DAIRY MANURE MANAGEMENT: MOVING FROM WASTE PROBLEM TO CLIMATE SOLUTION

PLATFORM RECOMMENDATIONS AT-A-GLANCE

- Scale Up AMMP Funding
- Develop Guardrails for Incentivizing Feed Additives
- Catalyze Innovations in Regional-Scale Manure Composting Infrastructure

A CLIMATE PLATFORM FOR CALIFORNIA AGRICULTURE

This is one in a series of CalCAN policy briefs that describe approaches to moving California agriculture boldly and quickly toward a carbon-neutral and climate-resilient future. Together, they make up *A Climate Platform for California Agriculture.*

Access the full report at: calclimateag.org/ca-agriculture-climate-platform

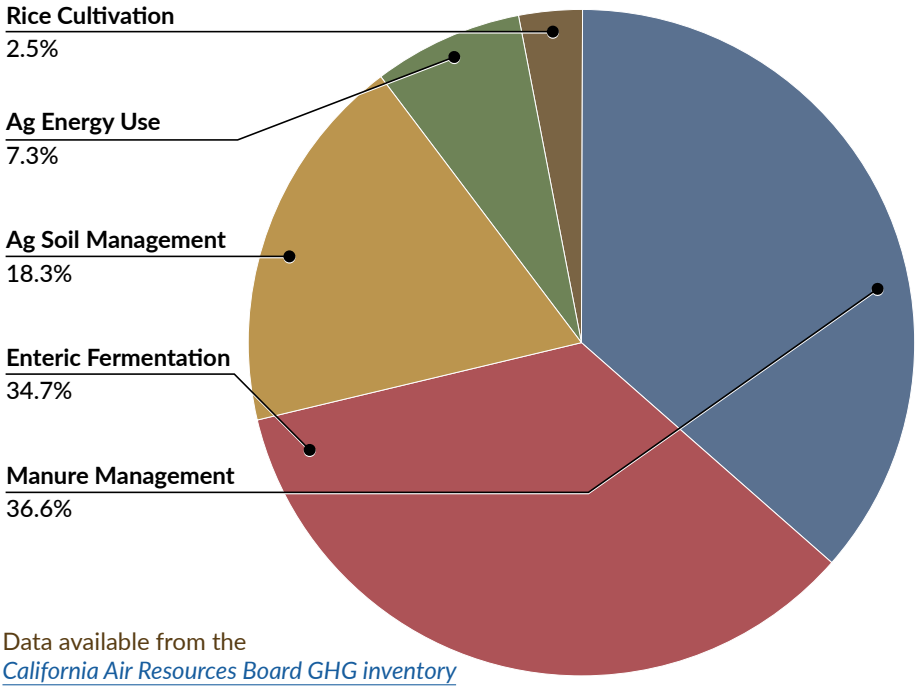
AUTHOR: Renata Brillinger

CalCAN
CALIFORNIA CLIMATE & AGRICULTURE NETWORK

INTRODUCTION

California's dairy operations are responsible for approximately 45 percent of the state's methane emissions (other livestock operations contribute an additional 10 percent),[26] and 80 percent of the state's agricultural methane is emitted on dairies.[27] Approximately equal amounts of methane come from the anaerobic decomposition of liquid manure and from enteric fermentation (gaseous emissions from the cows themselves). In 2016, Governor Brown signed SB 1383 (Lara) which includes a statewide target for reducing methane from dairy and livestock operations to 40 percent below 2013 levels by 2030.

2020 CA Agriculture Emmissions by Source (CARB GHG Inventory)



Data available from the *California Air Resources Board GHG inventory*

This law spurred state investments totaling more than $290 million in two voluntary incentive programs to cut methane emissions generated from manure. The California Department of Food and Agriculture (CDFA) launched the Dairy Digester Research and Development Program (DDRDP) in 2015 and has granted more than $200 million for

[26] California Air Resources Board. GHG short-lived climate pollutant inventory.
[27] Legislative Analyst's Office. (2021). Assessing California's climate policies—agriculture.

anaerobic dairy digester projects to capture methane from manure flushed from barns into lagoons and refine it for bio-energy or biofuel. Hundreds of millions more have been spent on biogas infrastructure to deliver and process the methane in refineries.

Then in 2017, CDFA started the Alternative Manure Management Program (AMMP) with grants to fund equipment that supports management of manure in a dry form, including separation of manure solids from liquids and production of valuable compost. In 2023, a U.S. Department of Agriculture (USDA) grant launched the Dairy PLUS Program at CDFA for projects that reduce both methane emissions and nutrient surplus associated with manure management.[28] Finally, CDFA is funding research into potential feed additives to reduce methane emissions from enteric fermentation,[29] and in the 2023 –24 fiscal year budget, $20 million was allotted to incentivize the use of these products.


Photo Credit: Joseph Camozzi Dairy

To evaluate progress made toward achieving the SB 1383 targets, the California Air Resources Board released a report in March 2022 that projected that the industry will get about halfway to the 2030 target of a reduction of 9 $MMTCO_2e$, assuming no additional funding beyond FY 2020 –21.[30] They concluded that to achieve the target, the dairy and other livestock sectors need to reduce annual methane emissions by another 4.4 $MMTCO_2e$ using new projects and programs.

CalCAN advocates for livestock methane reduction strategies that have multiple climate and other environmental benefits and work for small and medium-sized dairies[31] that face mounting challenges to staying in business. With insights gained from interviews with dairy producers, industry experts, technical assistance providers, and advocates, we focus here on approaches that are practical, economical, and feasible for producers and that cycle manure waste into fertility products, decreasing groundwater nitrate contamination and air pollutants, and creating healthier conditions for farmworkers, communities, and livestock.

FINDINGS

Incentives Skew Toward Large Dairies and Are a Driver of Consolidation

About half of milk production in California occurs on dairies with 2,000 cows or fewer and half on dairies with larger numbers of cows.[32] An economic analysis conducted by UC Davis predicts that over the next two decades, dairy herd sizes will increase and the number of farm businesses will decrease, especially dairies with fewer than 500 cows[33] (mainly pasture-based operations located on the North Coast). Most organic dairies in the Central Valley have gone out of business over the past decade as the price premium on organic milk has not kept pace with the higher cost of feed and land. Dairy producers tell us that they worry about their ability to stay in business, and they are watching the fabric of their communities change as more and more dairies close.

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[28] CDFA's Dairy PLUS Program has $85 million over five years.

[29] CDFA. (2022) *California livestock methane measurement, mitigation and thriving environments research program (CLIM3ATE-RP).*

[30] California Air Resources Board. (2022). *Analysis of progress toward achieving the 2030 dairy and livestock sector methane emissions target.*

[31] The average dairy herd size in California is approximately 1,200. Smaller herds of 500 or fewer are clustered on the North Coast and are mainly organic and grassfed. Medium-sized herds of 1,000 –2,500 and the 200+ largest herds with 2,500 to as many as 10,000 head are all located in the San Joaquin Valley. Source: Sumner, D. A. (2020). *California dairy: Resilience in a challenging environment.*

[32] Kaffka, S., et al. (2022). *Manure nutrient recovery, removal, and reuse on California dairies.* California Biomass Collaborative.

[33] Sumner, D. A. (2020). *California dairy: Resilience in a challenging environment.*

Funding Sources: Alternative Manure Management Versus Anerobic Digester

Alternative Manure Management:

- CDFA's AMMP program: **$88.4 million to date**

Garry Mahrt at Gillian's Dairy aerating manure in his compost pack barn, an eligible practice for AMMP funding.

Anaerobic Digesters:

- CDFA's DDRDP: **$203.7 million to date**
- California's Cap-and-Trade Carbon Market: approximately **$28.5 million in 2019**
- Low-Carbon Fuel Standard (LCFS) Credits
- USDA Environmental Quality Incentive Program (EQIP)
- USDA Rural Energy for America Program (REAP) grants and loans
- Electric Program Investment Charge, California Energy Commission
- Pipeline infrastructure for clusters of dairies with digesters: California Public Utilities Commission; Aliso Canyon natural gas leak legal settlement
- Other federal grants and loans, including Conservation Loan Program; Biorefinery, Renewable Chemical, and Biobased Product Manufacturing Assistance Program; Bioenergy Program for Advanced Biofuels; Biomass Research and Development Program; Biodiesel Fuel Education Program; and Carbon Utilization and Biogas Education Program

There are many sources of incentives for anaerobic digesters used by dairies with large herd sizes. In contrast, medium and small dairies have only California's AMMP grants to incentivize dry manure management techniques. Concerns About the Environmental Impact of Digesters Consolidating dairies also concentrates waste, related air quality impacts (from ammonia, particulate matter, and nitrous oxide), and nitrates that contaminate groundwater. Critics of the environmental impacts of large dairies see public subsidies for digesters driving the expansion of dairies, providing them with multiple revenue streams for producing more manure and more methane. Most of California's large conventional confinement dairies are in the San Joaquin Valley, concentrating environmental harms in poor rural and socially disadvantaged communities.

In particular, the method for calculating the carbon intensity of the Low Carbon Fuel Standard (LCFS) credit for biogas produced in anaerobic digesters is coming under scrutiny for its potential to exacerbate harm in environmentally burdened communities. Also, given the enormous amount of public funds invested in anaerobic digesters, it is also important to have a clear evaluation of the volume of methane that leaks from these systems and the amount of methane generated from the solids left after methane digestion (called digestate). One study reports that digestate accounts for more methane emissions per tonne than the original manure.[34] Another study noted the high degree of variability in research on methane emissions and found emissions 60 percent higher than those reported by CARB.[35]

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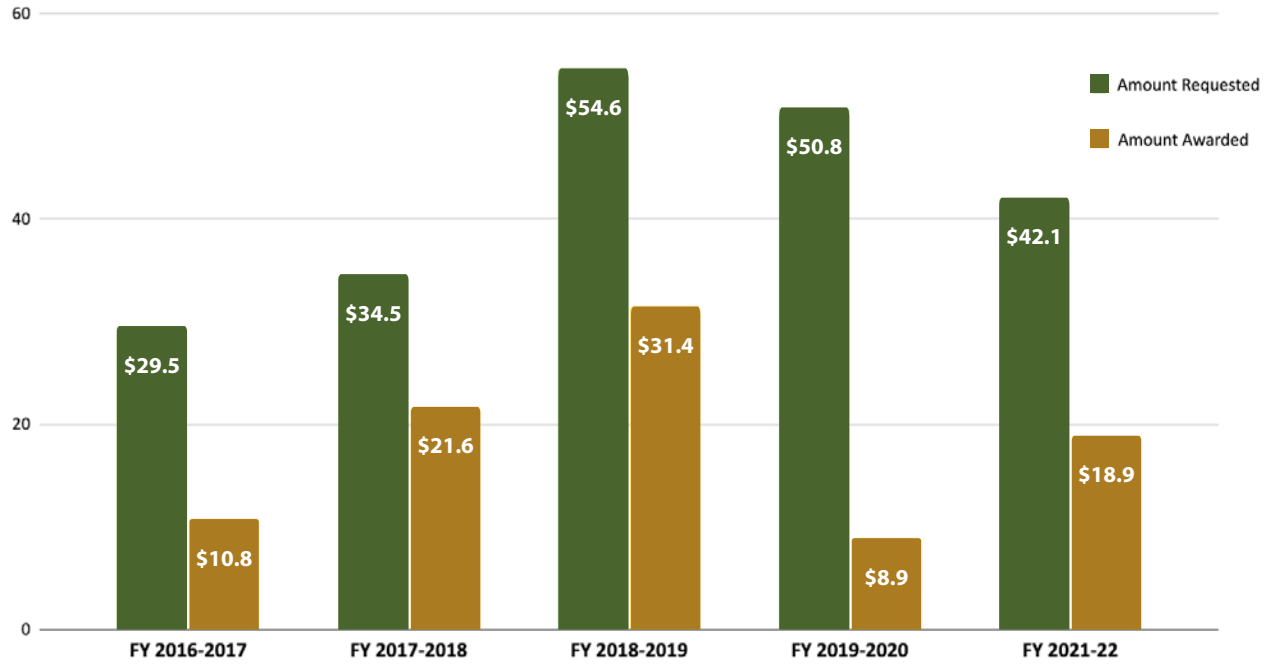
[34] Bakkaloglu, S., et al. (2022). Methane emissions along biomethane and biogas supply chains are underestimated. *One Earth, 5*(6).

[35] Vechi, N. T., et al. (2023). Ammonia and methane emissions from dairy concentrated animal feeding operations in California, using mobile optical remote sensing. *Atmospheric Environment, 293*(15).

Dairy Producers Are Interested in Modernized Manure Management Systems

The AMMP program has been oversubscribed by two to three times the available funds since it began in 2017. It provides grants to install equipment that manages manure with dry scrape systems, solid separation, compost pack barns, or increased pasture time. These techniques reduce the amount of manure stored anaerobically and dramatically reduce methane emissions by as much as 90 percent.[36] However, AMMP has been plagued by inconsistent and highly variable state support, making it difficult for producers to plan for and prepare time-consuming grant applications and assess their chances of getting funded.

Alternative Manure Management Program Demand ($ millions)



We consistently hear from small and medium-sized dairy producers that AMMP grants, besides reducing a potent greenhouse gas, also enable them to invest in capital improvements in their operations that they otherwise could not afford given their tenuous economics. Some producers use the composted manure solids for bedding, displacing the need to purchase bedding material and reducing greenhouse gases (GHGs) associated with bedding transport. Other farmers apply it to hay fields or orchards instead of fossil fuel–based fertilizer, which can save money and cut GHG emissions.

Interest and Concern About Enteric Fermentation Feed Additives

We heard a combination of interest and caution about feed additives such as seaweed to reduce enteric emissions of methane. While recognizing that there is potential, one interviewee told us that "feed is the most expensive line item on dairy ledgers, and adding to it is going to be a hard sell." As one small dairy farmer pointed out, the economies of scale often set up disadvantages for small operations, possibly skewing incentives once again in favor of large concentrated dairies. An organic producer wondered about how it might affect their organic certification or consumer perceptions. Research is needed to address grower concerns about palatability and the effect on the taste of the milk, as well as on the net cost increase of feed additives. Finally, a thorough environmental life cycle assessment of using additives is needed. We have heard general concern that the policy is getting ahead of the science and that farmers need to have access to reliable science and be at the table in policy debates.

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[36] Owen, J., & Silver, W. (2014). Greenhouse gas emissions from dairy manure management: A review of field-based studies. *Global Change Biology*, *21*(2).

Multiple Benefits of Turning Waste Into Resources

By design, CARB's approach to reducing methane emissions on livestock operations is very narrow. The GHG calculator used for AMMP projects does not account for improved soil health and the potential carbon sequestration and water use efficiency that can come from compost applications. It also does not include potential nitrous oxide reductions associated with avoiding the application of liquid manure to crops or pasture, nor the substitution of composted manure for synthetic forms of nitrogen on California croplands and pastures.

We heard about the importance of facilitating and incentivizing the composting of manure and other agricultural waste. A recent report of CDFA's Manure Recycling and Innovative Products Task Force[37] found that solar drying of separated solids is a key strategy for achieving whole-farm nutrient balance on dairies. However, nitrous oxide emissions may increase, so the impact on net GHG emissions should be evaluated.[38] Composting manure solids reduces methane emissions that could otherwise result from storing liquid or solid manure in anaerobic conditions. It can also reduce the leaching of nitrates into groundwater that can occur when dairies produce more manure or digestate than they can safely distribute on their land mass. Furthermore, compost applications can also improve soil health and thereby increase carbon sequestration and mitigate flooding and drought by improving the water-holding capacity of soils.

The State Water Resources Control Board recently clarified that dairies with Regional Water Quality Control permits that include manure management requirements can compost under their existing Regional Board permits and are not required to obtain a separate composting permit nor adhere to the feedstock import and compost export limitations of separate composting permits.[39] This clarification helped ensure compost remains a viable option for dairies to export their surplus manure to reduce nitrate leaching to groundwater and meet their existing permit requirements.

Manure solid separator funded by AMMP at Beretta Dairy in Sonoma County.

A 2022 study found that methane emissions from manure can be further reduced by 60 to 84 percent by adding biochar, and estimated that the SB 1383 target could be met with 132 fewer digesters than CARB projects are needed.[40] Compost augmented with biochar can improve soil nitrogen retention and plant productivity and therefore can improve air quality and water quality. The biochar could be produced through pyrolysis from the Central Valley's abundant amounts of almond shell and hull waste, removed trees, and other woody agricultural waste that would otherwise be burned in open piles.

Several interviewees for both this solution chapter and *Reducing Farmer Dependence on Fossil Fuel–Based Pesticides and Fertilizers* noted the opportunities available by taking a holistic approach to closing the agricultural waste cycle. One interviewee remarked that "creating some sort of innovation engine to deal with waste cycling that isn't necessarily commodity-specific is one role that governments can play to organize and fund solutions at a regional scale."

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[37] Manure Recycling and Innovative Products Task Force. (2022). *Final report to CDFA.*

[38] U.S. EPA. *Practices to reduce methane emissions from livestock manure management.*

[39] CDFA's On-Farm Compost Regulatory Overview states: "Dairy sites issued an individual permit or enrolled in a general order that includes requirements for manure management can accept agricultural material from offsite and can compost and give away or sell as much finished compost as desired."

[40] Harrison, B. P. ,et al. (2022). Dairy manure co-composting with wood biochar plays a critical role in meeting global methane goals. *Environ. Sci. Technol.*, *56*(15).

RECOMMENDATIONS

Scale Up AMMP Funding

To meet dairy producer demand, we recommend an average annual investment of $50 million for a total of $350 million by 2030. Including dairies that already have AMMP projects installed, this would reach an estimated total of two-thirds of California's 1,100 dairies. Assuming a consistent level of reductions as those achieved to date, by 2030 methane emissions would be reduced by a total of 6.56 MMTCO2e annually (73 percent of the SB 1383 methane reduction goal). We also recommend the creation of a new federal AMMP program to increase the reach of the program and to extend it to other dairy states across the country.

Develop Guardrails for Incentivizing Feed Additives

There is growing scientific and policymaker interest in feed additive products that may reduce methane emitted from enteric fermentation. Future policy, whether for carbon market protocol design, publicly funded grants, or regulations, should be informed by the following considerations:

- A complete life cycle assessment to evaluate the net greenhouse gas and environmental impact of growing, harvesting, and processing enteric fermentation feed additives
- An assessment of whether feed additives deliver co-benefits such as air and water quality improvements, reductions in ammonia and odor, and improved farmworker safety and well-being
- An evaluation of the economic feasibility and practical implications of purchasing and delivering the appropriate amounts of the feed additives to livestock, with particular concern for the operational challenges faced by small and medium-sized producers
- There should be no cost to small and medium-sized dairy operations, and they should accrue some of the market value of providing an ecosystem service
- No single product manufacturer should benefit from state funding and promotion of their products

Manure solid separator funded by AMMP at Brindeiro & Danbom Dairy in Stanislaus County.

Catalyze Innovations in Regional-Scale Manure Composting Infrastructure

Policies are needed to shift agricultural waste management in the dairy sector and other commodities from a narrow and siloed approach to a holistic, multi-beneficial approach. To the fullest extent possible, the use of manure and compost should be prioritized over synthetic nutrient sources, with a view to reducing synthetic fertilizer imports into the state. This can be done by building on the recommendations for compost strategies identified in the Manure Recycling and Innovative Products Task Force Final Report.[41] A life cycle analysis is needed to evaluate the potential to replace synthetic fertilizers with compost or manure, taking into account the ecosystem benefits of on-farm compost use, including GHG emissions reductions, soil health improvements, water conservation, and water quality improvements. Investments are needed in pilot projects to establish cooperatives that manage agricultural waste in regional hubs, perhaps under the framework of the Resource Conservation Districts.

[41] Manure Recycling and Innovative Product Task Force. (2022). *Final report to CDFA.* See Section 5.2, Compost Strategies.