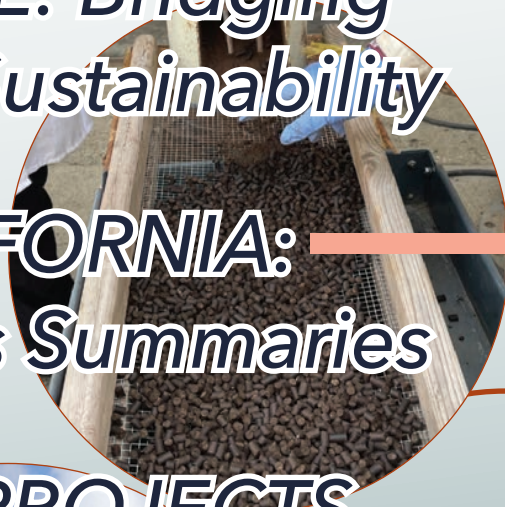
ANNUAL PROJECTS REPORT

CALIFORNIA DAIRY RESEARCH FOUNDATION
Science for a Sustainable Future

JULY 2025 - JUNE 2026

WHO WE ARE: Bridging Nutrition and Sustainability



FOCUS ON CALIFORNIA: Completed Projects Summaries

CURRENT PROJECTS PORTFOLIO: Science That Delivers Solutions for California

DIRECTOR'S NOTE

DENISE MULLINAX
EXECUTIVE DIRECTOR

California dairy continues to evolve, shaped by new expectations, new technologies, and new opportunities.

It's my pleasure to share this year's annual project report and highlight the many ways research, innovation, and collaboration are helping California dairy address today's challenges while creating opportunities for the future.

In an ever-changing world, one thing remains constant: the importance of credible science in decision making. CDRF is committed to ensuring California dairy producers have access to the research, innovation, and practical tools they need to remain competitive, resilient, and sustainable.

That commitment guides everything we do. Our investments span nutrition and human health, environmental stewardship, animal care, workforce development, and innovation—areas that are increasingly connected and critical to the future of California dairy.

This year's research generated valuable insights across every focus area.

Nutrition and food science projects reinforced dairy's role in healthy dietary patterns while opening new possibilities for product innovation and added value. Environmental research advanced practical strategies for nutrient management, methane reduction, and emerging technologies that can help producers meet future sustainability goals. Together, these projects are generating science-based solutions that strengthen California dairy and create benefits across the entire value chain.

Collaboration remains at the heart of everything CDRF does. Our progress depends on producers, processors, researchers, universities, public agencies, industry organizations, and funding partners working toward shared goals. Those partnerships not only advance research—they help ensure new discoveries become practical solutions that deliver real value on California dairies and throughout the dairy community.

That collaborative spirit was on full display throughout the year at industry meetings, conferences, farm visits, and countless Zoom meetings and phone conversations. Every conversation created an opportunity to exchange ideas, learn from one another, and build stronger connections. It's a reminder that meaningful progress rarely happens alone—it comes from people bringing different perspectives together to solve challenges and seize new opportunities.

Thank you to our Board of Directors for their leadership and guidance, along with the many producers, researchers, funding partners, and industry collaborators whose commitment makes this work possible. Their expertise and support allows CDRF to continue investing in research and programs that strengthen California dairy's leadership in nutrition, innovation, and sustainability.

We hope this report gives you a meaningful look at what we've accomplished together over the past year—and the opportunities still ahead.

Sincerely,

Denise Mullinax

WHO WE ARE

SPOTLIGHT on Kevin Comerford, Ph.D., Bridging Nutrition and Sustainability

KEVIN COMERFORD, PH.D.
CHIEF SCIENCE OFFICER

As Chief Science Officer at the California Dairy Research Foundation (CDRF), Dr. Kevin Comerford helps guide research and science-based programs that support an innovative and sustainable California dairy industry. With a doctorate in Nutritional Biology from UC Davis, a postdoctoral fellowship at the UC Davis Medical Center, and more than 30 peer-reviewed publications, his work spans human health, environmental stewardship, innovation, and food systems research.

Since joining CDRF in 2013, Comerford has managed our diverse portfolio of research projects focused on supporting environmental sustainability, strengthening dairy's role in healthy diets, and identifying new opportunities for the industry. His role includes helping shape research priorities, evaluating project proposals, monitoring scientific progress, and ensuring research findings are translated into information that producers, processors, policymakers, health professionals, and consumers can use.

Comerford's own research has focused on the role of dairy foods in human health, including nutrient adequacy, healthy dietary patterns, nutrition security, maternal and child health, and the dairy food matrix. His work has helped demonstrate how dairy foods contribute essential nutrients in a cost-effective way and has informed discussions around dietary guidance, sustainability, and health equity. This research perspective helps ensure that CDRF's investments continue to generate credible scientific evidence while identifying opportunities that strengthen dairy's value to consumers and society.

Through research leadership, scientific collaboration, and industry engagement—including production of CDRF's monthly Dairy Research Bulletin and service on multiple scientific advisory committees—Comerford helps connect emerging science with real-world opportunities. His work supports the development of solutions that are not only scientifically sound, but also practical, scalable, and relevant to California dairy producers as they continue to meet evolving consumer, environmental, and marketplace expectations.

BOARD LEADERSHIP

CDRF's Board of Directors brings together leaders from every corner of California's dairy community—from dairy farmers and processors to experts in nutrition, sustainability, dairy promotion, and consumer outreach. That diversity of experience helps ensure our research and programs reflect the real-world needs of the industry while keeping an eye on the opportunities ahead.

With perspectives spanning the dairy value chain, Board members help guide research investments that address the needs of California dairy producers while creating benefits that strengthen the industry's long-term success.

RECOGNIZING DEDICATED SERVICE AND WELCOMING NEW VOICES

This year, we celebrated the retirement and service of longtime Board member Dante Migliazzo, whose leadership helped guide CDRF through years of growth and strategic change. His thoughtful approach, industry knowledge, and commitment to collaboration left a lasting mark on the Foundation, and the Board was proud to recognize his many contributions. As Dante shared in his farewell remarks, the work of CDRF is as important as ever, and he emphasized the value of continuing strong California Milk Advisory Board representation on the Board.

We also welcomed two new directors whose experience reflects the broad expertise that makes CDRF's Board so effective. Stephanie Borba, succeeding Dante as the California Milk Advisory Board representative, is a California dairy farmer with a background in nutrition and consumer health. Amy DeLisio, CEO of Dairy Council of California, adds extensive experience in nutrition education, public health, and community engagement, further strengthening the Board's diverse expertise.

The Board also elected a new slate of officers for the coming year. New officer, Sietse "Sean" Tollenaar, a California dairy farmer, was elected Treasurer, adding another experienced producer to CDRF's leadership team. Josh Zonneveld remains Chairman; Jared Fernandes remains Vice Chairman; and Chuck Ahlem remains Secretary.

The CDRF Board of Directors' combined experience, ideas, and commitment help guide CDRF's work to advance research, support innovation, and create lasting value for dairy farmers, processors, and consumers alike.

2026 BOARD OF DIRECTORS

Josh Zonneveld: CA Dairy Farmer, Chairman

Jared Fernandes: CA Dairy Farmer, Vice Chairman

Sietse 'Sean' Tollenaar: CA Dairy Farmer, Treasurer

Chuck Ahlem: CA Dairy Farmer, Processor, Secretary

Michelle Slimko, DrPH, RDN: Dairy Management Inc.

Dixie Martinho: California Dairies Inc.

Bob Carroll: CEO California Milk Advisory Board

Amy Delisio, MPH, RDN: CEO Dairy Council of California

Stephanie Borba: CA Dairy Farmer, CMAB Representative

CONTACT US

Denise Mullinax,
Executive Director
mullinax @cdrf.org

Kevin Comerford, Ph.D.
kbcomerford@cdrf.org

Kimberly Yarris
yarris@cdrf.org

2020 Research Park Dr.,
Suite 110
Davis, CA 95618

FOCUS ON CALIFORNIA

FUELING INNOVATION FOR A SUSTAINABLE, RESILIENT DAIRY INDUSTRY

A thriving dairy industry depends on science. That belief lies at the heart of the California Dairy Research Foundation (CDRF), a nonprofit organization that has advanced research, innovation, and producer education for more than 35 years.

As a producer-led, 501(c)(3) research management organization, CDRF brings together dairy producers, industry leaders, researchers, and partners to address the evolving opportunities and challenges facing California dairy. By investing in practical, science-based research and sharing those findings with producers and stakeholders, CDRF helps strengthen the long-term success of California's dairy industry.

RESEARCH POWERED BY PRODUCERS

CDRF is primarily funded through the California Milk Advisory Board (CMAB), using California dairy producer checkoff dollars that are leveraged with grants and partnerships to maximize the impact of every research investment.

INDUSTRY EXPERTS PROVIDE INPUT

CDRF is supported by advisory committees focused on environmental management, animal welfare and social responsibility, and food science, human health, and nutrition. These committees bring together producers, researchers, and industry experts to provide technical expertise, identify knowledge gaps, explore emerging issues, and help ensure CDRF's research remains relevant and responsive to the needs of California dairy.

FIVE STRATEGIC FOCUS AREAS

CDRF's work is guided by five strategic priorities:

- Environmental Management
- Social Responsibility
- Food Science, Nutrition and Health
- Industry Development and Educational Outreach
- Innovation and Technology

Many CDRF projects address multiple focus areas, reflecting the interconnected nature of today's dairy industry and the Foundation's commitment to delivering meaningful, science-based solutions.

COMPLETED PROJECTS

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7 Characterization of Milk Fat Globules in Beta Serum and Buttermilk, Impact of Processing, Utilization

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CURRENT PROJECTS

19 - 27 CDRF's 2026 Projects Portfolio

COMPLETED PROJECT

Analysis of Dairy Fats Creates New Opportunities for Health, Nutrition, and Dairy Product Innovation

Food Science, Nutrition and Health

A HIDDEN WORLD OF LIPIDS INSIDE DAIRY FOODS

More than ever, consumers are hearing about the potential health benefits of full-fat dairy foods. At the same time, scientists are discovering that dairy fat is far more complex than previously understood. Most nutrition research has traditionally focused on a relatively small number of fatty acids in dairy foods, leaving many questions unanswered about the hundreds of other lipid-based compounds that naturally occur in whole milk, yogurt, cheese, kefir, butter, and cream.

That knowledge gap matters because emerging research suggests that dairy foods may have health effects that cannot be explained by total fat content alone. Understanding exactly what is present in dairy fat could help researchers better explain these findings and uncover new opportunities for improving nutrition and health.

To address this question, researchers at the University of California, Davis, with support from the California Dairy Research Foundation, conducted one of the most detailed analyses of dairy fats ever performed. Rather than focusing only on traditional fatty acids, the study examined a much broader range of lipids, including triglycerides, phospholipids, sphingolipids, and bacterial fermentation-derived compounds known as cyclopropane fatty acids.

The research team analyzed 184 commercially available dairy products across 11 categories, including milk, yogurt, butter, cottage cheese, cream cheese, cheddar, and other dairy foods commonly consumed by consumers.

The results revealed that dairy foods contain hundreds of distinct lipid compounds, many of which remain largely uncharacterized. Researchers found that each product category had its own unique lipid profile while also sharing a common set of abundant fats found across dairy foods. One particularly important finding was the identification of bacterial-derived cyclopropane fatty acids and other unique lipid signatures associated with fermented dairy products. These compounds may help researchers better understand why foods such as yogurt and cheese are consistently linked to favorable health outcomes in nutrition studies.

NEW DISCOVERIES COULD SHAPE THE FUTURE OF DAIRY NUTRITION

Beyond expanding scientific knowledge, the research creates new opportunities for the dairy industry. The findings may help scientists develop better lipid-based biomarkers that more accurately measure dairy consumption in nutrition studies. They could also help identify previously unknown bioactive lipids that contribute to health and support the development of future dairy products designed to deliver specific nutrition and health benefits.

For California's dairy industry, the study reinforces the value of continued investment in dairy science and nutrition research. As consumer interest in full-fat dairy continues to grow, a deeper understanding of dairy's unique composition can help support product innovation, strengthen nutrition science, and provide new insights into the role dairy foods play in healthy diets.

Overall, the project shows that dairy fat is far more complex than once believed. By creating one of the most comprehensive dairy lipid datasets available, researchers have laid the groundwork for future discoveries that could reshape how dairy fats are understood, evaluated, and utilized in nutrition and food science.

Dairy Fats as Healthy Fats: Interactions with the Gut Microbiota*
Dr. Sean Adams, UC Davis, School of Medicine

**This project is funded in partnership with National Dairy Council.*

KEY TAKE AWAYS

- **The findings create new opportunities for nutrition science and dairy innovation.**
- **Researchers uncovered a previously hidden diversity of fats in dairy foods.**
- **Each dairy product exhibited a distinct lipid fingerprint.**

COMPLETED PROJECT

Research Identifies Buttermilk as a Promising Dairy Co-Product for Future Nutrition and Health Applications

Food Science, Nutrition and Health

TURNING DAIRY CO-PRODUCTS INTO HIGH-VALUE NUTRITION INGREDIENTS

Dairy processors generate a variety of co-products during butter and cream production, but many of these streams have received relatively little attention compared with more established dairy ingredients. A recent project conducted at the University of California, Davis is helping change that by evaluating whether these materials could serve as sources of valuable health-promoting compounds.

The research focused on milk fat globule membrane (MFGM), a naturally occurring component of milk that contains an array of bioactive compounds associated with brain development, gut health and immune function. MFGM has become an increasingly important ingredient in infant nutrition products and other specialty foods, creating interest in identifying new dairy-based sources of this milk-derived component.

The project examined several co-products generated during butter and cream production, including buttermilk, butter serum, beta serum and alpha serum. Researchers worked with California dairy processors to collect samples and evaluate their composition, consistency, and potential for future ingredient development.

BUTTERMILK SHOWS STRONG POTENTIAL FOR FUTURE INNOVATION

The study found that all of the dairy streams evaluated contained beneficial bioactive components, although their composition varied. Among the products studied, buttermilk emerged as a particularly promising candidate because it consistently contained desirable bioactive compounds while demonstrating relatively stable composition across different processors and production batches.

Researchers noted that buttermilk offers practical advantages as well. It is produced in substantial volumes, is already routinely dried into powder, and has existing infrastructure that could support future development of value-added ingredients.

The project also highlighted opportunities to better utilize dairy streams that are currently underexplored. While whey-derived ingredients have traditionally been the primary source of commercial MFGM products, the findings suggest that butter and other milk fat processing streams may offer additional pathways for recovering valuable nutritional compounds.

Beyond characterizing the composition of these materials, the project examined how processing influences the concentration and recovery of MFGM components. Understanding these relationships may help identify future technologies and processing approaches that could increase the value of dairy co-products while creating new market opportunities.

Growing interest in functional foods is creating new opportunities for dairy co-products. This research is building the knowledge base needed to transform these materials into high-value ingredients for new products and markets.

Characterization of Milk Fat Globules in Beta Serum and Buttermilk, Impact of Processing, Utilization*
Dr. Daniela Barile, UC Davis

**This project is funded by the California Dairy Innovation Center*

KEY TAKE AWAYS

- **Identified processing opportunities that could improve recovery of bioactive MFGM components and expand market potential.**
- **Researchers identified buttermilk as a promising dairy co-product for future ingredient development.**
- **The project highlighted opportunities to create additional value from existing dairy streams.**

COMPLETED PROJECT

Translating Research and Helping Milk Science Reach People Around the World

Food Science, Nutrition and Health - Industry Development and Educational Outreach

MAKING MILK SCIENCE ACCESSIBLE TO EVERYONE

Milk is one of the most studied foods in the world, yet much of the research never reaches the people who could benefit from it most. Scientific findings, published in technical journals, can be difficult for producers, health professionals, educators, policymakers, and consumers to access or interpret.

Milk science is advancing rapidly, as researchers continue to uncover new insights into how dairy foods support healthy eating patterns, improves childhood growth and development, and reduces disease risk. Helping people understand these discoveries is important for California's dairy industry because it builds consumer confidence, encourages product innovation, and increases appreciation for the nutritional benefits of dairy foods.

TRANSLATING RESEARCH INTO REAL-WORLD IMPACT

To make this research more accessible, the International Milk Genomics Consortium (IMGC), with support from the California Dairy Research Foundation, translates complex science into practical information through its bi-monthly SPLASH! Milk Science Update, scientific workshops, conferences, and other educational outreach activities.

Founded in 2004, the IMGC brings together scientists from around the world who study milk, lactation, dairy foods, nutrition, immunology, microbiology, genomics, and human health. The consortium's goal is not only to advance research but also to make new discoveries understandable and useful beyond the scientific community.

One of its most visible tools is SPLASH!, which translates peer-reviewed research into short, accessible articles for broad audiences. Recent topics have explored how maternal diet and genetics influence milk composition, how milk antibodies interact with the gut microbiome, and how dairy components may support brain health, immune function, and nutrition. The publication has become a valuable resource for sharing milk science worldwide.

With a searchable archive containing hundreds of articles and annual readership exceeding 200,000 people, SPLASH! helps bring current milk research to audiences who may never read a scientific journal.

The consortium also supports scientific collaboration through its annual symposium and educational events, where researchers and industry leaders share discoveries and identify opportunities for innovation. These efforts help accelerate research while strengthening connections between science and real-world applications.

Overall, the project demonstrates that scientific discovery is only part of the equation. Through SPLASH! and its broader educational efforts, the IMGC continues to strengthen understanding of milk science while connecting researchers, industry leaders, health professionals, and consumers around the world.

Visit milkgenomics.org to access SPLASH! Milk Science Update and other outreach materials from the IMGC.

SPLASH! Milk Science Update*
Dr. Carl Whithaus, UC Davis

**This project is managed by CDRF and funded by the IMGC through its sponsors.*

KEY TAKE AWAYS

- **New discoveries are improving our understanding of how milk supports nutritional needs and lifelong wellness, creating opportunities for innovation across the dairy industry.**
- **The IMGC communications make milk and dairy science easier to understand.**
- **The consortium helps connect researchers and industry leaders globally–strengthening dairy's future.**

COMPLETED PROJECT

Yogurt Consumption Supports Healthy Aging and Provides New Insights for Gut Health Research

Food Science, Nutrition and Health

As people age, maintaining adequate protein and calcium intake becomes increasingly important for preserving muscle mass, bone strength, and overall health. Yet many older adults fall short of recommended intakes for these nutrients, increasing their risk of conditions such as osteoporosis and age-related muscle loss.

At the same time, interest in yogurt and other fermented foods continues to grow because of their potential benefits for digestive and immune health. However, researchers still have much to learn about how yogurt affects the gut and whether regular consumption can influence the body's natural immune defenses.

To better understand these questions, researchers at the University of California, Davis—supported by the California Dairy Research Foundation and National Dairy Council—conducted a clinical study evaluating the effects of yogurt consumption in adults between the ages of 50 and 75 years. Participants consumed two servings of conventional dairy yogurt each day for three weeks while researchers monitored dietary intake, digestive health, stool characteristics, and markers of gut immune function.

A SIMPLE WAY TO BOOST KEY NUTRIENTS FOR HEALTHY AGING

The first finding was straightforward: participants liked the yogurt and consistently consumed it. Adherence exceeded 95%, and researchers found no significant changes in gastrointestinal symptoms or stool consistency during the study. This suggests that adding two servings of yogurt per day is a practical dietary strategy for improving dairy food consumption among many older adults.

The nutritional benefits were even more significant. Daily protein intake increased by approximately 15 grams, while calcium intake increased by more than 600 milligrams per day. Both are especially important as people age because they help support muscle maintenance and bone health.

Researchers also examined whether yogurt consumption could strengthen mucosal immunity, an important defense system that helps protect the gastrointestinal tract from pathogens. The study did not find significant changes in two key markers of mucosal immune function during the three-week intervention. However, researchers noted that the participants were generally healthy and lactose tolerant, and that longer-term studies may be needed to better understand yogurt's effects on gut and immune health.

For consumers and the dairy industry, the findings reinforce yogurt's value as a nutrient-dense food that can help older adults improve overall dietary quality. The research also provides a foundation for future studies exploring how yogurt interacts with the gut microbiome and immune system.

LAYING THE GROUNDWORK FOR FUTURE GUT HEALTH RESEARCH

Overall, the study showed that consuming two servings of yogurt per day is a simple and effective way for older adults to increase intake of protein and calcium without causing digestive discomfort. While additional research is needed to better understand yogurt's role in gut immunity, the findings add to growing evidence that yogurt can support healthy aging.

The Effect of Yogurt on Mucosal Immunity in the Gastrointestinal Tract*
Dr. Danielle Lemay, USDA ARS

**This project is funded in partnership with National Dairy Council.*

KEY TAKE AWAYS

- **The study provides important new evidence to guide future yogurt and gut health research.**
- **Yogurt was highly acceptable and well tolerated by older adults.**
- **Yogurt significantly improved intake of key nutrients for healthy aging.**

COMPLETED PROJECT

Tricolored Blackbird Research in California: Helping to Improve Conservation Programs for Participating Dairy Producers

Social Responsibility - Industry Development & Educational Outreach

PARTNERSHIPS PROTECT BIRDS WHILE SUPPORTING DAIRY FARMS

The Tricolored Blackbird is one of California's most vulnerable bird species, and increasingly, it depends on dairy silage fields for nesting habitat. That creates a unique challenge for dairy producers because nesting often occurs at the same time fields are ready to harvest. Protecting nesting birds can require delaying harvest, which can impact forage quality, feed inventories, and farm economics.

Finding solutions that work for both wildlife and agriculture is especially important in California, where dairy farms provide some of the most important remaining natural habitat for multiple species. Without producer participation, many nesting Tricolor colonies would have few suitable places to breed successfully. At the same time, conservation efforts must recognize the operational and financial realities facing dairy farms.

To better understand what is working and where improvements are needed, a coalition of dairy organizations, conservation groups, researchers, and public agencies evaluated the effectiveness of California's Tricolored Blackbird conservation efforts. The project examined conservation outcomes, economic impacts on producers, and future strategies to reduce conflicts between bird nesting and forage production.

Researchers analyzed monitoring data and found that coordinated conservation programs have dramatically improved outcomes. Before organized partnerships and incentive programs were established, less than half of monitored colonies were successfully protected. Since 2015, approximately 93% of monitored colonies and 96% of nesting attempts in dairy silage fields have been successfully conserved.

A major focus of the project was understanding the economic impact on participating producers. Delaying harvest can reduce forage quality, require replacement feed purchases, and create management challenges.

The study provided the first comprehensive framework for estimating these costs, helping conservation partners improve compensation programs and strengthen long-term producer participation.

Researchers also explored alternative habitats that could reduce future conflicts. One promising area involves cover crops that may provide suitable nesting habitat while reducing harvest delays in silage fields.

Overall, the project provides strong evidence that collaborative conservation is working. Dairy producers and conservation partners have created a model that supports both agricultural sustainability and wildlife recovery. The results offer an encouraging example of how California agriculture can address environmental challenges while continuing to produce food and support rural communities.

Protection, Restoration, and Enhancement of Tricolored Blackbird Habitat*
PROJECT LEADS: Audubon California, California Farm Bureau, Dairy Cares, Western United Dairies, and others

**Audubon California has partnered with dairy organizations, conservation groups, and several farmer-funded groups, to support dairy farmers as they protect the threatened Tricolored Blackbird species .CDRF Contributes funding on behalf of the California dairy industry.*

KEY TAKE AWAYS

- **Voluntary conservation efforts are delivering results that benefit birds and dairies.**
- **Research helped quantify the true cost to producers.**
- **Working agricultural lands are critical to species recovery.**

COMPLETED PROJECT

New Research Paves the Way for Acidified Milk Feeding Systems for Calves on California Dairies

Social Responsibility

As California dairy producers look for ways to improve calf health while managing labor and feed costs, interest in group housing and acidified milk feeding systems continues to grow. Acidified milk allows calves to have access to milk for longer periods without rapid spoilage, however, most of the existing research and practical experience comes from cooler regions of North America. Producers in California have had limited information on how acidified milk performs under the state's warmer environmental conditions. That knowledge gap is important because maintaining milk quality is critical to calf growth, animal health, and feeding efficiency.

California dairies are also showing increasing interest in group housing systems for preweaned calves, where milk may remain available for extended periods. In these systems, producers need confidence that milk will be stable, resist bacterial growth, and retain its nutritional value.

MANAGING ACIDIFIED MILK IN CALIFORNIA CONDITIONS

To address these questions, researchers evaluated how temperature, mixing frequency, and storage time affect the quality and stability of acidified milk. Milk was acidified with citric acid to a target pH of 4.0 to 4.2 and monitored over a 96-hour period under different temperature and mixing conditions. Researchers measured pH stability, physical characteristics, milk quality parameters, and bacterial activity.

The study found that mixing frequency plays a major role in maintaining milk quality. Continuous mixing and mixing every two hours were the most effective protocols for keeping milk homogenized and maintaining a stable pH throughout storage. By comparison, milk mixed every six hours showed greater pH fluctuations and more visible separation between milk solids and whey. This finding is particularly relevant because six-hour mixing intervals are commonly used on dairies using mob feeding today.

The research also demonstrated important food safety benefits. Acidified milk suppressed the growth of *E. coli* under moderate temperatures, and under warmer conditions researchers observed a bactericidal effect after 48 hours across all mixing treatments. These results reinforce the value of acidification as a management tool for improving the microbial stability of milk intended for calf feeding.

IMPROVING CALF FEEDING EFFICIENCY AND MILK SAFETY

For producers, the findings provide some of the first California-specific data on how to successfully manage acidified milk systems. The results show that properly managed acidified milk can remain stable, maintain desirable physical characteristics, and resist bacterial growth even under challenging environmental conditions. That gives producers practical guidance for implementing feeding programs that may reduce milk waste, support calf health, and improve labor efficiency.

Given the growing interest in group housing and more flexible calf-feeding strategies, the study provides an important foundation for future on-farm adoption of acidified milk systems in California. The research helps move the industry closer to developing best management practices that can support healthy calves, more efficient feeding programs, and improved overall dairy management.

Evaluation of Protocols for Acidifying Milk Fed to Calves in California
Dr. Richard Pereira, UC Davis

KEY TAKE AWAYS

- **Acidification helped control bacterial growth under California conditions.**
- **Frequent mixing improved the stability of acidified milk.**
- **The findings provide a foundation for wider adoption of acidified milk feeding systems for dairy calves.**

COMPLETED PROJECT

Research Strengthens California's Ability to Detect and Respond to HPAI

Social Responsibility - Innovation & Technology

California dairy producers are still looking for answers about how diseases such as Highly Pathogenic Avian Influenza (HPAI) move within and between farms. During the recent outbreak, many dairies implemented strict biosecurity measures, yet infections continued to spread. Understanding whether disease-carrying particles can travel through the air (as aerosols) is critical for protecting herds, reducing economic losses, and improving future outbreak response.

That question is especially important in California, where HPAI affected more than three-quarters of the state's dairies and contributed to significant production losses. Producers, veterinarians, and regulators need better tools to understand HPAI transmission risks so they can respond more effectively when future outbreaks occur.

To help answer those questions, researchers developed new high-volume air sampling systems capable of collecting far more air than conventional technologies. Detecting airborne pathogens on dairies is notoriously difficult because only a small number of animals in a herd may be actively shedding disease at any given time. The project created two new systems: PASS, a portable battery-powered sampler that can be placed throughout a dairy, and SASS, a truck-mounted platform capable of surveying large areas while collecting aerosol and air quality data in real time.

As HPAI cases declined during the study period, researchers expanded their work to include common dairy-associated bacterial pathogens. These bacteria served as indicators that the systems were successfully collecting dairy-generated aerosols and helped confirm that negative disease results reflected a true absence of the pathogen rather than a sampling failure.

IDENTIFYING PATHOGEN HOTSPOTS TO STRENGTHEN BIOSECURITY

One of the most practical outcomes of the project was the identification of locations where airborne pathogens may be more likely to originate. Milk collection pits, washout areas, and some feed barn locations consistently produced strong aerosol signals. Mobile sampling also revealed localized hotspots that stationary samplers would likely have missed. These findings suggest that certain areas on dairies may warrant additional monitoring or targeted mitigation practices during disease outbreaks.

The project also demonstrated that the new sampling systems can successfully collect biologically meaningful information across large dairy operations. Researchers were able to detect viable HPAI during an active outbreak and consistently capture dairy-associated bacterial pathogens under real-world conditions. The work showed that high-volume air sampling can provide a clearer picture of where disease-carrying aerosols may be present and how they move through dairy environments.

While additional validation is needed, the study gives California dairies a powerful new tool for investigating how airborne diseases spread. The ability to identify potential pathogen hotspots, strengthen disease surveillance efforts, and rapidly survey large operations could help producers, veterinarians, and regulatory agencies respond more quickly and effectively during a future outbreak. As California continues to improve its disease preparedness, these tools may become an important part of the strategy.

BLAME-FLU (Bubbles with Virus-Laden Aerosols from Manure Lagoons and Influenza Spread)
Dr. Ira Leifer, Bubbleology Consultants

KEY TAKE AWAYS

- **New tools developed to improve airborne disease detection.**
- **Potential aerosol disease hotspots were identified.**
- **Supports future outbreak response in California.**

COMPLETED PROJECT

CDQAP: Industry Outreach Program Delivers Practical Solutions for California Dairy Producers

Industry Development & Educational Outreach - Environmental Management - Social Responsibility

California dairy producers spent much of 2025 navigating uncertainty. Bird flu continued to affect herds across the state, major changes to water quality regulations were taking shape, and concerns ranging from carcass disposal to farm security required attention. Throughout the year, the California Dairy Quality Assurance Program (CDQAP) served as a central source of information, resources, and support to help producers respond to these challenges.

One of the biggest issues currently facing dairies is preparing for upcoming environmental regulations. New requirements related to nitrogen management and groundwater protection are expected to affect many California operations in the coming years. To help producers get ahead of those changes, CDQAP worked with industry partners, consultants, researchers, and regulators to develop practical information and tools that can help dairies understand nutrient flows, evaluate management options, and prepare for future reporting requirements.

At the same time, the dairy industry continued responding to highly pathogenic avian influenza (HPAI). CDQAP kept producers informed through webinars, newsletters, alerts, and online resources focused on biosecurity, employee safety, and disease prevention. The program also worked closely with state and federal agencies and helped facilitate research into possible pathways of disease transmission, ensuring producers had access to the latest information as the situation evolved.

SUPPORTING PRODUCERS THROUGH SCIENCE AND STEWARDSHIP

CDQAP supported research to improve emergency mortality management on California dairies. The research was funded by the California Department of Food and Agriculture (CDFA) through a grant awarded to the California Dairy Research Foundation (CDRF). CDQAP, subject-matter experts and researchers evaluated emergency mortality composting under California conditions. Early results showed that properly managed composting systems can meet environmental and pathogen-reduction standards while minimizing impacts on soil and groundwater.

While much of the program's work focuses on helping producers prepare for future challenges, it also delivers direct benefits throughout the year. In 2025, 765 California dairies were certified through CDQAP's environmental stewardship program. Those certifications qualify producers for a 50% reduction in State Water Board fees, generating an estimated $2.5 million in annual savings statewide.

CDQAP also expanded efforts to address farm security. Working with the FBI, local law enforcement, and industry partners, the program provided guidance on issues ranging from trespassing and activist activity to theft, cybersecurity, and employee safety.

These efforts highlight the role CDQAP plays beyond certification and compliance. Whether helping producers prepare for new regulations, respond to disease outbreaks, improve environmental stewardship, or protect their operations, the program provides practical support for California dairies facing an increasingly complex operating environment.

Visit cdqap.org to access outreach materials from CDQAP

California Dairy Quality Assurance Program (CDQAP)*
Dr. Michael Payne and Dr. Deanne Meyer, UC Davis,
Denise Mullinax, CDQAP/CDRF

**CDQAP is an industry-academia-government partnership that serves to support California dairy producers. CDRF funds CDQAP outreach activities.*

KEY TAKE AWAYS

- **CDQAP provided rapid-response support on some of the dairy industry's most pressing challenges.**
- **New tools were developed to help dairies prepare for future water quality regulations.**
- **Environmental certification continued delivering direct value to producers.**

COMPLETED PROJECT

Outreach Highlights Environmental Gains on California Dairies

Industry Development & Educational Outreach - Environmental Management - Social Responsibility

California dairy farmers face growing pressure to produce nutritious and affordable food while meeting increasingly ambitious environmental and climate goals. As attention on greenhouse gas emissions, water quality, and sustainability continues to increase, it is important that the industry have opportunities to share both the progress being made on farms and the science behind those improvements.

That challenge is particularly important in California, where dairy producers are helping the state achieve some of the nation's most aggressive climate and water quality objectives. Farmers are being asked to reduce emissions, improve resource efficiency, and maintain a reliable food supply—all while operating in a highly regulated environment.

To help communicate these efforts, Dairy Cares, with support from the California Dairy Research Foundation (CDRF), continued updating and expanding its online outreach resources throughout 2025. The goal was to provide clear, science-based information about environmental stewardship practices being adopted across California dairies and the measurable results those efforts are producing.

The updates highlighted a wide range of sustainability initiatives underway on dairy farms, including methane reduction projects, improved manure management systems, renewable energy production, feed efficiency improvements, water quantity efficiency efforts, and other planet-smart farming practices. The resources are designed to help industry stakeholders (including policymakers, educators, consumers, media, and others) better understand how California dairy farmers are addressing environmental challenges while maintaining productive agricultural operations.

One of the most significant developments shared through these communications is California dairy's projected achievement of reducing methane emissions by 5 million metric tons of carbon dioxide equivalents annually as of 2025. This milestone reflects years of investment and collaboration among dairy producers, researchers, technology providers, and public agencies working together to develop practical solutions that reduce greenhouse gas emissions.

DEMONSTRATING CLIMATE GAINS THROUGH PRACTICAL FARM SOLUTIONS

Much of this progress has been driven by improvements in manure management, including the adoption of dairy digesters and alternative manure management practices that capture, avoid or reduce methane emissions. Continued gains in production efficiency have also contributed, allowing producers to produce more milk while using resources more efficiently.

For California dairy farmers, these achievements demonstrate that environmental progress and agricultural productivity can go hand in hand. The industry's efforts not only support state climate objectives but also help strengthen the long-term sustainability and resilience of dairy operations.

Just as importantly, the outreach work helps ensure these accomplishments are understood by audiences beyond the farm gate. By providing accessible, science-based information, Dairy Cares helps build public understanding of the environmental improvements occurring on dairies and encourages broader adoption of proven stewardship practices.

Visit dairycares.com for more information.

Dairy Cares Communications and CDQAP Support
PROJECT LEAD: Michael Boccadoro, Dairy Cares

KEY TAKE AWAYS

- **On-farm innovation is driving results.**
- **California dairies are making measurable climate and water quality progress.**
- **Outreach helps tell the dairy sustainability story.**

COMPLETED PROJECT

Developing the Next Generation of Dairy Nutrition Leaders through Real-World Experience

Industry Development & Educational Outreach - Social Responsibility

CREATING LASTING VALUE FOR CALIFORNIA DAIRY

California's dairy industry depends on highly trained professionals who understand both the science and day-to-day realities of dairy production. As dairies become more complex and nutrition, sustainability, animal health, and feed management continue to evolve, the need for skilled industry leaders has never been greater.

That challenge is especially important in California, where dairy producers rely on nutritionists, consultants, veterinarians, feed industry professionals, and researchers to improve productivity, animal health, and environmental stewardship. Developing that workforce requires more than classroom education; it requires hands-on experience with dairies and industry partners.

To help meet that need, the Feed Industry Fellowship paired graduate students with commercial dairies, feed companies, nutrition consultants, and other industry organizations. Supported by the California Dairy Research Foundation (CDRF), the program gives students a deeper understanding of dairy feeding systems while helping them develop practical skills and industry connections.

During the 2024-2025 fellowship period, two graduate students completed research projects on commercial California dairies while participating in internships within the feed and dairy sectors. One fellow studied how pregnancy affects mitochondrial function in dairy cows, while the second investigated inflammation markers associated with transition cow health.

Beyond their research, fellows gained firsthand experience working alongside industry professionals. Internships included placements with a dairy genetics and reproductive services provider, a dairy infrastructure and equipment solutions company, a dairy management and compliance consulting firm, and several dairy nutrition consultants. The experience allowed participants to see how scientific research is translated into practical recommendations on commercial farms.

The program also emphasized professional development. Fellows presented research findings at major industry and scientific meetings, including the California Animal Nutrition Conference, the American Dairy Science Association annual meeting, and American Registry of Professional Animal Scientists conferences. Their research received recognition at several events, including first- and second-place poster awards.

BUILDING A STRONG PIPELINE OF INDUSTRY LEADERS

Of the 19 fellows who have participated since the program's inception, nearly all have remained in careers supporting the dairy industry. Alumni have become nutrition consultants, technical service specialists, feed industry professionals, researchers, veterinarians, and extension advisors, with all but one currently working within California's dairy sector.

For California dairy producers, the fellowship has helped create a pipeline of highly trained professionals who understand both scientific research and real-world dairy management, strengthening the industry's future workforce.

Feed Industry Fellowship with a Focus on Dairy Feeding Systems*
Dr. Heidi Rossow, UC Davis VMTRC

**This project was additionally supported by the feed industry and/or consulting nutritionists.*

KEY TAKE AWAYS

- **Provided hands-on industry experience for future dairy professionals.**
- **Generated career-ready graduates equipped to support California dairies.**
- **Fellowship program strengthen connections between universities and the dairy industry.**

COMPLETED PROJECT

Emerging Manure Treatment Technologies Evaluated for Use on California Dairies

Environmental Management

EVALUATING NEW TOOLS FOR NUTRIENT MANAGEMENT

As California dairy producers continue to address evolving environmental and water quality challenges, CDRF is investing in evaluating advanced manure treatment technologies that may help dairies improve nutrient management and support long-term regulatory compliance.

New groundwater regulations, increasing scrutiny of nitrogen management, and the long-term impacts of the Sustainable Groundwater Management Act (SGMA) are creating pressure to find new ways to manage manure nutrients while maintaining economically viable dairy operations.

For many dairies, the challenge is balancing nutrients across the entire farm while demonstrating that manure nutrients are being used efficiently and not contributing to groundwater quality concerns. At the same time, technology vendors are increasingly marketing advanced treatment systems as solutions for regulatory compliance and environmental stewardship.

To help producers make informed decisions, this project evaluated several emerging manure treatment technologies under real-world operating conditions. Researchers measured changes in manure characteristics before and after treatment and assessed each system's potential role in sustainable nutrient management strategies.

BALANCING INNOVATION WITH PRACTICALITY

The results showed that advanced manure treatment technologies may help dairies better manage nutrient and solids flows, but they are not simple plug-and-play solutions. While several systems demonstrated promise, important questions remain regarding long-term reliability, operating costs, labor requirements, electricity use, and overall economic feasibility.

One key finding involved the management of separated solids. While treatment systems can remove nutrients and solids from liquid manure streams, they also create concentrated solid materials that must be stored, transported, reused, or disposed of. Researchers identified resulting solids and liquid streams as a critical issue requiring further evaluation before widespread adoption.

The project also highlighted the importance of evaluating treatment technologies within whole-farm nutrient management plans. Changes to manure composition can affect nutrient application strategies, manure export opportunities, and overall farm economics.

Project personnel plan to continue discussions with participating dairy operators and technology providers to better understand operational experiences, identify additional analytical needs, and evaluate producer perspectives regarding practicality and performance.

For California producers, the value of this research lies in providing objective information at a time when many dairies are evaluating options for meeting future environmental requirements. Continued collaboration among producers, researchers, technology developers, and regulators will be essential to identify technologies that support both environmental objectives and economically sustainable dairy operations.

Evaluation of Manure Treatment Technologies
Dr. Deanne Meyer, UC Davis

KEY TAKE AWAYS

- **Commercial-scale validation remains critical before widespread adoption.**
- **The true cost of manure treatment extends beyond nutrient removal.**
- **Careful evaluation of technology options is critical to ensure individual farm challenges and goals are addressed.**

COMPLETED PROJECT

Benchmarking Sustainability Metrics Today to Support California Dairy's Future Sustainability Success

Environmental Management - Industry Development & Educational Outreach

ESTABLISHING BENCHMARKS FOR FUTURE SUSTAINABILITY PROGRESS

California dairy farmers have made significant investments in environmental stewardship over the past several decades, improving water use efficiency, nutrient management, and energy practices while continuing to produce food for a growing population. As sustainability expectations evolve, the industry needs reliable baseline data to measure progress, identify opportunities, and demonstrate the effectiveness of ongoing improvements.

To help establish those benchmarks, researchers worked with California dairies to collect and analyze data on water use, energy systems, and nutrient management practices. The project was designed to provide science-based metrics that producers, researchers, and policymakers can use to track progress and guide future sustainability efforts.

IDENTIFYING OPPORTUNITIES FOR SMARTER RESOURCE MANAGEMENT

One of the project's most important outcomes was the development of new baseline information on water use throughout commercial dairy operations. Researchers gathered detailed data from dairies, documenting usage across milking parlors, holding pens, cooling systems, flush systems, soakers, water troughs, and freestall facilities. While data validation is ongoing, the information will help establish benchmarks that producers can use to evaluate future water-saving opportunities.

The research also examined adoption of electrified equipment. Researchers found that relatively few dairies have transitioned to fully electrified feed centers, although operations that have adopted the technology may benefit from labor efficiencies and more consistent feed mixing. The findings provide an early snapshot of adoption trends and establish a baseline for measuring future progress.

A major focus of the project was understanding nutrient flows and identifying opportunities to strengthen long-term nutrient management. Researchers analyzed nitrogen balances from 109 dairies and found that many operations generate more nitrogen than can be readily utilized through existing cropping systems. The findings provide insight into where future management strategies and technologies could create the greatest benefit.

The study also evaluated whether extending manure pipelines or increasing manure transport could help move additional nutrients to cropland. The analysis found that these approaches would likely provide only limited relief for many dairies, highlighting the need for a broader portfolio of nutrient management tools and nutrient recovery strategies.

For California dairy producers, the project provides objective data that can inform future decision-making and establishes an important set of sustainability benchmarks to support environmental stewardship and long-term sustainability.

Benchmarking and Describing California Dairy Sustainability Metrics
Jennifer Heguy, UC ANR

KEY TAKE AWAYS

- **Findings highlight the need for new approaches to nutrient management.**
- **First-of-its-kind benchmarks help document dairy sustainability performance.**
- **Water-use data reveal where future efficiency gains may be possible.**

COMPLETED PROJECT

Nanobubble Technology Shows Promise for Reducing Methane Emissions from Dairy Manure

Environmental Management

REDUCING METHANE IN EXISTING MANURE SYSTEMS

California dairy producers are under growing pressure to reduce methane emissions while continuing to manage manure in practical, cost-effective ways. Technologies that can reduce methane from manure could help dairies meet sustainability targets and participate in carbon market and incentive programs.

To explore one possible solution, researchers evaluated nanobubble technology for treating dairy manure and lagoon wastewater. Nanobubbles are tiny gas-filled bubbles that can increase dissolved oxygen and oxidation activity in wastewater systems. While the technology has been used in municipal and industrial wastewater treatment, this study was among the first to examine its potential for dairy manure management.

Researchers tested nanobubbles under controlled laboratory conditions using flushed manure and lagoon wastewater collected from multiple California dairies. Samples were treated with nanobubbles, conventional aeration, or no aeration. Emissions and manure characteristics were monitored for at least one month.

The results showed substantial methane reductions. In lagoon wastewater, nanobubble treatment reduced methane emissions by nearly 67% compared with untreated controls. The treatment also reduced ammonia emissions in some manure and wastewater samples, highlighting its potential as a tool for reducing emissions from dairy manure systems.

WHAT COMES NEXT FOR NANOBUBBLE TECHNOLOGY

The study also revealed important tradeoffs. While nanobubble treatment significantly reduced methane emissions, it increased emissions of nitrous oxide and carbon dioxide compared with untreated manure and conventional aeration. Researchers also found that the treatment changed how nitrogen behaved in the manure, converting more of it into nitrate. At the same time, compounds that microorganisms use to produce methane were reduced to very low levels, helping explain why methane emissions declined.

For producers, the findings point to a technology with real potential but also clear questions that must be answered before it can be adopted at scale. Economic models suggest nanobubbles may offer a more cost-effective approach to methane mitigation than conventional aeration and could create opportunities tied to sustainability incentives or carbon market programs.

At the same time, more research is needed before nanobubbles can be recommended for widespread on-farm use. The current study was conducted under controlled laboratory conditions, not in full-scale dairy manure systems. Researchers will need to determine how the technology performs under farm conditions and how to reduce or prevent increases in nitrous oxide and nitrate.

Overall, the study gives California dairies an early look at a promising manure management technology. Nanobubbles showed strong potential to reduce methane emissions from dairy manure, which could help support the state's climate and dairy sustainability goals. With further refinement and on-farm validation, the technology could become another tool for producers seeking practical ways to reduce greenhouse gas emissions while managing manure responsibly.

Effect of Nanobubbles on Dairy Manure Greenhouse Gases
Dr. Frank Mitloehner, UC Davis

KEY TAKE AWAYS

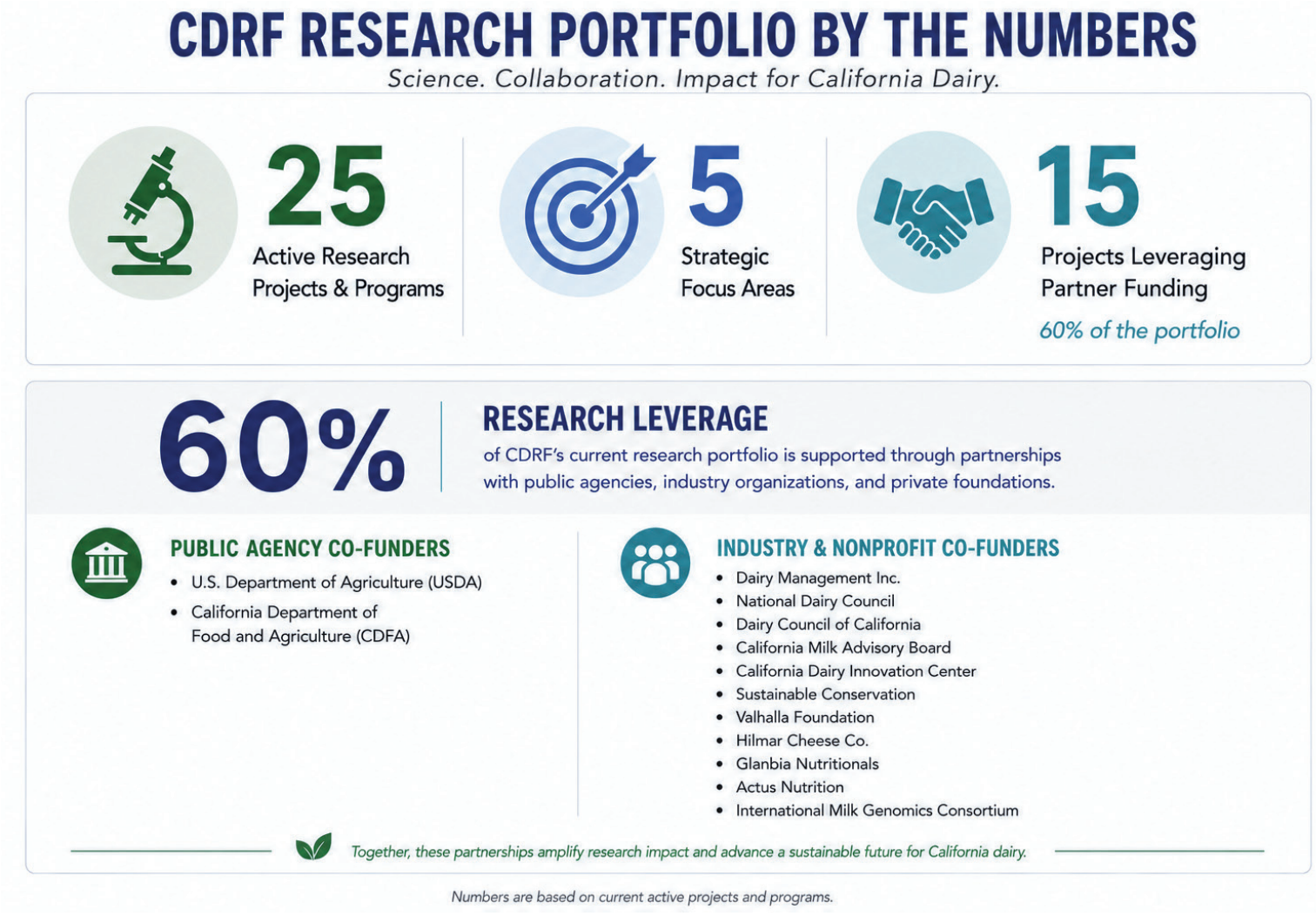
- **Nanobubbles reduced methane emissions from dairy manure.**
- **Nannobubble technology altered nitrogen dynamics and manure characteristics.**
- **Findings highlight both opportunity and challenges for technology implementation.**

CURRENT PROJECTS PORTFOLIO

SCIENCE THAT DELIVERS SOLUTIONS FOR CALIFORNIA DAIRY

The California Dairy Research Foundation (CDRF) invests in applied research that addresses the opportunities and challenges facing California's dairy industry. Working with leading universities, government agencies, nonprofit organizations, and industry partners, CDRF supports projects that generate practical, science-based solutions for producers while advancing innovation, environmental stewardship, animal care, and the nutritional value of dairy foods. Together, these investments strengthen the long-term competitiveness and sustainability of California dairy by translating research into real-world applications.

The current portfolio spans five strategic focus areas: Environmental Management; Food Science, Nutrition and Health; Social Responsibility; Industry Development and Educational Outreach; and Innovation and Technology. Collectively, these projects explore new approaches to reducing greenhouse gas emissions, improving water and nutrient management, developing value-added dairy ingredients, advancing human health research, strengthening producer education, and creating innovative technologies and products that benefit both the dairy industry and consumers.



CURRENT PROJECTS PORTFOLIO

ENVIRONMENTAL MANAGEMENT

CDRF's Environmental Management research supports science-based solutions that help California dairy producers meet evolving environmental goals while maintaining productive and economically sustainable operations. Through partnerships with universities, government agencies, conservation organizations, and industry leaders, these investments advance practical approaches to reducing greenhouse gas emissions, improving water quality, strengthening nutrient management, conserving natural resources, and increasing climate resilience.

Current projects evaluate innovative manure management technologies, methane reduction strategies, groundwater recharge, water-use efficiency, nutrient recovery systems, and sustainability benchmarking tools. Together, these efforts provide producers with the research, technologies, and decision-support tools needed to improve environmental performance, prepare for future regulations, and strengthen the long-term sustainability of California dairy.

Advancing Markets for Producers and the Dairy Plus Program*

TIMELINE: 2023-2028

In 2023, the California Dairy Research Foundation (CDRF), in collaboration with the California Department of Food and Agriculture (CDFA), the University of California, Dairy Cares, and other dairy organizations, secured over $85 million in funding from the U.S. Department of Agriculture (USDA) through the Partnerships for Climate-Smart Commodities (PCSC) program. This initiative, now managed as Advancing Markets for Producers (AMP), aims to incentivize producers to adopt advanced manure management practices, measure greenhouse gas and nitrogen reductions, and develop new markets for California dairy producers while helping demonstrate measurable environmental improvements that support long-term sustainability goals.

The largest component of the AMP grant is the Dairy Plus Program, established under CDFA's Office of Agricultural Resilience and Sustainability (OARS), which awards competitive grants to California dairy farms for implementing advanced manure management practices that reduce both methane emissions and nutrient surplus while improving water quality.

In June, CDRF announced what is expected to be the final round of funding for the Dairy Plus Program, making $34 million available to the state's dairy farmers. The Dairy Plus Program supports several pathways for enhanced manure management, including vermifiltration systems, manure solid separation using weeping walls, advanced solid-liquid separation with flocculants and/or bead filters, and advanced solid-liquid separation by centrifuge. Practices may also be paired with digesters and/or subsurface drip irrigation systems or composting.

All projects eligible for Dairy Plus Program funding consideration must be paired with other key manure management practices or technologies. This approach encourages comprehensive nutrient management systems that deliver multiple environmental benefits rather than relying on a single technology.

California dairy producers interested in applying for the Dairy Plus Program should refer to the CDFA funding solicitation for eligibility requirements, award amounts, and application materials are now available.

See cdfa.ca.gov/oars/dairyplus/for more information.

*This project is funded by the USDA Award #NR233A750004G048

Dairy Cares Communications and CDQAP Support

PROJECT LEAD: Michael Boccadoro, Dairy Cares
TIMELINE: 2026

This project is designed to raise public and industry awareness about the sustainable farming practices employed by California dairy farmers, showcasing their commitment to environmental stewardship. A key focus is fostering strong, collaborative partnerships among dairy producers, state agencies, researchers, and other stakeholders to ensure a unified approach to advancing sustainability goals.

CURRENT PROJECTS PORTFOLIO

Another essential objective is supporting communications for the California Dairy Quality Assurance Program (CDQAP), helping the program with outreach and informative materials. The benefits of this initiative are multifaceted. By promoting collaboration across the dairy industry and related sectors, Dairy Cares' communications strengthen networks that facilitate knowledge sharing and innovation. Additionally, Dairy Cares aims to develop clear, measurable metrics and compelling outreach materials that highlight the leadership role of California dairy farmers in sustainable agriculture. These efforts not only improve public perception but also encourage wider adoption of best practices, ultimately contributing to the long-term environmental and economic resilience of the dairy sector in California.

Visit dairycares.com for more information.

Scoping the Environmental Feasibility of DairyMAR

RESEARCHER: Dr. Helen Dahlke, UC Davis
TIMELINE: 2024 - 2026

This project aims to evaluate the feasibility of implementing DairyMAR (managed aquifer recharge) on dairy-controlled, manure-managed cropland in California's Central Valley, with a strong focus on ensuring that groundwater quality is not adversely affected. By studying this innovative water management practice, the project will develop foundational standards specifically tailored for DairyMAR implementation.

This initiative represents the first U.S. project to examine the groundwater quality impacts of DairyMAR, providing valuable insights and data. Economically, DairyMAR could reduce the pressure to repurpose dairy crop land due to water shortages, helping sustain dairy production and farm profitability in water-constrained regions.

Piloting Dairy Manure Subsurface Drip Irrigation (MSDI) System for Almonds*

RESEARCHER: John Cardoza, Sustainable Conservation
TIMELINE: 2024 - 2026

This project aims to improve groundwater quality by adapting an existing dairy manure subsurface drip irrigation (MSDI) system for safe use on almond orchards destined for pasteurization in the San Joaquin Valley. It focuses on expanding the application area of manure effluent nitrogen to almonds, providing sustainable nutrient management strategies, and evaluating potential food safety risks associated with MSDI use in almond production. Additionally, the project will perform a cost-benefit analysis to assess the economic feasibility of this approach.

The benefits include offering dairies a practical way to export excess nutrients, helping to prevent nitrogen over application on cropland. By linking dairy manure management with almond production, the project promotes environmental sustainability through nutrient repurposing and reduced impacts, showcasing a model of integrated agricultural resource use.

*CDRF is a minority funder of this project.

Enhancing the Climate Sustainability of Dairy Forage Production by Reducing Water Use and N2O Emissions with Manure Subsurface Drip Irrigation (MSDI)*

RESEARCHER: Dr. Sarah Castle, Sustainable Conservation
TIMELINE: 2024 - 2026

This project has two main goals: first, to verify the greenhouse gas (GHG) reductions from manure subsurface drip irrigation (MSDI) compared to flood irrigation (FI) in dairy forage production, while also assessing nitrogen efficiency as an indicator of nitrogen leaching and groundwater impacts. Second, to measure water use efficiency in the MSDI system.

Preliminary results indicate that MSDI can significantly l ower nitrous oxide emissions and the overall carbon footprint, while enhancing water and nitrogen use efficiency. The project will generate detailed data on milk yield, water use, nitrogen flows, and GHG emissions. These findings will inform scientific publications, guide on-farm practices, and help producers access financial incentives, ultimately supporting protecting groundwater, and advancing the environmental sustainability of California's dairy industry.

*CDRF is a minority funder of this project.

Fermented Agricultural Byproducts as Dietary Modulators to Reduce Methane from Cows*

RESEARCHER: Dr. Mattias Hess, UC Davis
TIMELINE: 2025 - 2026

This project aims to identify pre-fermented crop byproducts that can reduce methane emissions from dairy cows. By enhancing nutrient and bioactive availability for rumen microbes, the project promotes healthier digestion and feed efficiency. It also diverts agricultural waste from landfills, repurposing it into climate-smart feed resources that align with California's methane reduction goals under SB 1383.

The benefits are substantial—lowering feed costs through the use of affordable, locally sourced byproducts, improving supply chain resilience, and supporting California dairies in meeting climate policy targets. This strategy fosters new partnerships with crop processors, boosts sustainability, and enhances the image and marketability of sustainably sourced dairy products.

*This project is co-funded by the Valhalla Foundation.

CURRENT PROJECTS PORTFOLIO

Hand-held Meters to Measure Lagoon Water Nitrogen

RESEARCHER: Rubia Branco-Lopes, UC ANR
TIMELINE: 2025 - 2026

This project collaborates with dairy farms and producers willing to test and share data, aiming to compare simple, on-site water testing tools with standard laboratory methods for measuring nitrogen levels in lagoon water. It investigates how easily measured water indicators—such as pH or electrical conductivity—can serve as reliable proxies to estimate nitrogen content, offering a practical approach for on-farm nitrogen monitoring.

The benefits of this work include enabling targeted nitrogen management through quick, real-time testing directly on the farm, allowing for more frequent and accurate nitrogen measurements in lagoon water. This helps farmers optimize nitrogen application to forage crops, enhancing nutrient use efficiency and supporting compliance with state wastewater discharge regulations.

Isolating New Species of Methanogens

RESEARCHER: Dr. Timothy Hackmann, UC Davis
TIMELINE: 2025 - 2026

This project aims to isolate, characterize, and name species of methanogens from the rumen of California dairy cattle to support the development of effective methane mitigation strategies. Methanogens are the microbes responsible for all methane emissions from cattle, yet only five species have been described from the rumen, and only two from California—both over 50 years ago.

The newly isolated strains will enable researchers to understand methane production pathways, screen new additives, and identify weaknesses in existing approaches. Publicly available strains will also accelerate innovation by allowing other researchers and companies to test and refine methane-reduction technologies. Ultimately, these outcomes will support the California dairy industry in meeting methane reduction mandates under Senate Bill 1383, while enhancing its environmental sustainability and resilience.

Manure Nitrogen Mineralization Evaluation

RESEARCHER: Dr. Daniel Geisseler, UC Davis
TIMELINE: 2026 - 2027

The project aims to characterize how different types of dairy cattle manures release plant-available nitrogen under optimal conditions. By studying corral scrapings, composted solids, lagoon manure, and anaerobic digester effluent, the project seeks to generate reliable data on nitrogen availability. This information will be shared with farmers, crop consultants, and regulatory staff through online tools, presentations, and articles to support better nutrient management decisions.

Manure Nanobubbles with Acidification

RESEARCHER: Dr. Frank Mitloehner, UC Davis
TIMELINE: 2026 - 2027

The project evaluates integrated manure treatment strategies—nanobubbles, nitrification inhibitors, and acidification—to reduce greenhouse gas and ammonia emissions from dairy manure while improving nitrogen management and reducing nitrate leaching when applied to croplands. It also examines the economic feasibility and environmental benefits of these treatments.

Market-Ready Manure-Derived Soil Amendment

RESEARCHER: Dr. Pramod Pandey, UC Davis
TIMELINE: 2026 - 2027

This project intends to develop a safe, consumer-ready product from dairy manure using alkaline wet (AW) technology by transforming raw manure into a nutrient-rich, pathogen-free lignocellulosic material.

By optimizing processing conditions and validating field-scale feasibility, this project aims to advance sustainable nutrient management while creating valuable, marketable products for small- and mid-sized dairies.

CURRENT PROJECTS PORTFOLIO

FOOD SCIENCE, NUTRITION AND HEALTH

CDRF's Food Science, Nutrition and Health research advances the scientific understanding of how dairy foods and dairy-derived ingredients support human health while creating new opportunities for product innovation and value creation. Investments in this focus area explore the unique bioactive compounds naturally found in milk, the health benefits of fermented dairy foods, and novel uses for dairy co-products that can improve nutrition across all stages of life.

Current projects investigate topics including gut and immune health, healthy aging, cognitive function, personalized nutrition, the dairy food matrix, infant nutrition, and the development of functional dairy ingredients. Together, these efforts generate science-based evidence that strengthens consumer confidence in dairy, supports future nutrition recommendations, and creates new opportunities for California dairy producers and processors.

PROJECT EXTENSION: Characterization of Milk Fat Globules in Beta Serum and Buttermilk, Impact of Processing, Utilization*

RESEARCHER: Dr. Daniela Barile, UC Davis
TIMELINE: 2026

This project originally explored a high-value opportunity for harnessing buttermilk and beta serum—co-products of butter and anhydrous milk fat (AMF) production—as rich, untapped sources of milk fat globule membrane (MFGM) components. The project was extended in 2026 to further optimize methods for analyzing valuable MFGM compounds in buttermilk and AMF processing streams. Because these dairy co-products have unique characteristics and little previous research exists, the project allows researchers to refine sample preparation techniques and validate findings using new samples provided by industry collaborators.

The project will also evaluate whether membrane filtration can be used to concentrate beneficial MFGM components while reducing lactose content, creating new opportunities to develop high-value dairy ingredients from underutilized processing streams. This combined work will provide a more robust scientific dataset and strengthen the project's potential to support product innovation and value-added uses for California dairy co-products.

*This project is funded by the California Dairy Innovation Center

Improving Gut Function with Fermented Dairy Foods*

RESEARCHER: Dr. Maria Marco, UC Davis
TIMELINE: 2024 - 2026

This project aims to compare dairy-based yogurts and plant-based yogurt-like products to better understand their effects on gut health, specifically their ability to protect the intestinal barrier from damage caused by inflammation. Researchers will examine how each yogurt type affects intestinal responses and identify which compounds—particularly in dairy yogurt—contribute to maintaining barrier integrity. A key objective is to pinpoint soluble components common to different dairy yogurts that provide this protective effect, helping to explain the biological mechanisms behind yogurt's impact on gut function.

The results will provide scientific evidence to reinforce the image of milk and dairy as health-promoting foods, especially in relation to digestive wellness. By clearly distinguishing the gut health benefits of dairy yogurt from plant-based alternatives, the project will support more informed consumer choices. The findings will also be shared widely to educate health professionals and the public, positioning dairy yogurt as a functional food with unique advantages for maintaining intestinal integrity and overall health.

*This project is funded in partnership with National Dairy Council

Needs Assessment and Use of Fermented Dairy Products by WIC-Eligible Participants*

RESEARCHER: Dr. Jennifer Smilowitz, UC Davis
TIMELINE: 2024 - 2026

This project evaluates how WIC-eligible households use and perceive fermented dairy products, aiming to identify preferences, improve access, and assess the impact on diet quality, product acceptability, and overall experience. It also examines whether the use of educational materials and recipes increase understanding of the health benefits of fermented dairy.

By expanding access to these nutritious options and providing clear, culturally relevant guidance, the project supports healthier eating habits and promotes long-term wellness among WIC participants.

*This project is funded in partnership with Dairy Council of California.

CURRENT PROJECTS PORTFOLIO

Milk Type in Toddlers (TOT) Evaluation of the Microbiome*

RESEARCHER: Dr. Lorrene Ritchie, UC ANR
TIMELINE: 2024 - 2026

This project aims to evaluate how different fat levels in milk—specifically whole milk versus 1% milk—affect key health outcomes in young children, including body fat, diet quality, vitamin D status, cardiometabolic markers, and neurocognitive development. A central focus is on understanding how milk type influences the gut microbiome, an area of growing importance in early childhood health. By leveraging data from the NIH-funded Milk-Tot Study, the research integrates detailed microbiome analysis to address a critical gap in evidence regarding how dairy fat may support or alter gut health in children.

The findings from this project have the potential to significantly influence national nutrition policy and clinical practice. Results will inform key stakeholders such as the American Academy of Pediatrics, the American Heart Association, and the Academy of Nutrition and Dietetics, particularly on the relationship between milk type and microbiome health. Evidence-based insights will guide healthcare providers in making milk recommendations tailored to optimize health outcomes in children. Moreover, the results could support the Dietary Guidelines for Americans, potentially increasing support for whole milk consumption in children over two—benefiting both public health and the dairy industry.

*This project is funded in partnership with Dairy Council of California.

Dairy Co-Products Role in Gut-Brain Function*

RESEARCHERS: Dr. Ameer Taha, UC Davis and Dr. Daniela Barile, UC Davis
TIMELINE: 2024 - 2026

This project explores the potential of whey protein phospholipid concentrate (WPPC), a currently underutilized dairy co-product, to slow or reverse cognitive decline associated with unhealthy diets. A central focus is the presence and function of extracellular vesicles (EVs) within WPPC—tiny, naturally occurring structures that may transport milk-derived bioactive compounds directly to brain tissues.

By studying these EVs, the research aims to uncover their role in supporting brain health and position EV-enriched dairy fractions as innovative, food-based ingredients for cognitive support, particularly in older adults who already demonstrate strong acceptance of dairy.

The research could lead to a high-value application for WPPC, which currently holds low commercial worth, unlocking new revenue streams for the dairy industry. At the same time, it offers a novel nutritional approach to address cognitive decline, a growing public health concern. By developing scalable methods to isolate and apply beneficial milk components, the project supports both dairy sector innovation and broader efforts to promote brain health and healthy aging.

*This project is funded in partnership with National Dairy Council.

Effect of Yogurt on the Gut Microbiome of Older Adults*

RESEARCHERS: Dr. Jennifer Smilowitz, UC Davis and Dr. Danielle Lemay, USDA WHNRC
TIMELINE: 2025 - 2027

This project investigates how yogurt consumption affects the gut health of older adults, a group often at risk for reduced microbial diversity and increased susceptibility to harmful bacteria. Participants aged 50–75 years will consume two servings of California whole milk yogurt daily, allowing researchers to study changes in the gut microbiome using advanced DNA sequencing. The goal is to see whether yogurt increases beneficial microbes, decreases harmful ones, and supports overall gut health in aging populations.

By identifying how yogurt influences gut bacteria, immune markers like sIgA, and antimicrobial resistance genes, this project will generate valuable insights into the role of fermented dairy in healthy aging.

* This project is funded in partnership with National Dairy Council.

CURRENT PROJECTS PORTFOLIO

Role of Dairy in Providing High-Quality Protein for Personalized Nutrition*

RESEARCHER: Dr. Gail Bornhorst, UC Davis
TIMELINE: 2025 - 2026

This project explores how well dairy products—such as milk, yogurt, and kefir—deliver high-quality protein and beneficial peptides in different population groups, including healthy adults, older adults, and people who regularly take acid-suppressing medications like proton pump inhibitors (PPIs). As people age or take PPIs, their stomach acid levels drop, which may interfere with normal digestion. While dairy is known for its superior protein quality, very little is known about how these changes in digestion affect the release of protein and health-promoting peptides from dairy compared to plant-based alternatives like almond beverages.

Using advanced digestion models, this project will generate new knowledge on how well dairy proteins are broken down and absorbed. The findings can inform targeted nutritional recommendations and support the development of personalized nutrition strategies—especially for vulnerable populations like older adults or individuals with suppressed stomach acid as well as inform future research and communication efforts around the role of dairy in meeting personalized protein needs for specific populations.

*This project is funded in partnership with National Dairy Council.

Characterizing Extracellular Vesicles and MicroRNA in Whey Protein Isolates and Dairy Streams*

RESEARCHER: Dr. Daniela Barile, UC Davis
TIMELINE: 2025 - 2026

This project investigates the potential health benefits of extracellular vesicles (EVs) and their microRNA (miRNA) cargo naturally present in dairy protein ingredients such as Whey Protein Isolate (WPI) and Whey Protein Phospholipid Concentrate (WPPC). EVs are nanosized structures known to carry bioactive molecules that can influence immune regulation, intestinal development, and metabolic pathways. These miRNAs are thought to remain stable through digestion and interact with the intestinal lining.

The project aims to characterize EV and miRNA content in WPI and WPPC, develop scalable enrichment methods, and assess their effects on gut integrity using in vitro intestinal models. Results will provide health professionals with new insights into how dairy proteins may offer benefits beyond nutrition—through naturally occurring compounds that support gut and immune health. These findings could help inform dietary recommendations, personalized nutrition, functional foods, and preventive health strategies.

*This project is funded in partnership with Hilmar Cheese Co., Glanbia, and Actus Nutrition.

Sialic Acid and Cognitive Health

RESEARCHER: Dr. Daniela Barile, UC Davis
TIMELINE: 2026

This project investigates how dietary supplementation with whey protein phospholipid concentrate (WPPC) affects brain sialic acid and other sugars in a healthy and cognitively impaired rodent model. Findings will help determine whether naturally occurring compounds concentrated in a dairy co-product help support brain health and cognitive function, providing new evidence for the role of dairy ingredients in healthy aging and infant nutrition.

In addition, the project will evaluate practical testing methods that dairy processors can use to accurately measure these beneficial compounds and improve product quality and consistency.

'SPLASH! Milk Science Update' and the International Milk Genomics Consortium*

SPLASH! LEAD: Dr. Carl Whithaus, UC Davis
IMGC MANAGEMENT: CDRF
TIMELINE: 2026

This project produces SPLASH! Milk Science Update, a bi-monthly e-newsletter that shares the latest research and trends in milk and dairy science. It also supports the International Milk Genomics Consortium (IMGC) by organizing an annual symposium and additional educational events for researchers, industry professionals, communicators, and educators. These efforts keep the milk science community informed and connected to global advancements, fostering collaboration and innovation across the field.

Visit milkgenomics.org to access outreach materials, sign up for SPLASH!, and register for next year's symposium.

*This project is managed by CDRF and funded by the IMGC through its sponsors.

CURRENT PROJECTS PORTFOLIO

INDUSTRY DEVELOPMENT AND EDUCATIONAL OUTREACH

CDRF's Industry Development and Educational Outreach investments help translate scientific research into practical tools, training, and technical resources that support the long-term success of California dairy producers. Through partnerships with universities, government agencies, and industry organizations, these programs provide producers and allied professionals with the knowledge needed to improve environmental stewardship, strengthen regulatory compliance, manage emerging risks, and adopt innovative management practices.

Current projects focus on delivering science-based education through the California Dairy Quality Assurance Program (CDQAP), technical workshops, decision-support resources, and outreach initiatives that connect researchers, consultants, nutritionists, and producers. Together, these efforts accelerate the adoption of proven practices, strengthen industry resilience, and help ensure California dairies remain productive, sustainable, and competitive in an evolving agricultural landscape.

California Dairy Quality Assurance Program (CDQAP)*

PROJECT LEADS: Dr. Michael Payne and Dr. Deanne Meyer, UC Davis, and Denise Mullinax, CDQAP/CDRF
TIMELINE: 2026

This program is designed to ensure that all California dairy producers—regardless of size or location—have free, universal access to science-based management tools and regulatory support. Through environmental training classes tailored to California's unique dairy landscape, producers gain practical knowledge to meet state and federal environmental requirements while supporting sustainable practices. Certification services, including voluntary on-farm evaluations, offer benefits such as reduced water quality permit fees and decreased regulatory inspection frequency. These services can help producers stay compliant and reduce the risk of enforcement actions compared to non-certified operations, providing peace of mind and long-term operational stability.

The CDQAP program also delivers timely, producer-focused outreach on a broad range of issues critical to modern dairy operations. From animal care and food safety to farm security and emergency preparedness, all materials and events are developed to be accessible and actionable. Producers receive guidance on navigating evolving CDFA regulations—such as changes to livestock medication policies—and on maintaining business continuity in the face of catastrophic animal disease outbreaks.

The program also works closely with law enforcement and industry groups to prepare producers for threats like theft or activist activity, all while supporting efforts to promote a positive public image of California dairying. By bridging compliance, risk reduction, and proactive communication, this program is a vital resource for a resilient, sustainable dairy sector.

Visit cdqap.org to access outreach materials.

*CDQAP is an industry-academia-government partnership that serves to support California dairy producers. CDRF funds CDQAP outreach activities.

Sustainable Dairy Practices: Surveying Nutritionists to Inform Effective Outreach Strategies

RESEARCHER: Jennifer Heguy, UC ANR
TIMELINE: 2025 - 2026

This project addresses urgent sustainability challenges in California's dairy industry by focusing on feed—the largest cost in milk production and a major driver of environmental impact. A statewide survey of dairy nutritionists will assess their interest, knowledge, and barriers to adopting strategies that reduce nitrogen loss, salt loading, water use for forages, and methane emissions. Deliverables include peer-reviewed publications, presentations at major dairy science conferences, and articles in industry outlets. This project will produce a clear outreach plan to help nutritionists—and the dairies they serve—implement effective, sustainable feeding strategies in response to increasing environmental pressures and regulations.

CURRENT PROJECTS PORTFOLIO

SOCIAL RESPONSIBILITY

CDRF's Social Responsibility investments help California dairy producers strengthen responsible management practices that protect animal health, safeguard the environment, and build public confidence in dairy farming. Research in this focus area addresses emerging challenges in biosecurity, emergency preparedness, food safety, animal care, and environmental stewardship by developing science-based solutions that support both producers and the communities they serve.

Current projects focus on practical tools and best management practices that improve on-farm preparedness, reduce environmental impacts, and support regulatory compliance during both routine operations and emergency situations. By combining research, outreach, and producer education, these efforts help ensure California dairies remain resilient, responsible, and prepared for future challenges.

Composting as an Economical and Sustainable Emergency Animal Mortality Option*

RESEARCHER: Dr. Michael Payne, UC Davis
TIMELINE: 2023 - 2026

This project evaluates the environmental impacts of proper carcass composting on groundwater, surface water, and air quality, aiming to develop effective mitigation procedures and best management practices for poultry and livestock composting, especially where rendering services are unavailable. The study involves continuous monitoring of temperature, salinity, and moisture in compost piles to ensure optimal conditions, assesses pathogen reduction for biosecurity, and evaluates nutrient infiltration into soil to understand effects on soil and water quality. It also analyzes nutrient and heavy metal content in feedstock and finished compost and monitors air emissions throughout the composting process to mitigate potential impacts.

The benefits include demonstrating carcass composting as an effective, environmentally sustainable, and practical solution for managing routine and emergency animal mortalities. This approach offers a cost-effective alternative to rendering, helping producers comply with environmental regulations while protecting natural resources. The project establishes standardized composting protocols to ensure systems can handle both regular and surge mortality events, providing the livestock industry with reliable, science-based tools for sustainable mortality management.

* Funding for this project is provided by California Department of Food and Agriculture (CDFA).

INNOVATION AND TECHNOLOGY

CDRF's Innovation and Technology investments support the development of new technologies, value-added ingredients, and processes that create value for California dairy producers while advancing environmental sustainability and competitiveness. By bringing together researchers, industry partners, and technology developers, these projects explore innovative ways to improve resource utilization, reduce waste, and expand market opportunities for dairy-derived products.

Current projects focus on transforming dairy co-products into high-value materials and evaluating emerging technologies.

Dairy Byproducts Valorization to Bioplastics*

RESEARCHER: Dr. Ruihong Zhang, UC Davis
TIMELINE: 2025 - 2026

This project is focused on turning a common dairy byproduct—whey permeate—into high-value, biodegradable plastic that can be used in food packaging. Using a natural fermentation process powered by microbes, researchers are exploring how to convert leftover sugars from cheese production into a type of bioplastic called Polyhydroxyalkanoates (PHA). Unlike traditional plastics, PHA can break down in the environment and has a much smaller carbon footprint. Early research showed promise, but more work is needed to fine-tune the process so it's efficient, cost-effective, and produces a strong, flexible plastic suitable for real-world applications.

The goal is to create eco-friendly packaging from something that would otherwise go to waste. This project will improve the process for making PHA from whey permeate, test packaging prototypes like films and containers, and evaluate the economic feasibility of producing these products at scale. The outcome could give dairy producers new, sustainable uses for their byproducts while helping reduce plastic waste—turning what's often seen as waste into a win for both the environment and the dairy industry.

*This project is funded in partnership with California Dairy Innovation Center and Dairy Management Inc.

ANNUAL PROJECTS REPORT

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CALIFORNIA DAIRY RESEARCH FOUNDATION

Science for a Sustainable Future

2020 Research Park Dr.,
Suite 110
Davis, CA 95618

admin@cdrf.org