CALIFORNIA
AIR RESOURCES BOARD

California Dairy Sector Workshop

August 22, 2024

Overview

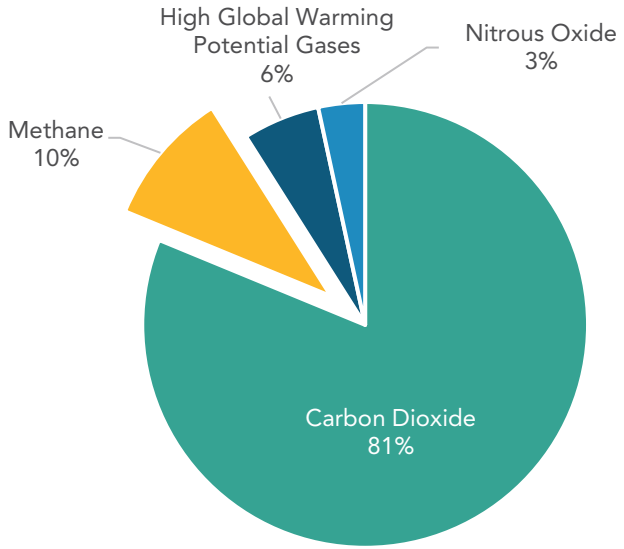
- Methane Policy Framework
- California Dairy and Livestock Database (CADD)
- Initial Findings
- Next Steps

Methane – Why It's Important

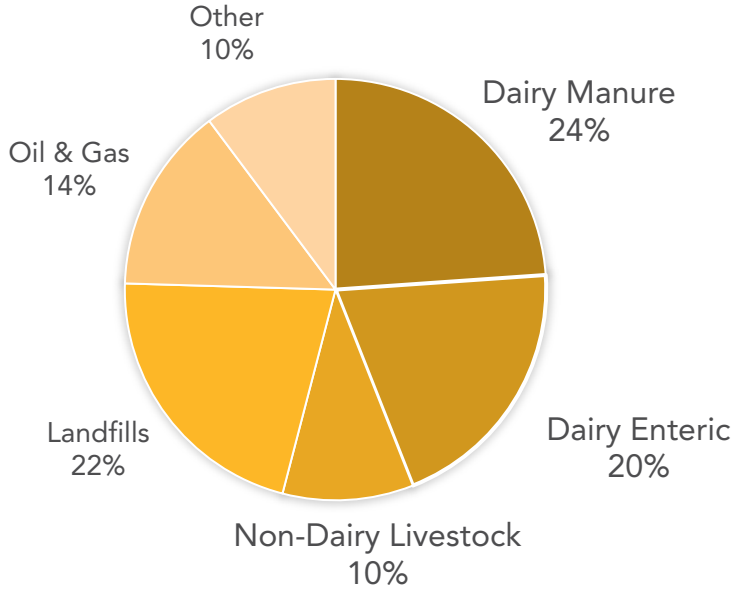
- Methane is a potent short-lived climate pollutant (SLCP) responsible for approximately 25% of current warming effects to date
  - Strong scientific consensus on the immediate need to reduce methane emissions to stabilize global warming in this decade
  - Strategies to reduce methane are cost effective and have health co-benefits from reducing ozone

- The Dairy and Livestock sector is the largest methane source in California, responsible for more than half of statewide methane emissions

Methane Emissions in California



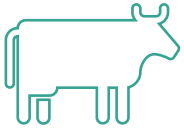
2021 Emissions by Greenhouse Gas
381 million metric tons (MMT) CO_2e



2021 Methane Emissions
37.4 MMTCO_2e

California AB 32 GHG Inventory 2000-2021 (2023 Edition)
using 100-year AR4 global warming potential

California Methane Emissions Sources



- Over 1,000 dairies in the state
- Over 1.5 million dairy cows
- 1 in 5 U.S. dairy cows live in California

- Nearly 400 landfills
- 20 million tons of organic waste disposed each year
- 74 million tons of degradable carbon accumulated in landfills

- Over 260,000 miles of fossil gas pipeline
- 50,000 active oil and gas wells
- Eighth largest oil producer and 15th largest gas producer in the U.S.

California's Greenhouse Gas (GHG) and Short-Lived Climate Pollutant (SLCP) Policy Framework

- AB 32 (Nuñez, 2006) and SB 32 (Pavley, 2016) require the State to reduce GHG emissions to 1990 levels by 2020, and 40% below 1990 levels by 2030
- SB 605 (Lara, 2014) and SB 1383 (Lara, 2016) require CARB to implement an SLCP Reduction Strategy and reduce methane 40% from 2013 levels by 2030
- AB 1279 (Muratsuchi, 2022) sets State goals to achieve carbon neutrality and reduce GHG emissions at least 85% below 1990 levels by 2045
- The 2022 Scoping Plan Update lays out a path to achieve carbon neutrality and identifies strategies for further reductions in SLCP and other key sectors
- California is a global leader in climate policy, research, and collaboration

California's Methane Reduction Strategy

Research	• Inventory, data collection, research, and monitoring
Regulations	• Landfill regulation for gas capture • Organic waste diversion regulation • Oil and gas methane regulation
Grants/Loans	• Organic diversion (AD/compost) • Dairy and livestock methane
Environmental Crediting	• Biomethane for transportation (LCFS) • Biomethane for energy, mine methane capture and rice cultivation (C&T)

SB 1383 Requirements

- SB 1383 establishes a sector-specific methane emissions reduction target for dairy & livestock, and calls for an incentives-first approach before regulation

- Prior to implementing regulation to reduce methane emissions from manure management, the State must continue to:
  - ☑ Work with stakeholders to address technical, market, and regulatory barriers to project development
  - ☑ Provide forums for public engagement in geographically diverse locations
  - ☑ Conduct or consider research on dairy methane reduction projects and adoption of emissions reduction protocols
  - ☑ Analyze progress made in overcoming barriers
  - ☐ Determine that any regulation is technologically feasible, economically feasible, cost-effective, inclusive of provisions to minimize and mitigate potential leakage to other states, and inclusive of an evaluation of the achievements made by incentives

✓ *Requirement has been substantially addressed, but the State's efforts are ongoing*

Regulatory Actions by Other Agencies

- State and Regional Water Boards
  - Water quality permitting requirements for dairies that include agronomic nutrient application and herd size limits
  - Mandatory annual reporting and periodic facility inspection
- Air Districts
  - Air quality permitting with health risk assessment for dairies and digesters that include strict emissions and herd size limits
  - Periodic facility inspection
- Local Agencies
  - Responsible for CEQA review of new dairies and herd expansions
  - Local level project approval

CARB Rulemaking Petitions

October 27, 2021

- CARB received a Petition to amend the Low Carbon Fuel Standard (LCFS) regulations to exclude all fuels derived from dairy and swine manure biomethane
- Partially denied and partially granted, committing to engage through public processes

March 25, 2022

- Petition for reconsideration of the October 2021 LCFS petition
- CARB hosted a comprehensive public workshop "Methane, Dairies and Livestock, and Renewable Natural Gas in California" to seek input on the concerns raised by petitioners

March 1, 2024

- Petition to initiate a rulemaking, expand research, investment, and other actions to reduce methane from California dairy and livestock operations
- Partially denied and partially granted, committing to continue methane strategies while not immediately adopting regulations on manure management

Dairies and Air Quality

- Dairies produce significant amounts of ammonia (NH_3) and total organic gases (TOG) which impact air quality
- Ammonia from dairies contributes to formation of ammonium nitrate, which makes up 30% of the fine particulate ($PM_{2.5}$) in the San Joaquin Valley
- Oxides of nitrogen (NOx) from vehicles are another contributor to ammonium nitrate formation
- Air quality modeling shows that reducing NOx, not ammonia, is most effective pathway to reducing ammonium nitrate in the San Joaquin Valley

Ongoing Assessment of Dairy Air Quality Impacts

- CARB beginning process of updating NH_3 and TOG emissions inventory for dairies, using best available livestock population data
- Accurate emissions inventory critical for development of 9 $\mu g/m^3$ $PM_{2.5}$ State Implementation Plans (SIP) due to US EPA in 2027
- Input of interested parties is key to improving emissions inventory for the SIP
- First SIP emissions inventory workshop in September 2024
- Many opportunities for public input before finalizing SIP emissions inventory in May 2025

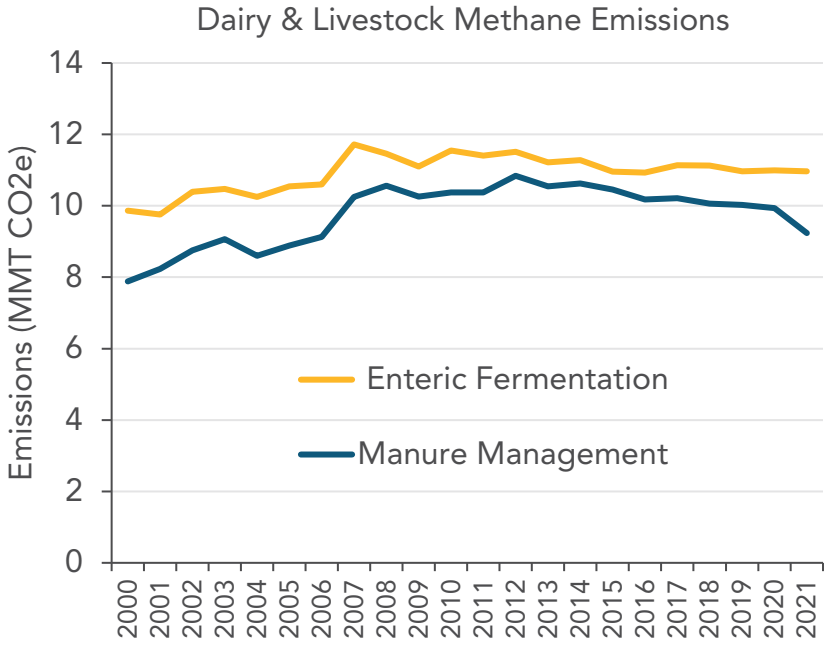
Research Efforts

CARB and California Department of Food and Agriculture (CDFA) have funded or conducted multiple dairy and livestock research studies, literature reviews, measurement campaigns, and model development efforts

- Onsite, Mobile, Flyover, and Satellite-based Emissions Measurement and Monitoring Campaigns
- Effectiveness of Manure Management Strategies
- Enteric Methane Reducing Strategies
- Enteric Testing Standard Development and Calibration
- California Dairy Emissions Model (CADEM) Development
- Digestate Land Application Emissions
- Biomethane Constituents

AB 32 GHG Emissions Inventory Trends

- GHG emissions from manure management and enteric fermentation increased as the State's dairy population grew
- Over the past decade, population decreases and increasing adoption of anaerobic digesters contributed to emission reductions

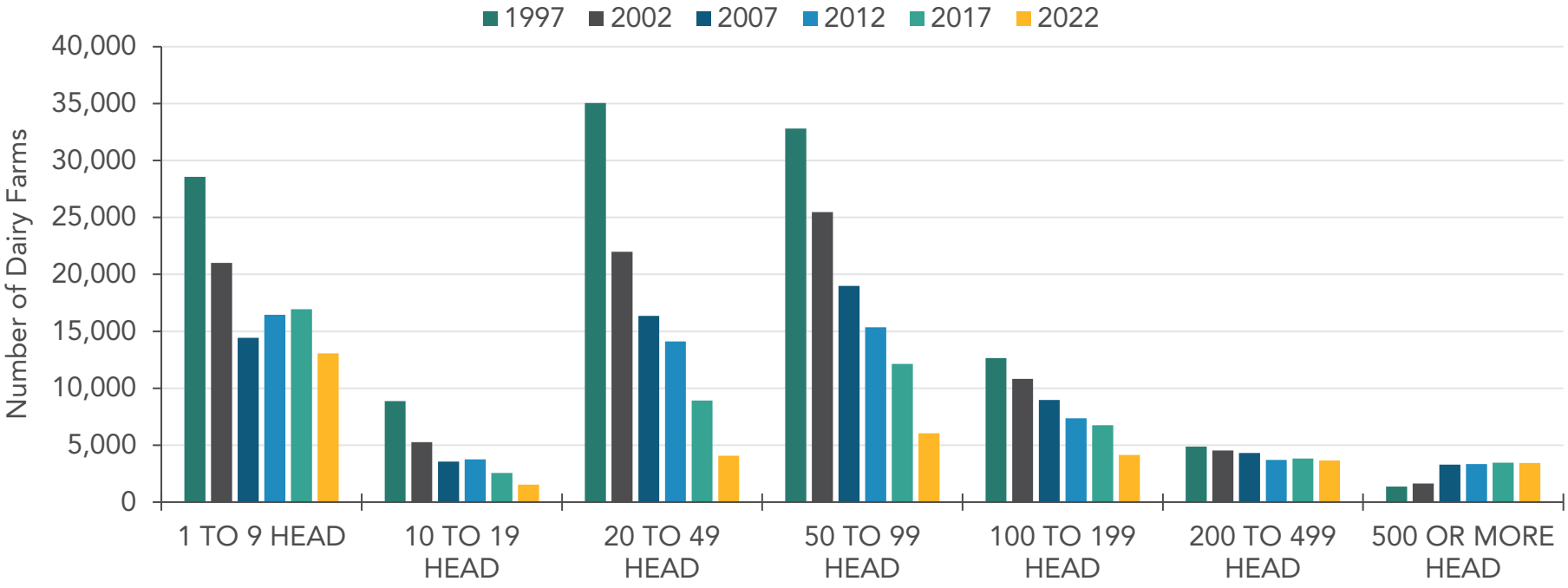


California GHG Emissions Inventory 2000 – 2021 (2023 Edition)

Dairy Sector Trends – 2022 USDA Census

- Nationally, the dairy population has remained static over the past quarter century (fluctuating by less than 5% across U.S. Department of Agriculture's (USDA) Census years)
  - In California, the number of dairy cattle has declined by 0.7% per year between 2012 and 2022
  - Populations grew in only seven major dairy producing states between 2012 and 2022 (Texas, Michigan, Idaho, Iowa, Colorado, South Dakota, and Kansas)
- The sector has been consolidating into fewer, larger farms for decades

U.S. Dairy Cattle Farms by Size



Source: USDA NASS

Questions Raised on Dairies and Methane Reduction Incentives

- Is California on track to achieve the SB 1383 target for the dairy and livestock sector? How effective are the current mitigation strategies?
- What are the trends in dairy and livestock populations in California? What is causing these trends?
- Are there data sources other than voluntarily reported survey data or verified incentive program data available to track progress?
- Are incentives for dairy digesters resulting in dairies consolidating or dairies getting larger?

Current GHG Inventory Data Sources

Dairy sector emissions in the GHG Inventory are calculated using:

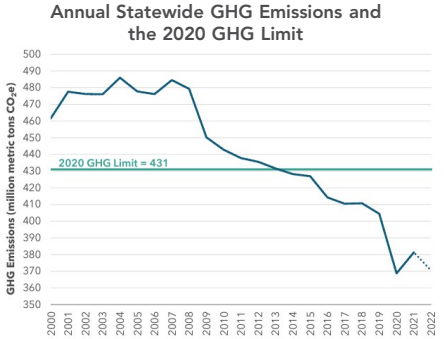
- Statewide population data from the USDA 5-year Census of Agriculture
- Parameters from the U.S. EPA GHG Inventory methodology (e.g., excretion rate, methane conversion factor, manure management system distribution)
- Verified digester project data from the Low Carbon Fuel Standard and Cap-and-Trade Program (number of cows; fraction of manure sent to the digester)

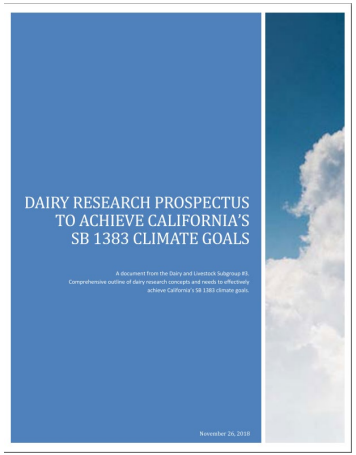
Data challenges include:

- Census population data is only available at the county level, and is only updated every five years
- Digester project data is only available for the subset of projects participating in these incentive programs, resulting in undercounting GHG reductions from digester adoption and changes to manure management

Importance of Improved Data Sources

- The GHG Emissions Inventory enables analysis of overall statewide emissions trends. However, current activity data for California dairies are not refined enough to evaluate the additional questions
- More detailed data on dairies and methane mitigation, e.g., at the individual dairy level, would help assess environmental outcomes and progress
- In response to Board member inquiries, stakeholder requests, communities' concerns, and the SB 1383 Working Group recommendations, CARB's Research Division initiated an effort to improve data sources





CARB Research Program

Legislatively mandated

Sound science to inform CARB programs and support CARB goals

Five-year strategic research plan

Operationalizing racial equity

California Dairy and Livestock Database (CADD)

What is it and how was it developed?

What is CADD?

CADD contains **publicly accessible** information on facility-level cattle herd size and digester projects for **California dairies** for **every year from 2012 – 2022**

CADD is based on the following primary data sources:

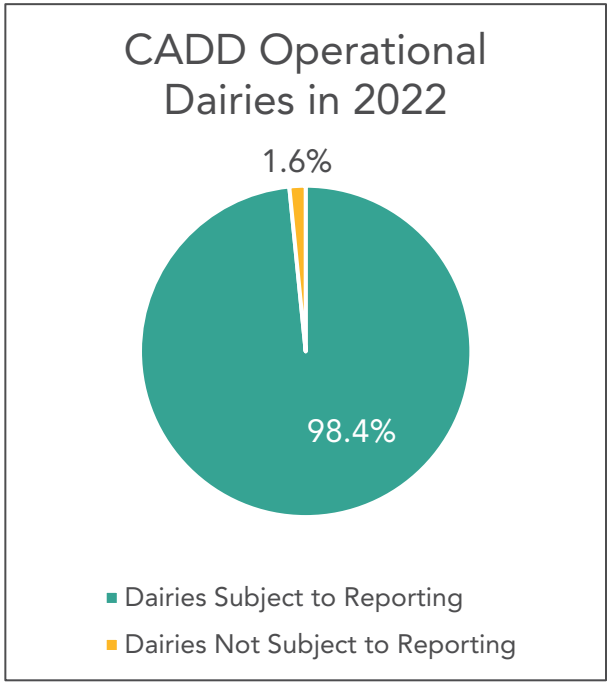
- Annual reports from Regional Waterboards
- California Integrated Water Quality System (CIWQS) database from State Waterboard
- Project-level data from CDFA's Dairy Digester Research and Development Program (DDRDP)
- AgSTAR Livestock Anaerobic Digester Database from U.S. EPA

What Facilities Are Included in CADD?

Cattle facilities in California:

- Subject to reporting* to the Regional Waterboards
- Received funding from CDFA's DDRDP or Alternative Manure Management Program (AMMP)
- Permitted by the San Joaquin Valley Air Pollution Control District in 2019, or
- Housed cattle in 2012 – 2022 (using Google Earth images)

*For example, dairies that started operating after October 17, 2005, or expanded since then, are exempt from reporting to the Central Valley Regional Waterboard Dairy General Order (R5-2013-0122)

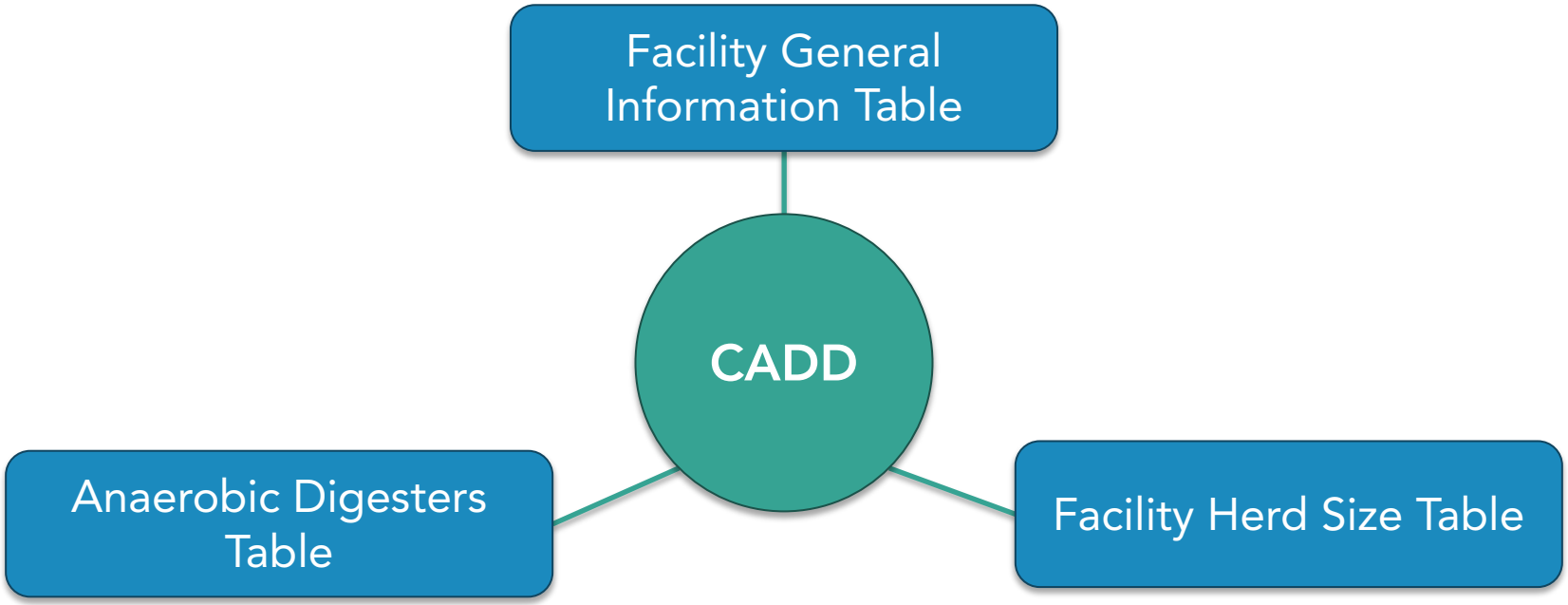


Non-Dairy Cattle Facilities

- Some CADD facilities are non-dairy cattle facilities that started submitting annual reports in 2019, as required by the Bovine General Order (R5-2017-0058) – the CADD coverage years for these facilities is 2019 – 2022

- While CADD contains valuable facility-level herd size information for these facilities, since many non-dairy cattle facilities are exempt from reporting under the Bovine General Order, **CADD does not capture all non-dairy cattle facilities in the State**

CADD Structure



Facility General Information Table

Description: Contains facility name and location information with a total of 2,115 facilities

Primary data source: State Waterboard's CIWQS database

- CIWQS is a computer system to track information about places of environmental interests, manage orders, and track inspections
- Contains general information (name, location) about facilities

Facility Herd Size Table

Description:

- Contains facility-level herd sizes of seven cattle categories for all facilities for each year from 2012 – 2022
- **Cattle categories:** Milk Cows, Dry Cows, Old Heifers (Heifers 15 – 24 months old), Young Heifers (Heifers 7 – 14 months old), Old Calves (Calves 4 – 6 months old), Young Calves (Calves 0 – 3 months old), and Beef Cattle

Primary data source: Regional Waterboards' annual reports

Regional Waterboards' Annual Reports

- In California, all owners/operators of dairies and confined bovine feeding operations – with some exemptions – are required to submit annual reports to their regulating Regional Waterboards
- These reports include detailed herd size information for each facility for each year
- We requested annual reports for 2012 – 2022 (+12,000 PDFs)

Example of the herd size table in an annual report submitted under Dairy General Order

Annual Report - General Order No. R5-2007-0035
Reporting period 01/01/2022 to 12/31/2022.

AVAILABLE NUTRIENTS

A. HERD INFORMATION

	Milk Cows	Dry Cows	Bred Heifers (15-24 mo.)	Heifers (7-14 mo. to breeding)	Calves (4-6 mo.)	Calves (0-3 mo.)
Number open confinement	0	0	0	0	0	0
Number under roof	500	0	200	0	0	0
Maximum number	500	0	200	0	0	0
Average number	500	0	200	0	0	0
Avg live weight (lbs)	1,400	0	900	0		

Predominant milk cow breed: Holstein

Average milk production: 75 *pounds per cow per day*

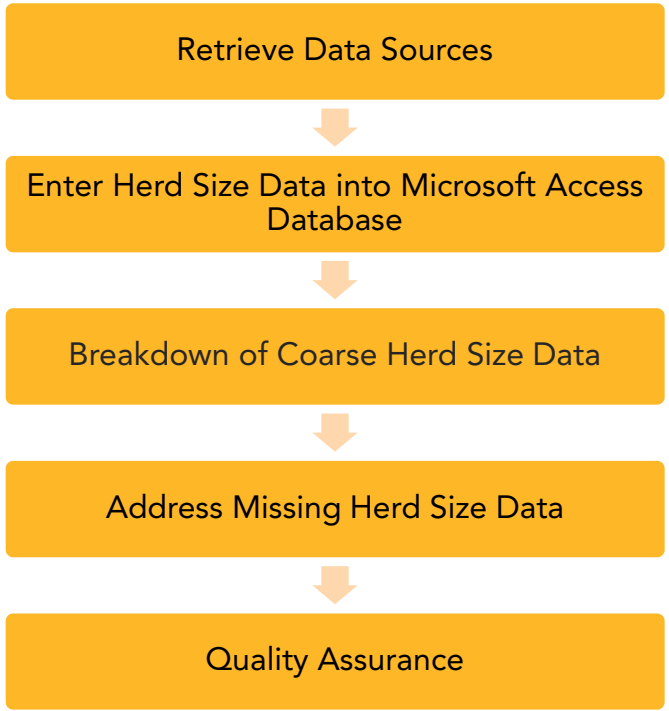
Anaerobic Digesters Table

Description: Contains facilities with anaerobic digesters, the year when they became operational, and the year they shut down (if applicable)

Data sources:

- CDFA DDRDP (through March 2023): Project-level data of DDRDP grant awardees published quarterly
- U.S. EPA AgSTAR Livestock Anaerobic Digester Database (through January 2023): Provides comprehensive details about the status of dairy digester projects within the U.S.

CADD Development



Retrieve Data Sources

Regional Waterboards

- Annual reports for 2012 – 2022 (PDF and spreadsheet)
- Inspection reports for 2012 – 2022 (PDF)
- Waste management plans, nutrient management plans, and notices of intent (PDF)

State Waterboard

- California Integrated Water Quality System (CIWQS) database (spreadsheet)

San Joaquin Valley Air Pollution Control District

- Air permits for 2019 (PDF)

CDFA

- DDRDP project-level data through March 2023 (PDF)
- AMMP project-level data through March 2023 (PDF)

CARB

- California Climate Investment implemented projects database; accessed in October 2023 (spreadsheet)

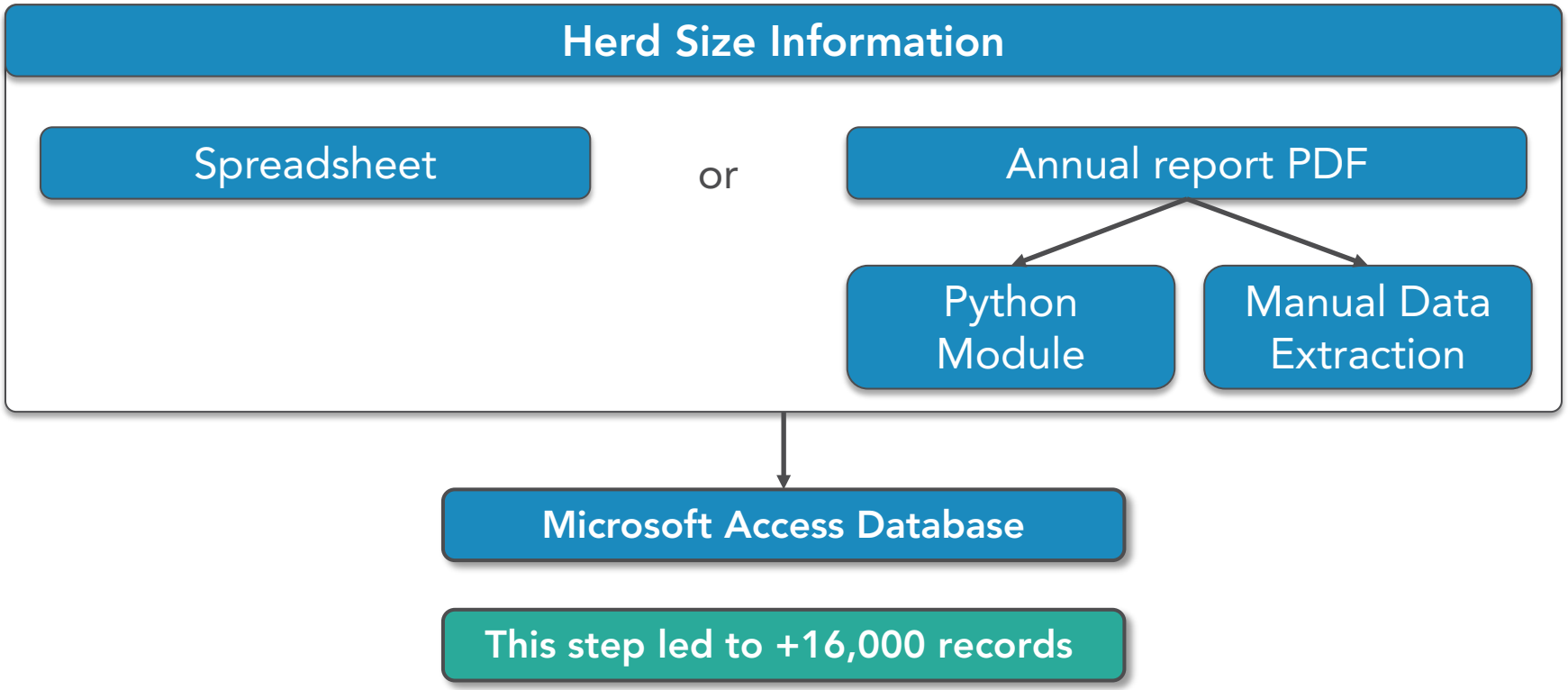
U.S. EPA

- AgSTAR Livestock Anaerobic Digester Database through January 2023 (spreadsheet)

NASA

- Vista-CA using data sources spanning 2005 – 2019 (Google Earth layers [Dairies, Feed Lots, Digesters])

Enter Herd Size Data into Microsoft Access Database

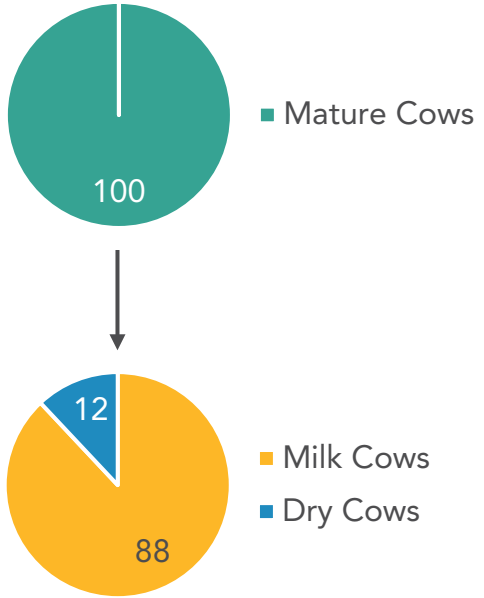


Breakdown of Coarse Herd Size Data

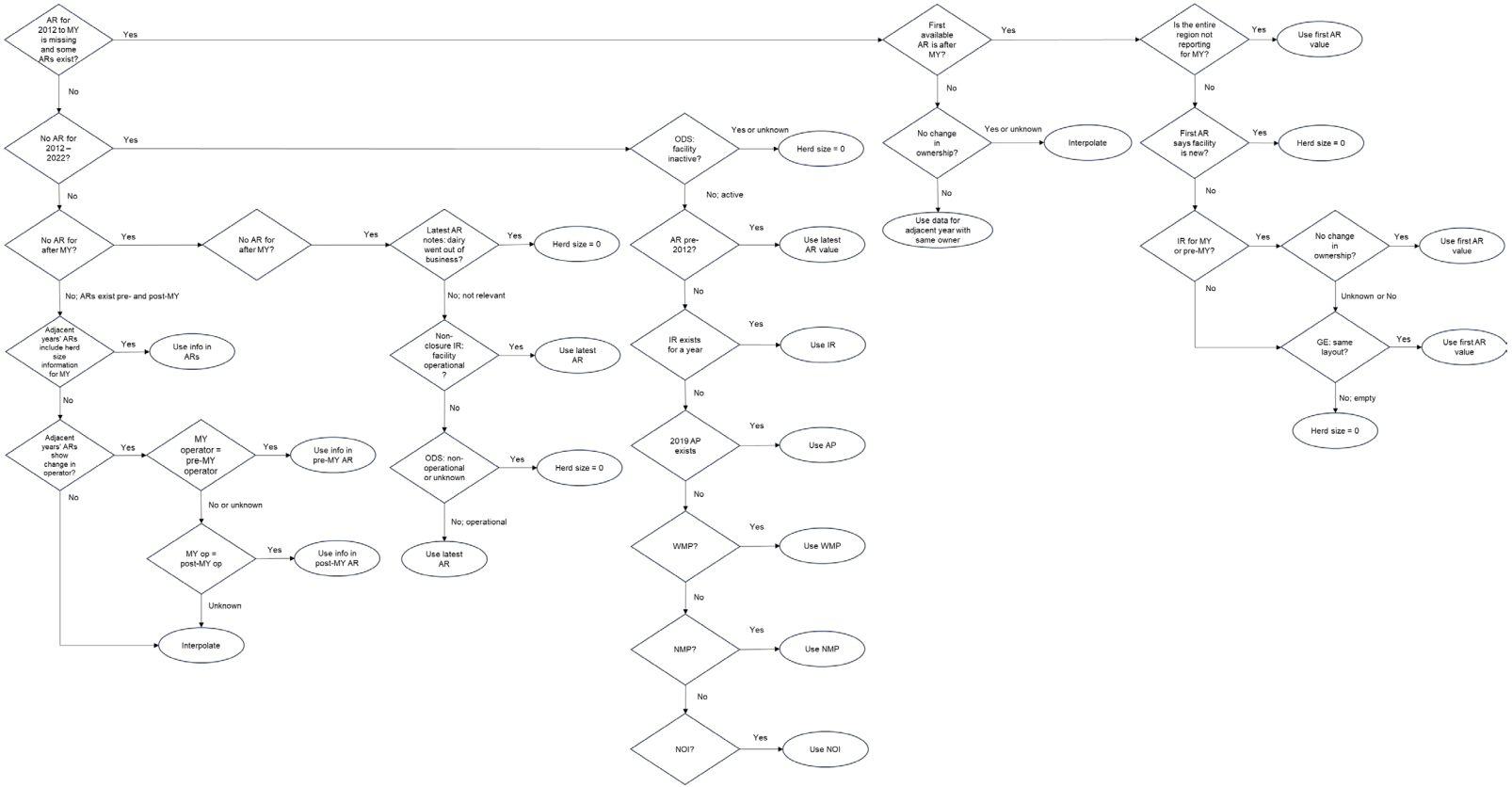
- Annual report cattle categories are not consistent across different Regional Waterboards
- Coarse herd size information (12% of the records) was broken down into detailed cattle categories

Average ratios of herd sizes of different cattle categories from annual reports that reported detailed cattle categories

Cattle Categories	Average Ratios
$\frac{\text{Milk Cows}}{\text{Mature Cows}}$	88%
$\frac{\text{Dry Cows}}{\text{Mature Cows}}$	12%
$\frac{\text{Old Heifers}}{\text{Non–Mature Cow}}$	42%
$\frac{\text{Young Heifers}}{\text{Non–Mature Cow}}$	30%
$\frac{\text{Old Calves}}{\text{Non–Mature Cow}}$	17%
$\frac{\text{Young Calves}}{\text{Non–Mature Cow}}$	11%



Address Missing Herd Size Data



Data Sources Used to Address Missing Herd Size Data

- **Inspection Reports:**
  - Regular inspections conducted by the regulating Regional Waterboard staff
  - Provide information on a facility's herd size

- **Air Permits for 2019:**
  - Issued by the San Joaquin Valley Air Pollution Control District
  - Specify the maximum permitted herd size for each facility

- **Google Earth images and CIWQS Regulation Measures:** provide information about the operational status of a facility in any given year

- **Waste management plan, nutrient management plan, notice of intent:**
  - Generally submitted once by the facility owners/operators to enroll in the Dairy and Bovine General Orders
  - Provide information on a facility's herd size at the time of document submissions

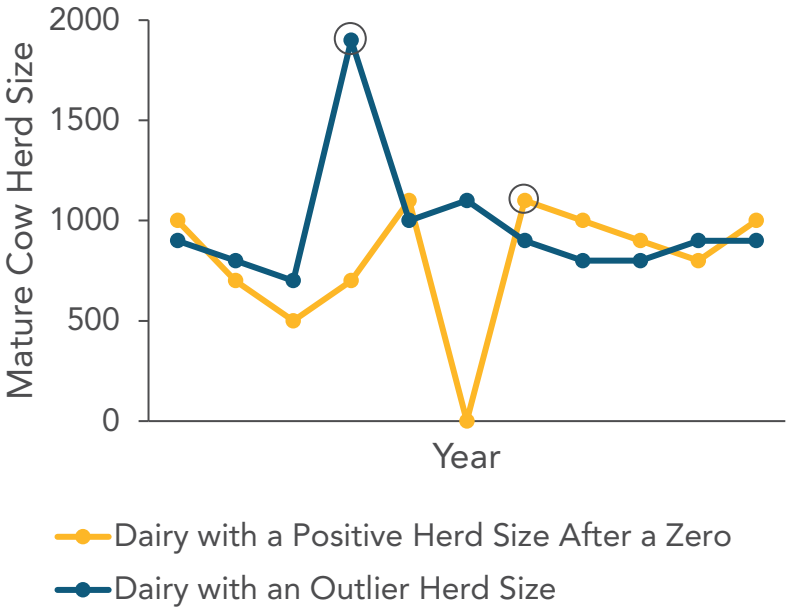
Quality Assurance of Location Information

- CADD's location information was compared against the following data sources, and inconsistencies were addressed:
  - CARB California Climate Investment implemented projects database for AMMP and DDRDP: Provides location information of the awardees
  - Vista-CA: Consists of detailed spatial maps of cattle facilities in California

Quality Assurance of Herd Size Information

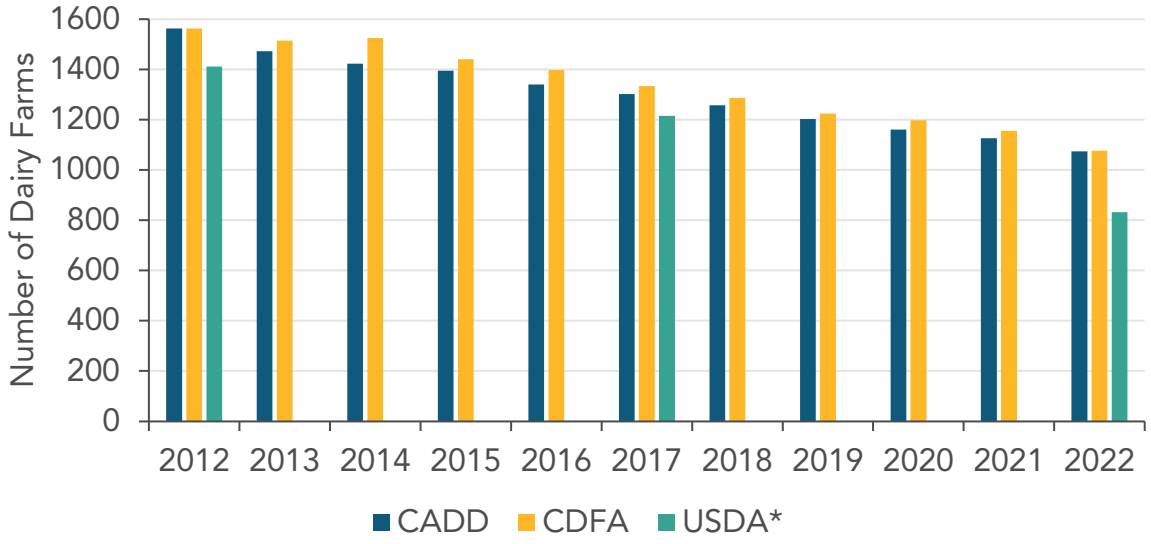
- Investigated and addressed potential data entry errors if:
  1. the mature cow herd size of a facility turned positive after being zero for a year, or
  2. the mature cow herd size of a facility for a year was an outlier

CADD is developed



How Comprehensive is CADD for Dairies?

- In California, all dairy farms (with more than two milk cows) that produce milk for distribution must hold a permit issued by CDFA
- A comparison of the number of dairy farms in CADD, the USDA Census, and CDFA-permitted dairies indicates that **CADD's coverage of dairy farms is comprehensive**



*USDA data is filtered for facilities with 50+ mature cows to avoid counting farms with cows for home use

CADD Limitations

- For facilities without annual reports between 2012 and 2022, CADD uses limited herd size information reported in other data sources to **estimate** herd size

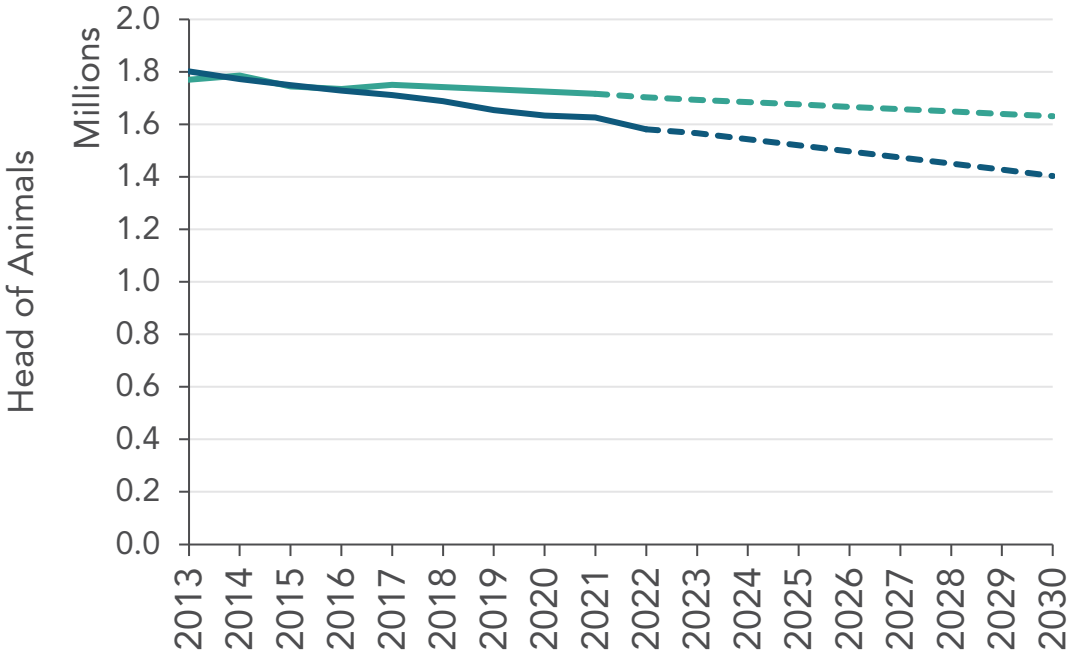
- If herd size information of a facility is missing from all data sources, CADD assumes the herd size of the facility is zero across all years
  - Potentially up to 68 small dairies – 6% of total dairies
  - Used Google Earth to verify these are small or non-operational
  - May lead to a slight undercounting of operational dairies or herd size data
  - To ensure CADD was as comprehensive as possible, facilities were included that might not have been operational any time during 2012 to 2022
  - Due to conservativeness, it is expected that a fraction of 68 dairies were not operational or reported their herd sizes under other facilities

Initial Findings Using CADD

Initial Findings Using CADD

- Statewide Trend Analysis (2013 – 2030)
  - Dairy mature cow population trend
  - Number of operational dairy farms trend
  - Average dairy herd size trend
- Dairy Digester Analysis
- Methane Emissions Implications

Statewide Dairy Mature Cow Population from 2013 to 2030



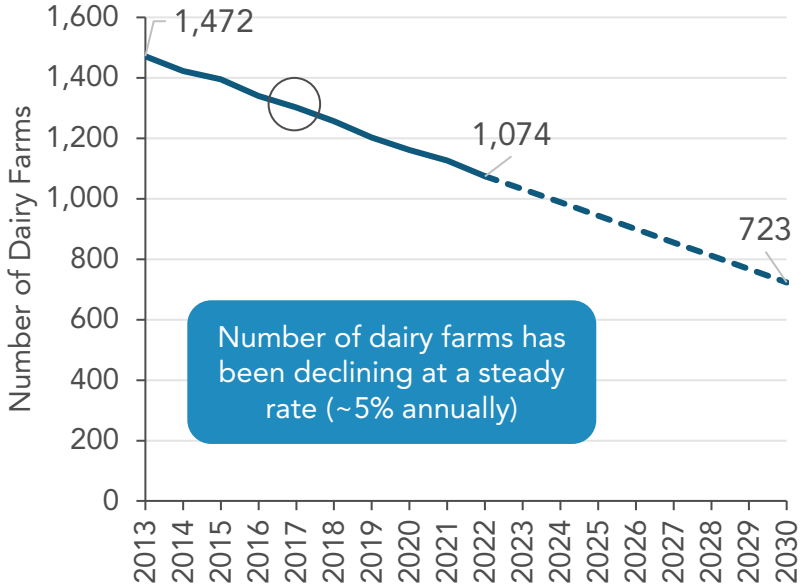
CARB GHG Emissions Inventory
Population Reduction (2013 – 2030) = 8%
Annual Reduction = 0.5%

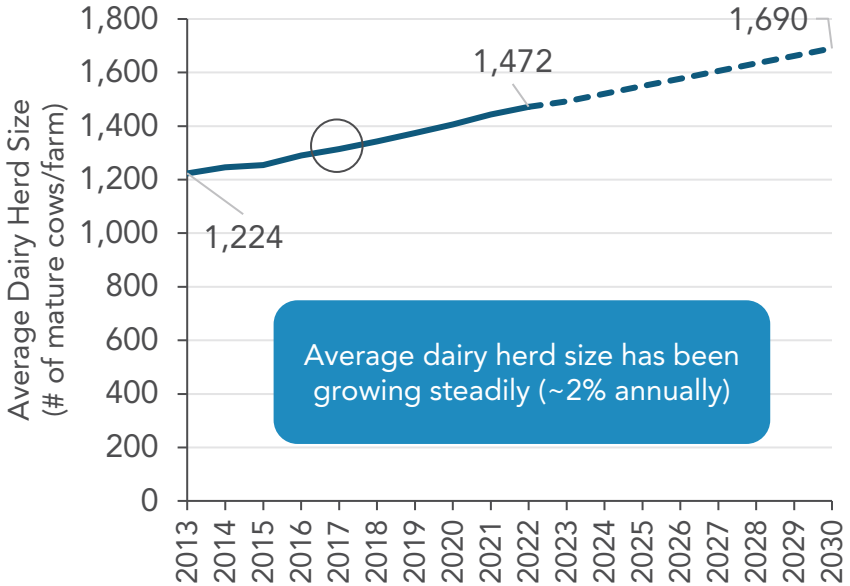
CADD
Population Reduction (2013 – 2030) = 22%
Annual Reduction = 1.3%

CARB GHG Emissions Inventory data is based on the California GHG Emissions Inventory 2000 – 2021 (2023 Edition)

Dashed lines based on simple linear regression

Number of Dairy Farms and Average Dairy Herd Size from 2013 to 2030



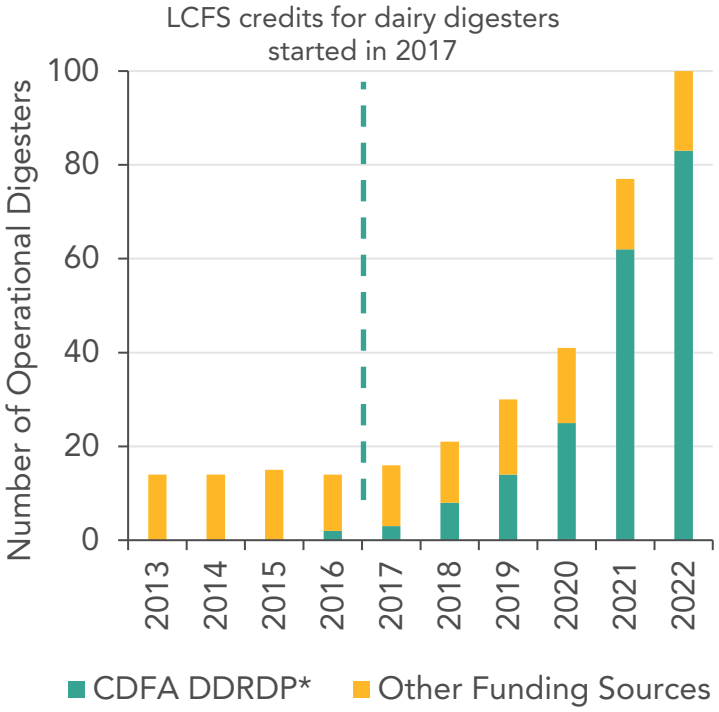


LCFS credits for dairy digesters started in 2017

→

Steady trends suggest that LCFS has not driven dairy sector trends

Dairy Digester Trend



*Number of projects that utilized CDFA DDRDP funding

- Before 2017, there were fewer than 20 dairy digesters; by 2022, there were 100 operational digesters in California
- Of the 100 operational dairy digesters in 2022,
  - 83 received funding from CDFA DDRDP
  - 50 were participating in the LCFS program
  - 8 were participating in the CPUC Bioenergy Market-Adjusting Tariff program (BioMAT)
  - 5 were participating in the Cap-and-Trade program

Statistics 101 – p-value: Finding Real Differences

Example: Determine if a new fertilizer helps plants grow taller

- Test the new fertilizer on one group of plants (Group A) while using conventional fertilizers on plants in Group B and measure the growth rate of plants
- On average, plants in Group A and Group B got taller by 4% and 3%, respectively
- Is the 1% difference real or simply due to normal variability in growth rates?
- p-value helps answer this question

p-value represents the probability at which the difference in averages is a coincidence (not real):

- A low p-value (<0.05) suggests that **the difference in averages is real**
- A high p-value (≥ 0.05) suggests that **there is not enough evidence to conclude that the difference in the averages of the two groups is real**

Have dairies with digesters had a higher growth rate than others?

STEP 1: Assign dairies that have been operational since 2017 to one of the groups below:

1. **Digester dairies:** had an operational digester in 2022, and
2. **Non-digester dairies:** did not have an operational or under-construction digester in 2022

STEP 2: Calculate the **annual growth rate (%)** of mature cow herd size for 2018 – 2022 for every dairy in these groups

Example: A dairy's mature cow herd size was 1,000 in 2017 and 1,100 in 2018. Its annual growth rate in 2018 is:

$$\frac{1{,}100 - 1{,}000}{1{,}000} \times 100 = 10\%$$

STEP 3: The average annual growth rate of digester dairies is 1.3%, and that of non-digester dairies is 0.6%

Is this difference real?

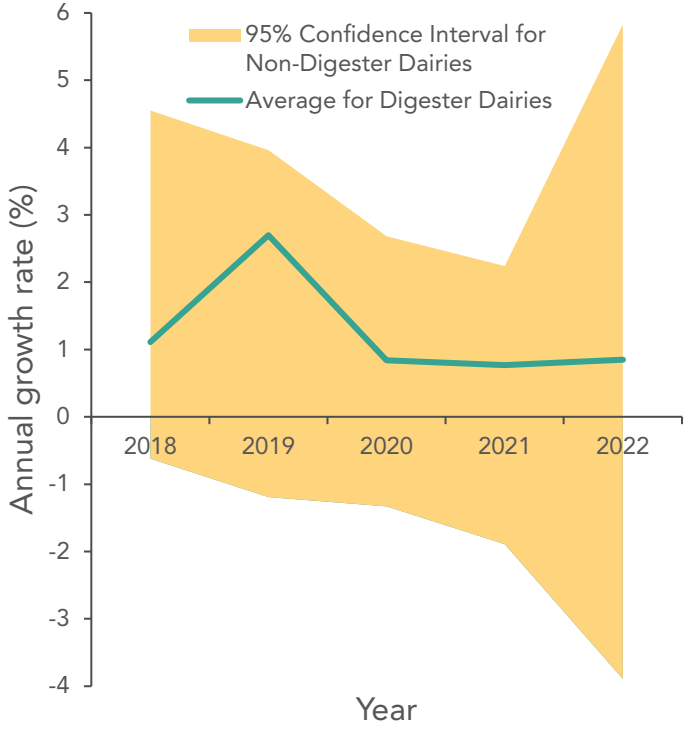
Have dairies with digesters had a higher growth rate than others?

The average annual growth rate of digester dairies is 1.3%, and that of non-digester dairies is 0.6%

Is this difference real?

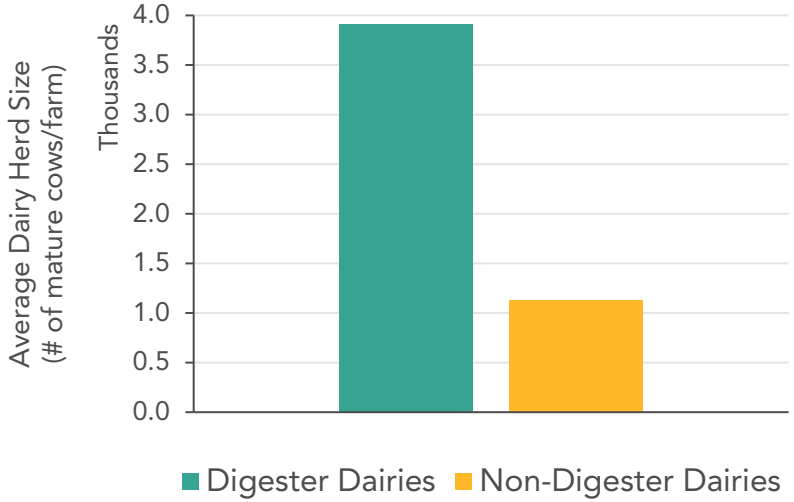
STEP 4: Statistical test (bootstrapping) results in a p-value of 0.24, meaning that **there is not enough evidence to conclude that the difference between the average growth rates of digester dairies and non-digester dairies is real**

In other words, **the average growth rate of digester dairies lies within the uncertainty range of the growth rates of the non-digester dairies**

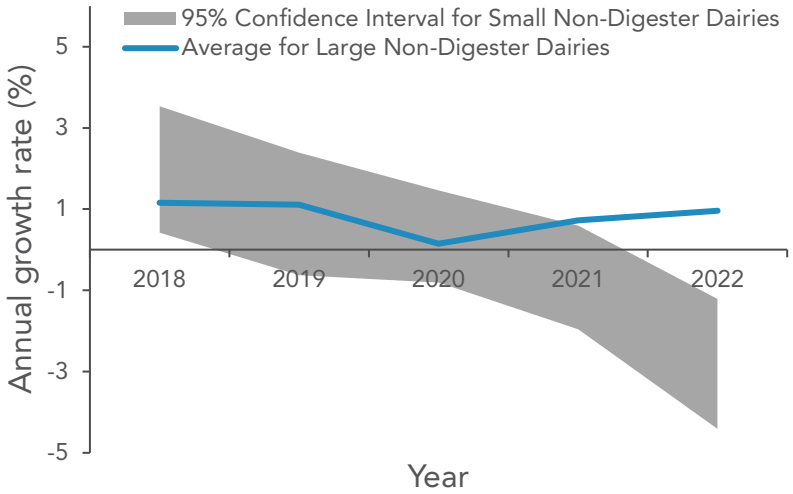


Have digesters led to a higher growth rate? Important Considerations

Dairy farms with digesters are larger than dairy farms without digesters (p-value<0.05)



On average, large dairies (≥1000 mature cow herd size) have a higher annual growth rate (0.8%) than the small ones (-0.1%), even for non-digester dairies (p-value<0.05)

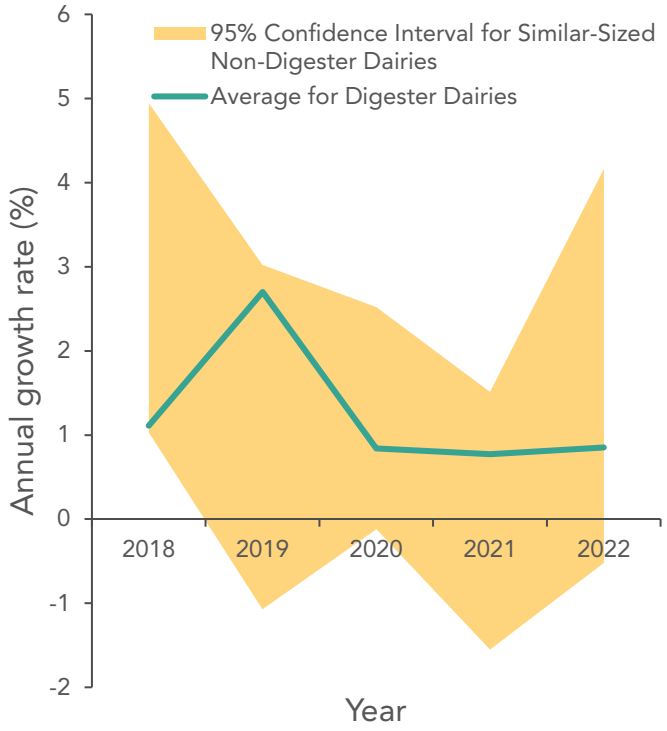


Given the difference in growth rates between large and small dairies and that most digester dairies are large, we compared the growth rate for dairies of **similar herd size** to reduce biases caused by small non-digester dairies

Have digesters led to a higher growth rate?

- We used weighted mature cow herd size data of non-digester dairies that had a similar herd size distribution to the digester dairies
- The average annual growth rate of similar-sized dairies with and without digesters are both equal to 1.3%

On average, when comparing similar-sized dairies with and without digesters, there is no difference between their growth rates

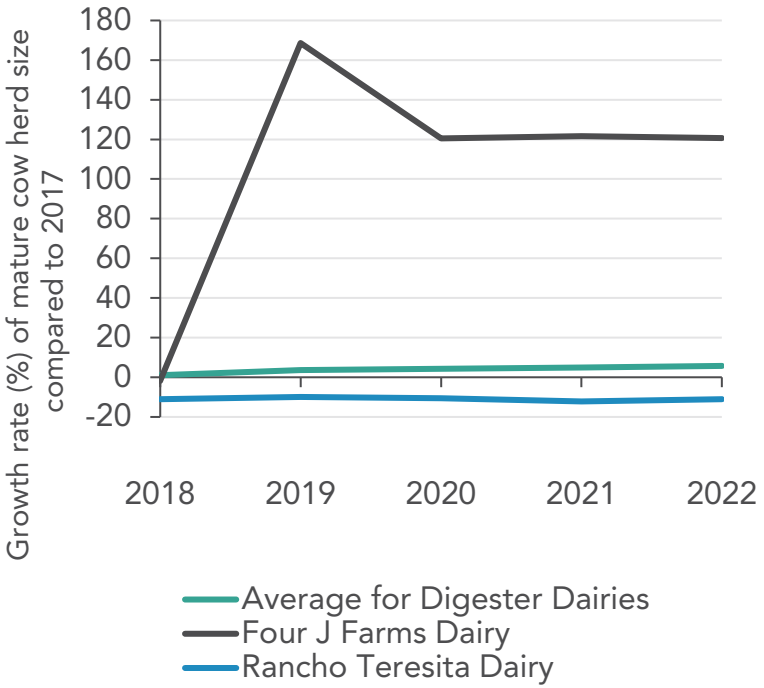


Using Individual Farm Data Can Result in an Incomplete Picture

With the lack of a comprehensive facility-level database, there is a potential concern of examining growth rates of individual farms to make generalized statements; some examples:

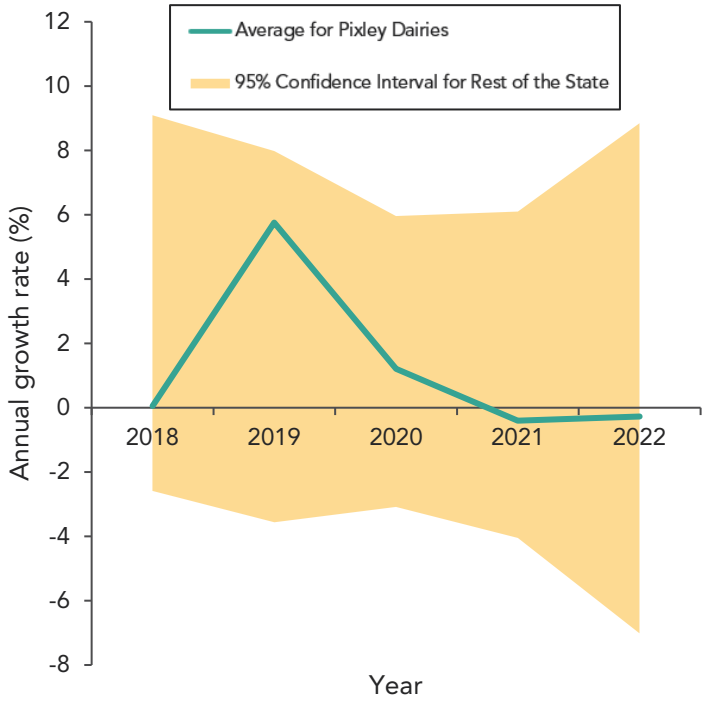
1. How a California Dairy Methane Project Threatens Residents' Air and Water – Capital & Main
2. A Battle Is Underway Over California's Lucrative Dairy Biogas Market – Inside Climate News
3. This California program lets polluters harm vulnerable communities – CalMatters

The growth rate of mature cow herd size for Four J Farms Dairy does not represent the average for digester dairies

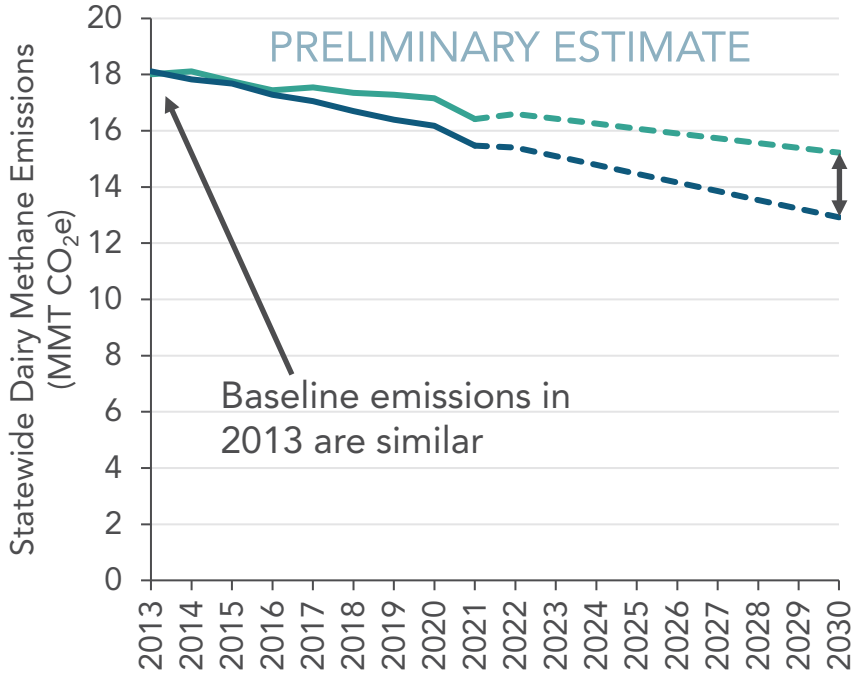


Dairies in Pixley, CA

- There are 20 dairies in the City of Pixley that have been operational for the entire period between 2017 and 2022
- Four J Farms has the highest growth rate among all the 20 dairies, while its mature cow herd size ranks 13th out of 20
- Average annual herd size change of dairies in Pixley is 1.27% while that for the rest of the State is 0.71% (p-value = 0.6). Since p-value>0.05, **there is not enough evidence to conclude that dairies in Pixley, on average, are growing at a disproportionate rate than the rest of the State**
- The same conclusion holds if we compare the growth rates of dairies located within a larger boundary (overlapping with Pixley, Tipton, Corcoran, Porterville, Alpaugh, and Earlimart) to the rest of the State (p-value = 0.94)



How Would CADD Impact Statewide Dairy Methane Emissions Estimates?



CARB GHG Emissions Inventory 2030 Projection
15.2 MMT CO_2e

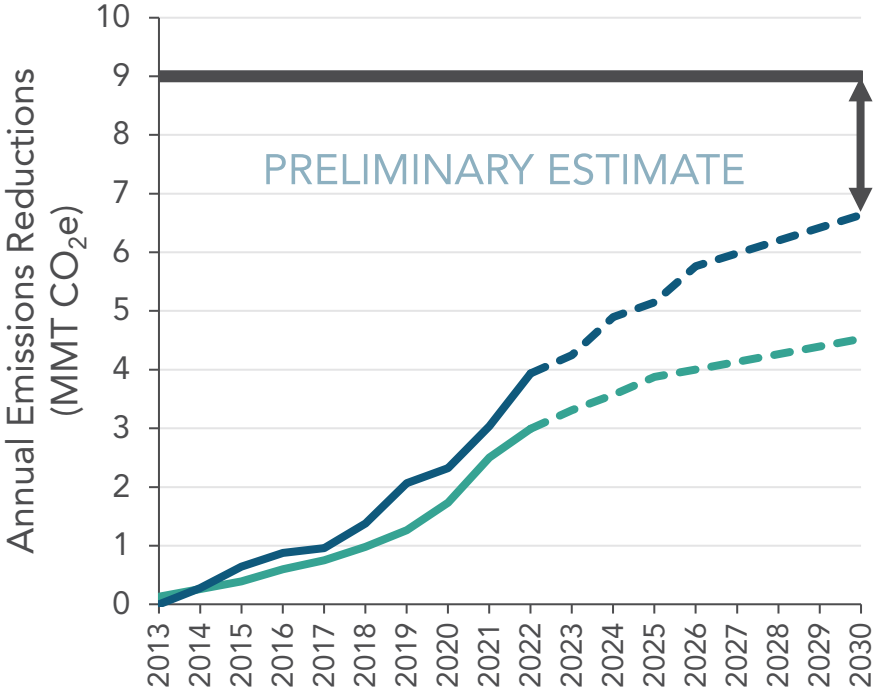
2030 Projection using CADD
12.9 MMT CO_2e

Analysis using CADD: Utilized CARB GHG Inventory emission factors but replaced dairy cattle populations with CADD

CARB GHG Emissions Inventory data is based on the California GHG Emissions Inventory 2000 – 2021 (2023 Edition)

Dashed lines based on simple linear regression

How Would CADD Impact the Analysis of Progress Toward Achieving the 2030 Dairy & Livestock Sector Methane Emissions Target?



2022 Analysis of Progress manure project data revised to account for emissions reductions in operational years

2030 Target = 9 MMT CO_2e

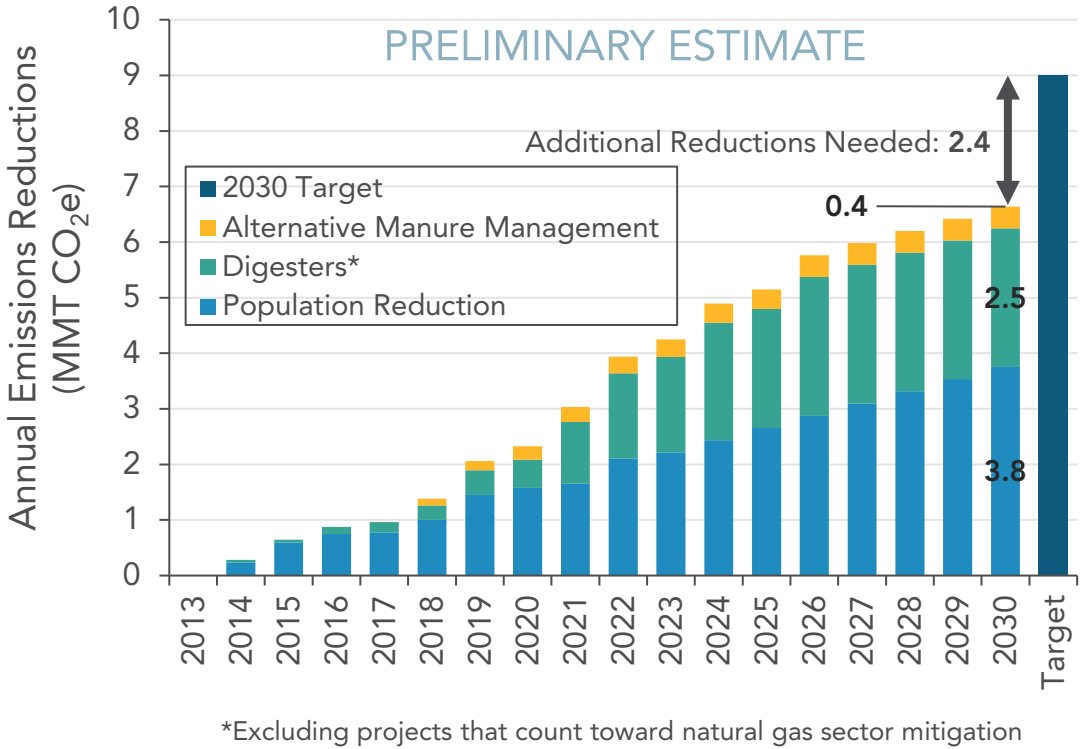
Additional reductions needed = 2.4 MMT CO_2e

CADD = 6.6 MMT CO_2e
(assumes no additional grant funding after FY23-24)

2022 Analysis of Progress = 4.6 MMT CO_2e
(assumes no additional grant funding after FY20-21)

Without additional funding or new measures beyond FY23-24, the sector is projected to achieve 6.6 MMT CO_2e emissions reductions

Contributions to Estimated 2030 Dairy & Livestock Sector Methane Emissions Reductions



*Excluding projects that count toward natural gas sector mitigation

- State incentives including DDRDP and LCFS contribute to increasing digester adoption
- Reductions from digesters and alternative manure management practices are estimated using CDFA's quantification methodology
- Reductions attributable to decreasing dairy cattle population are estimated using CADD population data

Takeaways

- Historically, CARB GHG Emissions Inventory primarily relied on USDA dairy population data, requiring CARB to make assumptions – by developing CADD, CARB can fill these data gaps and provide a new perspective on dairy trends

- Robust data and analysis tools are necessary to evaluating stakeholder concerns and can take time

- CADD-based analyses of dairy trends suggest that there has not been any relationship between the installation of digesters and dairy growth rates

- While the State has made significant progress toward meeting the SB 1383 target for the dairy & livestock sector, additional mitigation measures are still needed

Seeking Feedback

- Public Comments due October 22, 2024
  - Is CADD sufficient for representing CA dairies? If not, what additional improvements are needed?
  - What data gaps could be filled with additional reporting by dairies to the State?
  - What other existing data sets should be considered?
  - General feedback on initial findings?

Next Steps

- Potential updates to CADD in response to the public feedback
- Additional evaluations to integrate CADD into the CARB GHG Emissions Inventory
- Consider CADD during SIP emissions inventory update process

THANK YOU!

For questions, please contact CADD@arb.ca.gov