy Science*, 107(6), pp.3651-3668. https://www.journalofdairyscience.org/article/S0022-0302(24)00010-9/fulltext
37. Thoma, G., Popp, J., Nutter, D., Shonnard, D., Ulrich, R., Matlock, M., Kim, D., Neiderman, Z., Kemper, N., East, C., & Adom, F. (2013). Greenhouse gas emissions from milk production and consumption in the United States: A cradle-to-grave life cycle assessment circa 2008. *International Dairy Journal, 31, Supplement 1.* https://doi.org/10.1016/j.idairyj.2012.08.013
38. Uddin, M.E., Tricarico, J.M. and Kebreab, E. (2022). Impact of nitrate and 3-nitrooxypropanol on the carbon footprints of milk from cattle produced in confined-feeding systems across regions in the United States: A life cycle analysis. *Journal of Dairy Science*, 105(6), pp.5074-5083. https://doi.org/10.3168/jds.2021-20988

Dairy organization-level and incident-level information

- **Annual reports/10Ks:** Disclosures of dairy/food companies on topics deemed as material risks to the business, which provide evidence of financial materiality
- **Published sustainability reports of U.S. dairy companies**
- **Individual occurrences or summary reports:** Information provided supporting evidence of actual impacts when industry-wide data was not readily available.

39. Polaris. 2021. Polaris Analysis of 2020 Data from the National Human Trafficking Hotline. https://polarisproject.org/wp-content/uploads/2022/01/Polaris-Analysis-of-2020-Data-from-the-National-Human-Trafficking-Hotline.pdf
40. U.S. Occupational Health and Safety Administration. 2024. Establishment Search: OSHA Inspections within Industry. https://www.osha.gov/ords/imis/establishment.html

- **Legal cases,** including analysis of litigation trends, provided evidence of occurrence of actual impacts and insights into potential impacts and risks associated with noncompliance and other violations

41. Baay, D., Rawlinson, M. and Machado, K. 2024. Navigating The New Rise of Greenwashing Litigation. Law360. https://www.law360.com/articles/1854670/navigating-the-new-rise-of-greenwashing-litigation

- **Reports from advocacy organizations and initiatives**
- **Public service and investigative journalism:** Information provided evidence of actual and potential adverse impacts and brought in voices and perspectives of affected stakeholders.

Agriculture/livestock/food processing/food and beverage

- **Published data and reports**

42. Bigelow, Daniel, Allison Borchers, and Todd Hubbs. (2016). U.S. Farmland Ownership, Tenure, and Transfer, EIB-161, U.S. Department of Agriculture, Economic Research Service. http://www.ers.usda.gov/publications/pub-details?pubid=74675
43. U.S. Centers for Disease Control and Prevention. (2024). Food Safety: People at Increased Risk for Food Poisoning. https://www.cdc.gov/food-safety/risk-factors/index.html
44. U.S. Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health (2024). Agriculture Worker Safety and Health. https://www.cdc.gov/niosh/agriculture/about/?CDC_AAref_Val=https://www.cdc.gov/niosh/topics/aginjury/pubs.html
45. U.S. Department of Agriculture. (n.d.). Agriculture-Driven Deforestation in the United States: Data Assessment. https://www.usda.gov/sites/default/files/documents/USDA-Assessment-of-Ag-driven-Deforestation.pdf
46. U.S. Food and Drug Administration. (2024). Keeping your milk safe from the grass to the glass. https://www.fda.gov/consumers/consumer-updates/keeping-your-milk-safe-grass-glass

- **Academic research and other research publications**

47. Beaupied, B.L., Martinez, H., Martenies, S., McConnel, C.S., Pollack, I.B., Giardina, D., Fischer, E.V., Jathar, S., Duncan, C.G. and Magzamen, S. (2022). Cows as canaries: The effects of ambient air pollution exposure on milk production and somatic cell count in dairy cows. Environmental Research, 207, p.112197
48. Freedgood, J., M. Hunter, J. Dempsey, A. Sorensen. (2020). Farms Under Threat: The State of the States. Washington, DC: American Farmland Trust. https://farmlandinfo.org/wp-content/uploads/sites/2/2020/09/AFT_FUT_StateoftheStates_rev.pdf

- **Reports from advocacy organizations and external initiatives**

49. AccountAbility. (2015). AA1000 Stakeholder Engagement Standard. https://www.accountability.org/standards/aa1000-stakeholder-engagement
50. FoodPrint. (2020). The FoodPrint of Food Packaging. https://foodprint.org/wp-content/uploads/2020/09/2020_09_22_FP_FoodPackagingReport_5FINAL.pdf
51. KnowTheChain. 2023 Food & Beverage Benchmark Report. https://media.business-humanrights.org/media/documents/KTC_2023_FB_Benchmark_Report_Oct_23.pdf. Searchable results: https://knowthechain.org/benchmark/

- **SASB Standards** for relevent sectors and the associated Basis of Conclusion documents and related information for input on financial materiality

52. Sustainability Accounting Standards Board (2018). SASB Standards Basis of Conclusion for Processed Foods.

53. Sustainability Accounting Standards Board. (2020). Preliminary Framework on Human Capital and the SASB Standards. https://sasb.ifrs.org/wp-content/uploads/2020/12/Human-Capital_Preliminary-Framework_2020-December_FINAL.pdf

National and global-level research and information

- **Scientific research**

54. Bolster, C.H., R. Mitchell, A. Kitts, A. Campbell, M. Cosh, T.L. Farrigan, A.J. Franzluebbers, D.L. Hoover, V.L. Jin, D.E. Peck, M.R. Schmer, and M.D. Smith (2023). Ch. 11. Agriculture, food systems, and rural communities. In: Fifth National Climate Assessment. Crimmins, A.R., C.W. Avery, D.R. Easterling, K.E. Kunkel, B.C. Stewart, and T.K. Maycock, Eds. U.S. Global Change Research Program, Washington, DC, USA. https://doi.org/10.7930/NCA5.2023.CH11

55. Domingo, N.G., Balasubramanian, S., Thakrar, S.K., Clark, M.A., Adams, P.J., Marshall, J.D., Muller, N.Z., Pandis, S.N., Polasky, S., Robinson, A.L. and Tessum, C.W. (2021). Air quality–related health damages of food. Proceedings of the National Academy of Sciences, 118(20), p.e2013637118

56. Drouin-Chartier, JP, Brassard, D, Tessier-Grenier, M, et al. Systematic review of the association between dairy product consumption and risk of cardiovascular-related clinical outcomes. Adv Nutr. 2016;7(6):1026-1040. Published 2016 Nov 15. doi:10.3945/an.115.011403.

57. Food and Agriculture Organization of the United Nations. (2023). Contribution of terrestrial animal source food to healthy diets for improved nutrition and health outcomes – An evidence and policy overview on the state of knowledge and gaps. Rome, FAO. https://doi.org/10.4060/cc3912en

58. Hess, JM, Stephensen, CB, Kratz, M, Bolling, BW. (2021). Exploring the links between diet and inflammation: Dairy foods as case studies. Adv Nutr. 2021;12(Suppl 1):1S-13S. https://doi:10.1093/advances/nmab108

59. Hsiang, S., S. Greenhill, J. Martinich, M. Grasso, R.M. Schuster, L. Barrage, D.B. Diaz, H. Hong, C. Kousky, T. Phan, M.C. Sarofim, W. Schlenker, B. Simon, and S.E. Sneeringer. (2023). Ch. 19. Economics. In: Fifth National Climate Assessment. Crimmins, A.R., C.W. Avery, D.R. Easterling, K.E. Kunkel, B.C. Stewart, and T.K. Maycock, Eds. U.S. Global Change Research Program, Washington, DC, USA. https://doi.org/10.7930/NCA5.2023.CH19

60. Intergovernmental Panel on Climate Change (2022). Climate Change 2022: Impacts, Adaptation, and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [H.-O. Pörtner, D.C. Roberts, M. Tignor, E.S. Poloczanska, K. Mintenbeck, A. Alegría, M. Craig, S. Langsdorf, S. Löschke, V. Möller, A. Okem, B. Rama (eds.)]. Cambridge University Press. Cambridge University Press, Cambridge, UK and New York, NY, USA, 3056 pp., https://doi:10.1017/9781009325844

61. Marvel, K., W. Su, R. Delgado, S. Aarons, A. Chatterjee, M.E. Garcia, Z. Hausfather, K. Hayhoe, D.A. Hence, E.B. Jewett, A. Robel, D. Singh, A. Tripati, and R.S. Vose (2023). Ch. 2. Climate trends. In: Fifth National Climate Assessment. Crimmins, A.R., C.W. Avery, D.R. Easterling, K.E. Kunkel, B.C. Stewart, and T.K. Maycock, Eds. U.S. Global Change Research Program, Washington, DC, USA. https://doi.org/10.7930/NCA5.2023.CH2

62. Thaler, E.A., Kwang, J.S., Quirk, B.J., Quarrier, C.L. and Larsen, I.J. (2022). Rates of historical anthropogenic soil erosion in the midwestern United States. Earth's Future, 10(3), p.e2021EF002396

63. Tschofen, P., Azevedo, I.L. and Muller, N.Z. (2019). Fine particulate matter damages and value added in the US economy. Proceedings of the National Academy of Sciences, 116(40), pp.19857-19862

64. Uludere Aragon, N., Xie, Y., Bigelow, D., Lark, T.J. and Eagle, A.J. (2024). The realistic potential of soil carbon sequestration in US croplands for climate mitigation. Earth's Future, 12(6), p.e2023EF003866

65. U.S. Environmental Protection Agency. (2016). Office of Water and Office of Research and Development. National Rivers and Streams Assessment 2008-2009: A Collaborative Survey (EPA/841/R-16/007). https://www.epa.gov/sites/default/files/2016-03/documents/nrsa_0809_march_2_final.pdf

66. U.S. Environmental Protection Agency. (2018). National Emissions Inventory (Version 2 Technical Support Document, US Environmental Protection Agency, Research Triangle Park, NC, 2018). https://www.epa.gov/sites/production/files/2018-07/documents/nei2014v2_tsd_05jul2018.pdf

67. U.S. Environmental Protection Agency. (2024). Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2022. EPA 430-R-24-004. https://www.epa.gov/ghgemissions/inventory-us-greenhouse-gas-emissions-and-sinks-1990-2022

68. Weiskopf, S.R., Rubenstein, M.A., Crozier, L.G., Gaichas, S., Griffis, R., Halofsky, J.E., Hyde, K.J., Morelli, T.L., Morisette, J.T., Muñoz, R.C. and Pershing, A.J. (2020). Climate change effects on biodiversity, ecosystems, ecosystem services, and natural resource management in the United States. Science of the Total Environment, 733, p.137782

69. Wallace, TC, Bailey, RL, Lappe, J, et al. (2020). Dairy intake and bone health across the lifespan: a systematic review and expert narrative [published online ahead of print, 2020 Sep 14]. Crit Rev Food Sci Nutr. 2020;1-47

70. Warziniack, T., Arabi, M., Brown, T.C., Froemke, P., Ghosh, R., Rasmussen, S. and Swartzentruber, R. (2022). Projections of freshwater use in the United States under climate change. Earth's Future, 10(2), p.e2021EF002222

71. West, J.J., C.G. Nolte, M.L. Bell, A.M. Fiore, P.G. Georgopoulos, J.J. Hess, L.J. Mickley, S.M. O'Neill, J.R. Pierce, R.W. Pinder, S. Pusede, D.T. Shindell, and S.M. Wilson (2023). Ch. 14. Air quality. In: Fifth National Climate Assessment. Crimmins, A.R., C.W. Avery, D.R. Easterling, K.E. Kunkel, B.C. Stewart, and T.K. Maycock, Eds. U.S. Global Change Research Program, Washington, DC, USA. https://doi.org/10.7930/NCA5.2023.CH14

72. Zamuda, C.D., D.E. Bilello, J. Carmack, X.J. Davis, R.A. Efroymson, K.M. Goff, T. Hong, A. Karimjee, D.H. Loughlin, S. Upchurch, and N. Voisin. (2023). Ch. 5. Energy supply, delivery, and demand. In: Fifth National Climate Assessment. Crimmins, A.R., C.W. Avery, D.R. Easterling, K.E. Kunkel, B.C. Stewart, and T.K. Maycock, Eds. U.S. Global Change Research Program, Washington, DC, USA.

- **International agreements and conventions**

General topic-level information

73. Albrecht, S. L., Green, C. R., and Marty, A. (2021). Meaningful Work, Job Resources, and Employee Engagement. Sustainability, 13(7), 4045. https://doi.org/10.3390/su13074045

74. Bose, S. (2022). Economic impacts to consumers from extended producer responsibility (EPR) regulation in the consumer packaged goods sector. Policy Brief. https://academiccommons.columbia.edu/doi/10.7916/n2af-vv87

75. EY. (2024). Technical Line: A closer look at California's recently enacted climate disclosure laws. https://www.ey.com/content/dam/ey-unified-site/ey-com/en-us/technical/accountinglink/documents/ey-tl21228-231us-09-30-2024.pdf

76. Feber, D., Goel, A., Nordigården, D., and Ponkshe, S. (2023). Sustainability in packaging: US survey insights. McKinsey & Company. https://www.mckinsey.com/industries/packaging-and-paper/our-insights/sustainability-in-packaging-us-survey-insights

77. Federal Bureau of Investigation. (2023). Internet Crime Report. Internet Crime Compliant Center. https://www.ic3.gov/AnnualReport/Reports/2023_IC3Report.pdf

78. Greene, J.M., Wallace, J., Williams, R.B., Leytem, A.B., Bock, B.R., McCully, M., Kaffka, S.R., Rotz, C.A. and Quinn, J.C. (2024). National greenhouse gas emission reduction poten-tial from adopting anaerobic digestion on large-scale dairy farms in the United States. Environmental Science & Technology, 58(28), pp.12409-12419

79. Hamilton, Neil D. (n.d.). How Land Tenure Will Shape the Future of U.S. Agriculture. Drake University Law School. www.usda.gov/sites/default/files/documents/Hamilton.pdf

80. Harter, J., Tatel, C. E., Agrawal, S., Blue, A., Plowman, S., Asplund, J., Yu,S., and Kemp, A. (2024). The Relationship Between Engagement at Work and Organizational Outcomes: Q12® Meta-Analysis: 11th Edition. Gallup. https://www.gallup.com/workplace/321725/gallup-q12-meta-analysis-report.aspx
81. Hernández, D.L., Vallano, D.M., Zavaleta, E.S., Tzankova, Z., Pasari, J.R., Weiss, S., Selmants, P.C. and Morozumi, C. (2016). Nitrogen pollution is linked to US listed species declines. BioScience, 66(3), pp.213-222. https://doi.org/10.1093/biosci/biw003
82. Hussain, Malik Altaf and Dawson, Christopher O. (2013). Economic Impact of Food Safety Outbreaks on Food Businesses. Foods 2013, 2, 585-589; doi:10.3390/foods2040585
83. Lakhan, C. (2021). Modeling impact on consumer packaged goods pricing resulting from the adoption of Extended Producer Responsibility in New York State. York University. https://wastewiki.info.yorku.ca/files/2021/06/New-York-State-EPR-Modeling-Revised-1.pdf?x63676
84. Momblanco, H., Aiuto, K. and Huckins, S. (2024). Overview of GHG Protocol Integration in Regulatory Climate Disclosure Rules. https://ghgprotocol.org/sites/default/files/2024-03/GHG-Protocol-Integration.pdf
85. NRDC (Natural Resources Defense Council). (2021). Soil Erosion 101. https://www.nrdc.org/stories/soil-erosion-101#what-is
86. Source Intelligence (2024). *Packaging EPR laws in the U.S*. https://blog.sourceintelligence.com/packaging-epr-laws-in-the-us
87. Sustainability Accounting Standards Board. (2020). Preliminary Framework on Human Capital and the SASB Standards. https://sasb.ifrs.org/wp-content/uploads/2020/12/Human-Capital_Preliminary-Framework_2020-December_FINAL.pdf
88. U.S. Department of Agriculture. (n.d.). *A renewed focus on soil carbon*. https://www.climatehubs.usda.gov/hubs/northeast/topic/renewed-focus-soil-carbon
89. U.S. Environmental Protection Agency. (2024). Containers and Packaging: Product-Specific Data. https://www.epa.gov/facts-and-figures-about-materials-waste-and-recycling/containers-and-packaging-product-specific
90. U.S. Environmental Protection Agency. (2024). Regulatory and Guidance Information by Topic: Air. https://www.epa.gov/regulatory-information-topic/regulatory-and-guidance-information-topic-air
91. Rabbitt, M., Hales, L. and Reed-Jones, M. (2024). USDA Economic Research Service. The prevalence of food insecurity increased in 2023 compared with 2022. https://www.ers.usda.gov/data-products/ag-and-food-statistics-charting-the-essentials/food-security-and-nutrition-assistance
92. U.S. Food & Drug Administration. (2024). *GMO crops and food for animals*. https://www.fda.gov/food/agricultural-biotechnology/gmo-crops-and-food-animals
93. U.S. Food & Drug Administration. (2024). How GMO crops impact our world. https://www.fda.gov/food/agricultural-biotechnology/how-gmo-crops-impact-our-world
94. U.S. Food & Drug Administration. (2024). *Nutrition, food labeling, and critical foods.* https://www.fda.gov/food/nutrition-food-labeling-and-critical-foods

INNOVATION CENTER FOR U.S. DAIRY

HEALTHY PEOPLE • HEALTHY PRODUCTS • HEALTHY PLANET