Nutrition and management implications of the U.S. dairy 2050 environmental stewardship goals and net zero initiative for bovine practitioners

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Abstract

U.S. dairy collectively commits to achieve greenhouse gas neutrality, optimize water use while maximizing recycling, and improve water quality by optimizing utilization of manure and nutrients by 2050. The farm and field strategy to achieve these goals is termed the Net Zero Initiative. Enteric methane mitigation is a key area of focus for the 2050 Environmental Stewardship Goals and the Net Zero Initiative that is relevant to the dairy management and nutrition fields. Bovine practitioners have various critical roles to support the dairy value chain in making progress toward the 2050 environmental stewardship goals due to their focus on promoting cattle health, welfare and productivity. Bovine practitioners will contribute greatly to enteric methane mitigation and the evaluation of nutritional interventions to mitigate methane. Therefore, bovine practitioners need to better understand and articulate the environmental value animal and feed management options provide in addition to nutritional contributions, health status and cost savings.

Key words: GHG emissions, enteric methane, mitigation options

Introduction

In 2008, the U.S. dairy industry was the first in the food agricultural sector to conduct a full life cycle assessment at a national scale.[1] Since then, the U.S. dairy community has built a collaborative effort that unites the assets and expertise of trade, professional and industry organizations to create a path forward. The Innovation Center for U.S. Dairy® (Innovation Center) is a leadership forum that brings together the dairy community and third parties to address the changing needs and expectations of consumers and customers. Initiated in 2008 by dairy farmers through the dairy check-off, Innovation Center leaders and members collaborate on important areas like the environment, nutrition and health, animal care, food safety and community contributions. Through the Innovation Center, the U.S. dairy community demonstrates its commitment to continuous improvement from farm to table, striving to ensure a socially responsible and economically viable dairy community. For the past decade, the Innovation Center has led efforts to help the dairy community understand and manage its most significant social, environmental and economic impacts. The Innovation Center developed the U.S. Dairy Stewardship Commitment (Stewardship Commitment) (**https://www.usdairy.com/about-us/innovation-center/stewardship-commitment**) to support dairy farmers, cooperatives and processors who voluntarily choose to work across the industry to advance sustainability leadership and transparently report progress. Retailers and other dairy buyers can adopt and use the Stewardship Commitment to track their suppliers' sustainability and continuous improvement efforts and are encouraged to share this story with consumers.

The Innovation Center, in consultation with industry and external stakeholders, developed the first national materiality assessment for U.S. dairy (**https://www.usdairy.com/getmedia/9ae815f1-c547-4e93-91de-de1fa35baac5/U-S-Dairy-Stewardship-Commitment-Materiality-Assessment.pdf?ext=.pdf**) to substantiate industry-wide priorities and to serve as a guide to individual companies as they identify their own priorities. The materiality assessment was first published in May 2019 and applied GRI Sustainability Reporting Standards principles. The assessment considered 3 key items. First, the impact dairy production has on social, environmental, and economic factors. Second, the importance of sustainability to stakeholders for informing their assessments and decisions. And third, the degree of operational control those dairy farmers, cooperatives and processors have over sustainability. The results are summarized in a materiality matrix with 2 thresholds for materiality. Topics falling beyond the first threshold, set at 2.5, are material for reporting, while topics beyond the upper threshold, which is set at 4.5, represent the highest-rated priorities, which are: Product Safety and Quality, Health and Nutrition, GHG Emissions, Animal Care, Water Quality, Water Conservation and Nutrient Management. The materiality assessment results have been used in many beneficial ways to inform and support industry efforts, such as the prioritization of national goal setting, including the 2050 Environmental Stewardship Goals.

2050 environmental stewardship goals

Setting industry-wide goals helps accelerate collective action. Following a year-long consultation process and more than 12 years of collaborative action on environmental topics, the Innovation Center announced an ambitious new vision of dairy as an environmental solution, with goals in areas where dairy collectively has the greatest impact. The environmental stewardship voluntary and collective goals are to 1) achieve greenhouse gas (GHG) neutrality, 2) optimize water use while maximizing recycling and 3) improve water quality by optimizing utilization of manure and nutrients by 2050. As collective goals, not every farm, cooperative or processor is expected to reach these goals individually, but together the industry can leverage its diversity to meet them collectively. These goals will help dairy build upon and quantify industry progress toward its vision to be an environmental solution.

The 2050 environmental stewardship goals (**https://www.usdairy.com/sustainability/environmental-sustainability**) build on a decades-long commitment to producing nutritious dairy foods that can sustainably feed a growing global population. Representative leadership across the dairy value chain, including farmers, cooperatives, processors, retailers and other stakeholders, led the 2050 Environmental Stewardship Goals development process, which included an extensive stakeholder and public comment period. The 2050 Environmental Stewardship Goals encompass the field, dairy farm and processing stages of the supply chain collectively and represent the industry's commitment to reducing GHG footprint and water impacts. The goals focus on the most pressing areas of environmental sustainability and are consistent with the 2019 materiality assessment and the U.S. Dairy Stewardship Commitment.

Progress against each of the 2050 environmental stewardship goals will be reported out every 5 years, beginning in 2025. This reporting will not only document progress but also identify technological and other advancements that can accelerate improvements, enabling nimble adaptation and focus on what can be scaled for maximum impact. The industry's comprehensive GHG accounting, and reporting guidance was thoroughly reviewed and recently endorsed by the World Resources Institute.

The U.S. dairy community is leveraging advances in technologies and practices and working to make these innovations accessible and affordable for farmers and companies. Dairy companies and farms across the country are already contributing to the goals individually, and the U.S. Dairy Stewardship Commitment helps the industry document and demonstrate social responsibility efforts. Additional metrics will be developed through the Stewardship Commitment as needed to track progress.

The U.S. dairy community is working together to identify multiple economically viable pathways for reaching these goals collectively, leveraging the strength of U.S. dairy's diversity in size, region and practice. Initially, these strategies include: 1) attracting investment and partners to ignite new technology and innovation, 2) creating new revenue sources such as manure-based product development and ecosystem services markets, 3) expanding science-based research and data collection that closes knowledge gaps, improves analysis and advances practices and technologies that reduce environmental impact in dairy production, and 4) increasing the utilization and expansion of best practices, resources and tools for farmers, cooperatives and processors.

Net Zero Initiative

The U.S. Dairy Net Zero Initiative (NZI) (**https://www.usdairy.com/getmedia/89d4ec9b-0944-4c1d-90d2-15e85ec75622/Game-Changer-Net-Zero-Initiative.pdf?ext=.pdf**) is an industry-wide collaboration with key stakeholders to help farmers collectively achieve the 2050 Environmental Stewardship Goals by making sustainable practices and technologies more accessible and affordable to U.S. dairy farms of all sizes and geographies.

The initiative is led by 6 U.S. dairy organizations working on behalf of their member constituents: Dairy Management Inc., Innovation Center for U.S. Dairy®, International Dairy Foods Association, National Milk Producers Federation, Newtrient and U.S. Dairy Export Council®. The initiative also includes Nestlé and Starbucks as corporate partners and The Foundation for Food & Agriculture Research, the Soil Health Institute and The Nature Conservancy, along with leading dairy research institutions, as project partners.

The intention of NZI is addressing barriers and investing in research and partnerships to make it more accessible and economically viable for farms of all sizes and geographies to adopt practices and technologies that can provide environmental benefits on the farm, in the field and within the broader community. At the same time, these efforts will advance new revenue streams such as clean energy and carbon sequestration. The primary expected outcomes of NZI include: 1) the collective U.S. dairy industry advances toward carbon neutrality and significant improvements in water use and quality, 2) in addition to nutrient-dense foods and beverages, dairy farms provide products and services that enable other industries and communities to be more sustainable, and 3) farmers can realize untapped value on the farm, making the system of continuous improvement self-sustaining.

Success requires addressing the affordability of technology and practice solutions, closing the gaps on data and research for more quantifiable outcomes, and making solutions accessible to farms of all sizes to scale. This is achievable through research, on-farm pilots, development of manure-based products and ecosystem markets, and other farmer technical support and opportunities. There are 3 distinct workstreams within NZI to organize the collaborative efforts on research (Groundwork), on-farm demonstration (Dairy Scale for Good) and reporting the positive impact of adopting solutions (Collective Impact). Groundwork research provides foundational scientific evidence and knowledge, fills in data gaps, improves the models used to estimate environmental outcomes, and identifies areas for largest potential benefits. Dairy Scale for Good is focused on implementing the full suite of best practices and technologies on 3-5 farms across the country to prove the economic viability of reaching GHG neutrality on-farm. Collective Impact will support broad, voluntary farmer adoption of proven best practices and technologies. An industry-wide network will share the positive collective impact that farms of varying geographies, sizes and capabilities are making on the environment to support learning and adoption.

The U.S. Dairy Net Zero Initiative concentrates on 4 key areas to reduce dairy's environmental footprint, while delivering benefits on farms and beyond. The 4 key areas of focus are: 1) feed production and agronomic practice changes, 2) enteric methane reduction, 3) manure handling and nutrient management, and 4) on-farm energy efficiency and renewable energy use.

Implications for bovine practitioners

Bovine practitioners have a critical role to play for the U.S. dairy community to achieve the collective environmental stewardship goals by 2050 since they work to promote cattle health, welfare, and productivity. Through their actions focused on managing animal health, wellbeing, and their productive and reproductive status, bovine practitioners contribute to nutrient use efficiency, nutrient excretion and enteric methane emissions.

Feeding balanced diets reduce dairy farm GHG emissions

Feeding balanced diets have already contributed significantly to historical reductions in farm-gate GHG emissions intensity (g of methane per unit of milk produced) simply by formulating balanced rations that meet nutrient requirements for growth and lactation and promote health and reproductive success.[2-3] Many of the nutrition and feeding management practices that contributed to these historical reductions are described in the online resource "Considerations and Resources on Feed and Animal Management" (**https://nationaldairyfarm.com/wp-content/uploads/2018/10/ConsiderationsResourcesOnFeedAnimalMgt.pdf**) published by the Innovation Center in 2014. Over 40 dairy professionals from industry and academia contributed to the report. The easy-to-use manual also includes

257 supporting resources that are accessible by hyperlinks for those seeking additional information. This resource continues to serve as an important tool for 1) dairy farmers and their advisors working to improve dairy cattle efficiency and health, 2) academic and government researchers and educators interested in sustainability and dairy nutrition research, 3) undergraduate and graduate curricula (and textbook) in dairy science and nutrition, 4) agriculture journalists and media as a background source or primary content of a dairy management article emphasizing best practices, and 5) dairy co-ops, processors and brands for an easy one-stop, science-based resource to validate specific examples of best management practices on U.S. dairy farms. It serves as the trusted resource for users of the Farmers Assuring Responsible Management – Environmental Stewardship (FARM-ES) (**https://nationaldairyfarm.com/dairy-farm-standards/environmental-stewardship/**) program and a basis for Chapters 3, 4 and 5 of its *Environmental Stewardship Continuous Improvement Reference Manual* (**https://nationaldairyfarm.com/wp-content/uploads/2018/10/ES-Reference-Manual.pdf**). This resource will continue to provide important guidance in the future for practicing nutritionists whose objectives are to improve business value for dairy farmers while reducing enteric methane emissions intensity.

Improving feed efficiency reduces GHG emissions and improves nutrient use

Developing and implementing nutrition and feeding programs that focus on improving feed efficiency also represent an opportunity for bovine practitioners to contribute to enteric methane mitigation intensity reductions.[4] Anywhere between 4 to 10% of the cow's gross energy intake is lost as methane.[5] An evaluation of 20 energy metabolism studies with 579 lactating dairy cows concluded that high milk yield and high energetic efficiency reduce enteric methane energy losses as a proportion of energy intake.[6] Reducing GHG emissions associated with cropping is an additional benefit of improving feed efficiency. Increasing milk production per cow resulted in greater net returns to management and lower GHG emissions intensity using a simulation model of a representative Wisconsin dairy farm over a 25-year period.[7] More recently, a simulated case study using the animal module of the Ruminant Farm Systems (RuFaS) Model and estimated reductions in enteric methane emissions between 5.8% and 11.9% for high (at 16 percentile of present-day efficiencies) and very high (at 2.5 percentile of present-day efficiency) feed efficiency improvements.[8] On-farm measures of feed efficiency can be useful instruments to identify improvement opportunities and evaluate changes in nutrition and management to simultaneously increase feed efficiency and reduce GHG emissions in individual dairy operations.[9]

Byproduct feeds provide nutritional, economic and environmental benefits

Balanced dairy cattle rations include substantial amounts and a wide variety of byproduct feeds. These byproduct feeds represent effective vehicles to recycle valuable nutrients in agricultural crop processing streams that are either indigestible by humans or undesirable for direct human consumption into milk and dairy foods. Since byproduct feeds are substituted for forages and grains in dairy cattle diets, minimal long-term emissions of enteric methane and manure methane and nitrous oxide are generated by this practice.[10] This study reported that, on average, 70 g of CO2-eq per kg of byproduct feed DM are emitted when byproduct feeds partially replace forages and whole grains in U.S. milking cow diets. The study also reported that avoided GHG emissions from most alternative disposal methods are even greater since landfill disposal, composting, and combustion emit 3,448,328, and 31 g of CO2-eq per kg of byproduct DM. Bovine practitioners will need to better understand and articulate the environmental value byproduct feeds provide in balanced dairy cattle rations beyond nutrient supply and costs savings as they help farmers adopt new nutrition and feeding programs to make progress towards the 2050 Environmental Stewardship Goals.

Models to balance dairy rations need to support production, profitability and environmental objectives

Mitigating enteric methane emissions without limiting the supply of nutrients to dairy animals and reducing their performance while maintaining, and preferably increasing, profitability is an important challenge that practicing bovine practitioners will face more often in the future. The application of models to improve the sustainability of the dairy industry has frequently focused on minimizing mineral and nitrogen excretion. The Cornell Net Carbohydrate and Protein System (CNCPS) version 6.5 included extant equations to add the capacity to predict enteric methane and carbon dioxide emissions at the animal level.[11] Two case studies were later used to demonstrate how the CNCPS can be used to reduce nitrogen and phosphorous excretion and evaluate enteric methane and carbon dioxide emissions by modifying nutrient formulations.[12]

Mathematical models can also be useful to determine the costs associated with methane mitigation through nutritional interventions. A study showed that mitigating methane emissions by dietary manipulation to meet environmental policies, such as a tax or a constraint on emissions, may be expensive.[13] Therefore, it is valuable to develop models capable of trade-off analysis that allow identifying dairy cattle diets that generate reduced amounts of methane without compromising milk production at the lowest cost. An optimization framework was developed for the joint minimization of dietary costs and methane emissions that provides the decision maker the opportunity to select the desired ration according to current feed prices and methane emission reduction targets.[14] The modeling optimization framework sequentially applies an equation to predict methane emissions, 2 linear programming models to minimize dietary costs and methane emissions, and a weighted goal programming model to identify a set of feasible solutions representing various levels of trade-off between diet costs and methane emissions. Application of this optimization framework using 2013 data from dairies in the California Central Valley produced a set of 12 distinct solutions with methane ranging from 17.9 to 21.6 MJ/cow x day and diet costs ranging from $5.95 to $7.31 per cow x day. Calculated methane mitigation costs expressed per ton of CO2-equivalents ranged from $127 to $23,119. Clearly, bovine practitioners will have to evaluate and formulate diets that support production, profitability and environmental objectives to make progress towards the 2050 Environmental Stewardship Goals.

Bovine practitioners need to provide guidance and best practices to evaluate methane inhibitors

Bovine practitioners will also have an important role to play as new enteric methane inhibitors, primarily in the form of feed additives, enter the marketplace. Feed additives are commonly included in diary diets to improve feed-use efficiency, animal health and performance, and milk composition and quality. Development of feed additives that mitigate enteric methane emissions has been a very active area of research during the last decade. The scientific evidence for feed additives with potential for mitigating enteric methane emissions from cattle is growing actively with new information becoming available almost every week. A recent article reviewed primarily in vivo data to provide a concise summary of feed additives currently available, or in development, that offer potential to reduce methane emissions from ruminants.[15] This review summarized the available information on mode of action, efficacy, safety and readiness for adoption of various anti-methanogenic feed additives. Average reductions in enteric methane between 3 and 104 grams per day (1 to 48%) resulting from cattle feed supplementation are documented in this review. These reductions exemplify the potential promise that feed additives represent for enteric methane mitigation, NZI, and making progress toward the 2050 Environmental Stewardship Goals.

The difference between potential and actual enteric methane mitigation rests on the possibilities for dairy farmers to include these additives in dairy cattle feed. Mitigating enteric methane is not the only requirement for dietary inclusion. Including these feed supplements in balanced cattle diets requires other considerations. For example, the U.S. food industry can't risk exchanging greenhouse gas reductions for decreased food productivity within the current scenario of growing global food demand; rather, the challenge is to do more with less on both fronts. Successful feed supplements must provide both enteric methane mitigation and production benefits, or at least an acceptable trade-off between these 2 outcomes. Furthermore, either potential or known animal, food and/or environmental safety risks are associated with some feed supplements.[15] These potential and known risks need to be further characterized and managed to increase the chances for feed additives inclusion in dairy diets. Finally, the practical aspects of feed additives use by dairy farmers, such as ease of use and availability, also need consideration to turn potential into actual enteric methane reductions.

Solid evidence is needed to ensure feed additives effectively reduce enteric methane with sustained and positive outcomes on various other attributes important throughout the dairy value chains. It will be only through value chain collaboration and partnerships that the main challenges facing the adoption of feed additives to mitigate enteric methane will be solved. The Innovation Center identified at least 3 challenges that need to be addressed by the dairy value chain: 1) more research is needed because the current quality of evidence for enteric methane mitigation by feed additives varies widely; 2) methane-reducing feed additives must be economically advantageous for dairy producers, either enhancing milk or meat production and efficiency; and 3) feed additives must ensure consumer safety and cow health.

The Innovation Center already started conversations within the dairy value chain on the considerations listed above. For example, a stakeholder panel discussed how the dairy value chain – producers, co-ops and associations, scientists, feed companies and food processors – share common goals and can take action to align on a "wish list" of desired attributes and standards for evaluating feed additives and supplements for environment, economic, productivity, cow health and human safety considerations. The main goal of this effort is to provide guidance to the dairy value chain that instills confidence and best decision-making for broad adoption of effective, enteric methane-reducing interventions. Bovine practitioners will need to contribute to this guidance and become familiar with the best practices to evaluate feed additives marketed for enteric methane mitigation and other environmental benefits.

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