California Dairy Greenhouse Gas and Air Quality Research: Summary

What are the policy drivers for dairy greenhouse gas (GHG) and air quality (AQ) research?
AB 32 and SB 32 – GHG reduction targets; SB 605 – Short-Lived Climate Pollutant (SLCP) strategy; SB 1383 – methane (CH4) reduction target; AB 1496 – statewide CH4 survey; AB 617 – community air quality monitoring and protection; and meeting State Implementation Plan (SIP) targets.

What California relevant dairy GHG and AQ research has been done?
Experimental measurements and model simulations have been used to determine the environmental impacts of dairy-related air pollutants (including GHGs) that are typically emitted through various stages of its operation. Air pollutants include GHGs such as CH4 and nitrous oxide (N2O), and other important AQ drivers such as volatile organic compounds (VOCs), ammonia (NH3), hydrogen sulfide (H2S), oxides of nitrogen (NOx), and particulate matter (PM1-8. These efforts include, but are not limited to: estimating air pollutant emission rates/factors to evaluate and improve emission inventories2, 9-11; developing process-based emission models12-14; assessing impacts on regional air quality and climate change1, 5, 15-17; and investigating various mitigation practices for air pollution emission reductions18-20.

For summary of agricultural emissions research in California, please visit: https://www.arb.ca.gov/ag/2017apr21agresearch.pdf

What were the conclusions from these studies?
• Dairies and livestock are the largest sources of methane emissions in the San Joaquin Valley21, 22.
• Dairy-related emissions such as VOCs and NH3 contributes to a significant fraction of the secondary air pollutants that are formed in the San Joaquin Valley (e.g., ozone, PM)16, 23.
• There are considerable variabilities in when, where, and how much air pollutant emissions occur from dairies24-26.
• Emission inventories appear to underestimate CH4 and NH3 emissions associated with dairies27-30.
• Process-based emission models are useful in quantitatively estimating air pollutant emissions from dairies, but are not complete and need additional improvements to better represent real-world conditions (i.e., chemical, biological, and physical processes that affect emissions)13, 31, 32.
• Available dairy-related air measurements are spatially sparse and lack temporal resolution.
• Potential mitigation options (such as alternative manure management strategies and renewable energy) are available, but need further review to evaluate impacts33-38.

What future research are needed to move toward effective reduction of GHG emissions and improved AQ?
• Assess localized air pollution issues associated with dairies, especially in environmental justice communities.
• A Long-term dairy GHG emission and AQ monitoring program should be implemented to track air pollutant emissions from dairies (e.g., quantify baseline concentrations of air pollutants such as CH4, and then evaluate the effectiveness of air pollution mitigation strategies).
• California-specific data should be used to conduct a comprehensive reassessment of the current emission inventories (e.g., CH4, NH3, etc.). This includes improvement of process-based emission models and additional air measurements to support their development.
• Scenario-based regional GHG emission and AQ modeling should be used to evaluate the environmental impacts of changing dairy operations (e.g., potential GHG and AQ benefits of producing renewable energy from dairies) to identify the most effective and feasible air pollution mitigation strategies.
The figure below provides an overview of the research needs using the four main research objectives as outlined in this section:

- Drivers
  - GHG and AQ Policy and Related Regulations

- Need
  - Dairy GHG and AQ Research

- Future Research
- Current Research
- Past Research

- Research Objectives
  - Local Air Pollution Issues (EJ Communities)
    - Identify and mitigate dairy-related AQ impact at local EJ communities
  - Long-Term Dairy GHG Emission and AQ Monitoring Program
    - Track changes in GHG emissions and AQ as dairy operations evolve
  - Emission Inventory
    - Evaluate and improve emission inventory (e.g., CH₄ and NH₃) using models and air measurements
  - Scenario-Based Regional GHG Emission and AQ Modeling
    - Conduct scenario-based regional GHG emission and AQ modeling to determine the impact of changing dairy operation before and after various tech. implementations

- Funding Sources
  - CARB’s Research
  - CDFA’s DORDP
  - CDFA’s AMMP
  - CEC’s RDDP
  - USDA’s REAP
  - USEPA’s AgSTAR
  - Industry
  - NGOs
  - Other

- Air Measurements
- AQ Modeling
- GHG Emission and Modeling
References


December 18, 2017


