National dairy research programs: what is their role in animal health and sustainability research?

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ABSTRACT
The US dairy industry has made great strides in improving animal health over many decades, which has driven substantial improvements in economic, social, and environmental sustainability. As consumer and corporate focus on climate continues to grow, the continued need to research and improve animal health and understand its connection with the environment is integral to the success of the dairy industry. Research to address these areas can be supported by national research programs and collaboration between them. The USDA and Dairy Management Inc established a collaborative research agreement in 2007; to date, this collaboration has not explicitly focused on animal health or its intersection with the environment. It is integral to the success of animal agriculture in an ever-changing sustainability landscape that animal health is addressed as a key piece of socioeconomic and environmental sustainability. An academic-industry stakeholder committee reached a consensus that supported this idea and identified that it is equally important to communicate these research findings with consumers in a way that resonates. The purpose of this Viewpoint article is to highlight that national research programs at the USDA Agricultural Research Service’s National Animal Disease Center and Dairy Management Inc can and should play an important role in supporting and facilitating research at the intersection of animal health and sustainability broadly.

Keywords: animal health, sustainability, research collaboration, stakeholder, sustainable dairy

Introduction
The dairy industry has fought for years to overcome a common consumer perception that it is responsible for a disproportionate share of environmental impact, including greenhouse gas (GHG) emissions, nutrient management, water use, and land use. This perception is one of the biggest obstacles in expanding and protecting markets among consumers who are increasingly making purchase decisions based on considerations around environmental outcomes. Investing in research at the intersection of environmental outcomes and animal health improves farm viability and demonstrates to the public that the dairy industry is committed to animal welfare and reducing environmental impacts, both critical to maintaining trust and sales.

Current Connections Between Animal Health and Socioeconomic and Environmental Sustainability
Animal health is an area that is central to dairy farming as it is essential for high productivity and important to consumers in its role in animal welfare, but its impacts on environmental sustainability are just beginning to be investigated. Globally, a 10% decrease in livestock disease incidence is estimated to reduce GHG emissions by 800 million metric tons, and for every percentage point that dairy-cattle disease rates decrease, milk production increases enough to meet the nutritional/food-security needs of 80 million people. Initial modeling has shown that prevalent diseases (including mastitis and lameness)
and reproductive-efficiency improvements can have a substantial impact on GHG emissions.\textsuperscript{5} Research from the Wageningen group has shown that for every case of lameness, emissions per unit of milk (ie, kilograms of fat- and protein-corrected milk) increased by 1.5%. For mastitis, the first time it occurs in a cow is associated with an increase in emissions of over 6% per unit of milk, with emissions per unit almost doubling for cows that experience 3 or more cases of mastitis.\textsuperscript{7} Given that mastitis and lameness are the 2 most prevalent diseases in the dairy industry both in the US and globally, continued research on these areas of animal health (prevention, diagnosis, disease pathophysiology, etc) and further investigation of their impacts on the carbon footprint of dairy production are warranted.\textsuperscript{8,9}

For other dairy cow health issues, the situation is even less clear. Some research suggests that cow longevity (the lifespan of an individual milking cow) is an indicator of health and welfare, as well as economic and environmental sustainability. However, herd longevity (the average lifespan of the population) is driven simply by the number of replacements available.\textsuperscript{10} Given the inverse relationship between herd longevity and milk production when examining country-level differences, available data indicate that a higher replacement rate can be associated with better welfare, management, and economic and environmental sustainability. Replacement rates can increase when cows are healthy enough to become pregnant efficiently and a moderate excess of heifers is available, allowing for more proactive replacement based on phenotypic decisions (milk production), even in healthy cows.\textsuperscript{11} Therefore, all else equal, a higher replacement rate could be an opportunity for improved sustainability, from both the economic and environmental lens. Further research that clarifies the push versus pull of dairy cow replacement rates and their impact on food production efficiency is needed.

When considering cow longevity, reproductive failure is the most common reason an individual dairy cow leaves the herd.\textsuperscript{12-14} Therefore, the opportunity to improve reproductive performance and reduce the need to replace otherwise productive animals has the potential to improve environmental outcomes.\textsuperscript{15} There is also increasing evidence that heat stress and other climatic changes have clinically relevant impacts on dairy cows and are likely to become greater issues in much of the US in the coming years.\textsuperscript{16,17} Clearly, there are many questions about the impacts of animal health on environmental sustainability and there remains a sizable need for research to address these questions.

Historically, the US has invested extensive resources in animal disease diagnosis, treatment, and prevention. However, these are often overlooked as techniques for mitigating climate change, and it is important that future efforts focus on investigating opportunities to optimize the socioeconomic and environmental sustainability of the food system. It is imperative that federal agencies and other organizations continue rigorous research programs on animal health and begin to dig deeper into understanding the relationship between animal health and sustainability. National research programs, including those at the USDA Agricultural Research Service’s National Animal Disease Center (USDA/ARS-NADC) and Dairy Management Inc (DMI), are well positioned to support and facilitate animal health research and elucidate its intersections with environmental sustainability.

**Stakeholder Committee Meeting Objectives and Outcomes**

On June 22, 2023, representative scientists from the USDA/ARS-NADC and the DMI Environmental Research Team met with an 8-member external stakeholder committee of dairy health experts (Dr. Gerard Cramer, University of Minnesota; Dr. Kendra Wells, Valley Veterinary Clinic; Dr. Kelly Reed, Diamond V; Dr. Sarah Overby, Minnesota Veterinary Associates; Mariah Busta, Midwest Dairy; Dr. Pamela Ruegg, Michigan State University; Dr. Geoffrey Dahl, University of Florida; Dr. Patrick Gorden, Iowa State University) who came from academia, industry, and private practice at the USDA/ARS-NADC facility in Ames, Iowa. The purpose of their meeting was to discuss research priorities and create a plan for research that contributes to an improved understanding of animal health in the dairy industry, including its role in environmental sustainability. Animal-sourced foods contribute to a sustainable food system by providing economic viability, providing broad benefits to society through access to nutrient-rich foods at affordable prices, and sustaining the environment utilizing human-inedible ingredients to create nutritious foods, contributing to the circularity of nutrients. Animal health is key to this sustainable food system because healthy animals, specifically healthy dairy cows, efficiently meet critical key nutritional needs of Americans in supplying 13 essential nutrients.\textsuperscript{18}

Through this convening, the specific objectives of the meeting were as follows:

1. Understand and share the current state of dairy animal health research taking place at USDA/ARS-NADC and the plan for research in the upcoming 2 to 5 years
2. Discuss and identify gaps in animal health research and potential emerging topics (including animal health’s role in environmental sustainability)
3. Determine prioritization of dairy animal health research projects that present opportunities for collaboration between the USDA/ARS-NADC and DMI and that meet the needs of the US dairy industry

To achieve the previously mentioned objectives, an experienced facilitator joined the group to promote collaborative dialogue among meeting participants within 3 facilitated breakout groups focusing on (1) which dairy research areas should be “preserved,” describing those research areas and topics that continue to be important for the industry; (2) which ar-
The primary outcomes of the stakeholder meeting included recommendations to focus on highly prevalent diseases including mastitis and lameness (Table 1) and to begin to conduct research that investigates and quantifies the relationship between socioeconomic and environmental sustainability and the health and management of dairy cows (Table 2). The attendees also discussed that the economic pillar of sustainability should not be excluded from this research and that, while animal health and environmental impacts are important to uncover, the economic implications must also be included.

Following the outcomes of the stakeholder meeting, this Viewpoint article is meant to communicate that national research programs can play a vital role in animal health and sustainability research, focusing on economic, environmental, and social/welfare outcomes as they relate to dairy animal health. It also stresses the role of national research programs in communicating research findings with broad stakeholders and supporting the development of future research in these areas.

### Opportunities to Financially Support Animal Health and Sustainability Research

Dairy Management Inc and the USDA/ARS-NADC can collaborate on the importance of this research as they can each focus on research programs that improve the industry. Dairy Management Inc cannot support research that increases milk production but can support research that improves consumer trust in the US dairy industry. As environmental, economic, and social topics become increasingly relevant in sustainability conversations as they relate to the health and care of dairy animals, DMI has the opportunity to financially and scientifically support this research. Dairy Management Inc also has the ability to partner with outside organizations, including not-for-profit and for-profit corporations, through the creation of research consortia or other private-public partnerships to support research that might otherwise be financially risky for individual academicians or farmers to implement. These private-public partnerships can reduce the risk and burden of innovating or implementing unproven technology. USDA/ARS-NADC

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**Table 1**—Stakeholder feedback for current USDA Agricultural Research Service’s National Animal Disease Center research topics.

<table>
<thead>
<tr>
<th>Preserve</th>
<th>Refocus</th>
<th>Enhance/add</th>
</tr>
</thead>
<tbody>
<tr>
<td>Johnes</td>
<td>Johnes</td>
<td>Explore the impact on longevity</td>
</tr>
<tr>
<td>1964 herd</td>
<td>Evaluate whether further progress is needed</td>
<td>Broaden industry connections to the application of discoveries from the 1964 herd</td>
</tr>
<tr>
<td>Mastitis</td>
<td>Consider alternative reproductive practices</td>
<td>Related to today’s genetics and how deficiencies can be improved</td>
</tr>
<tr>
<td>Mastitis</td>
<td>Focus on control of more prevalent pathogens (gram-positive cocci, <em>Klebsiella</em> spp, and <em>Prototheca bosis</em>)</td>
<td>Control and prevention research (nonantimicrobials)</td>
</tr>
<tr>
<td>Lameness</td>
<td>Emphasize/educate others on the economic importance of this disease</td>
<td>Focus on emerging pathogens (gram-positive cocci, <em>Klebsiella</em> spp, and <em>P. bosis</em>)</td>
</tr>
<tr>
<td>Leptospirosis</td>
<td>Identify genes related to disease resistance and improved immunity</td>
<td>Economic impact of management include trade-offs of environmentally sustainable practices with udder health</td>
</tr>
<tr>
<td>Leptospirosis</td>
<td>Identify measurable indicators of welfare</td>
<td>Address noninfectious agents causes</td>
</tr>
<tr>
<td>Leptospirosis</td>
<td>Improve alternatives to antibiotic therapy</td>
<td>Identify prevention strategies and treatments in dairy-cross animals</td>
</tr>
<tr>
<td>Leptospirosis</td>
<td>Emphasize/educate others on the economic importance of this disease</td>
<td></td>
</tr>
<tr>
<td>Leptospirosis</td>
<td>Nonantimicrobial treatments</td>
<td></td>
</tr>
<tr>
<td>Leptospirosis</td>
<td>Broaden research from dairy reproductive disease to include public health</td>
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</tbody>
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**Table 2**—Research topics to add to animal health and sustainability research pillars.

<table>
<thead>
<tr>
<th>Animal welfare</th>
<th><em>Salmonella</em> spp</th>
<th>Immune function</th>
<th>Calf health and growth</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Identify measurable indicators of welfare</td>
<td>Prevention and treatment of <em>Salmonella dublin</em></td>
<td>Impact of climate change on immune function</td>
<td>Investigate impacts of calf respiratory disease on environmental impact</td>
</tr>
<tr>
<td>2 Determine link between welfare, milk production, and longevity</td>
<td>Prevention and treatment of other <em>Salmonella</em> spp impacting dairy cows</td>
<td>Improve resiliency of dairy cows to climate change</td>
<td>Quantify socioeconomic and environmental impacts of prevention and treatment of calf respiratory disease</td>
</tr>
<tr>
<td>3 Research longevity—economic, environmental, and social impacts</td>
<td></td>
<td></td>
<td>Identify and quantify other factors that impact calf health and socioeconomic and environmental sustainability</td>
</tr>
</tbody>
</table>
is unique in its ability to support long-term projects that academics who are seeking grant funding cannot easily pursue. Sustainability research, especially environmental-impact sustainability research that might span generations of dairy cows, is exactly the type of research that could be supported by long-term funding programs like those at the USDA or DMI.

Role of National Research Programs in Supporting Capacity Building

Other points raised during the discussion included the need to maintain a long-term research strategy and coordinated approach, as well as a need for capacity building within the dairy industry to support animal health. Capacity building could include but is not limited to the following: recruiting and training individuals at all levels of the industry about appropriate animal health and handling, creating and enabling internships and student training, and supporting the next generation of scientists. National research programs have the unique opportunity to support budding scientists through the support of graduate students and postdoctoral candidates with an interest in researching how animal health intersects with economic, social, and/or environmental sustainability.

Another important area that national research programs can support is financial backing for new faculty who conduct research aligned with the intersection of animal health and sustainability. Dairy Management Inc can pursue an effort to support new (tenure-track, but not yet tenured) faculty by partnering with organizations including the Foundation for Food and Agriculture to assist in funding the New Innovator Program. Another route is to hold a research-prioritization convening directed toward new faculty that will fund projects aiming to quantify the interrelationships and impacts of dairy health and management with socioeconomic and environmental sustainability. All of the aforementioned ideas are ways national research programs can support both their scientific objectives and capacity building in research at the intersection of animal health and sustainability.

Conclusions

There is a large opportunity for DMI and the USDA/ARS-NADC to support research at the intersection of animal health and socioeconomic and environmental sustainability, as there is very little research on the connection between these topics. The academic-industry stakeholder committee meeting at the USDA/ARS-NADC facility provided a means for researchers and veterinarians to gain insights from each other and for the USDA and DMI to receive recommendations on potential areas for collaborative research to improve the understanding of animal health in the dairy sector. The stakeholder meeting marked the start of a renewed partnership between the USDA and DMI focusing specifically on animal health. It is vital that the sustainability of the dairy food system is researched, focusing on animal health, as this priority area is important to producers and consumers. National research programs, especially those housed at DMI, have the opportunity to engage early-career scientists, building interest and capacity on these topics for decades to come, which will be integral to continued progress.

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Disclosures

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References


