Project Title - Benchmarking of pre-Alternative Manure Management Program Dairy Emissions

Project Leaders:
Frank Mitloehner, PhD, Professor & Air Quality CE Specialist, Department of Animal Science, 2151 Meyer Hall, University of California, Davis

Ruihong Zhang, PhD, Professor, Biological & Agricultural Engineering Department, University of California, Davis

Executive Summary

The California Air Resources Board (ARB) recently adopted the Short-Lived Climate Pollutant Strategy (SLCP) to reduce emissions of black carbon, methane and other SLCPs, including emissions of manure methane from California dairies. Recent legislation (SB 1383, Lara 2016) requires implementation of the SLCP strategy by January 1, 2018. The strategy includes a 40% methane emission reduction from 2013 levels by 2030.

In addition to greenhouse gases (GHG), manure is a source for the emission of ammonia, hydrogen sulfide, and volatile organic compounds (VOCs). Several technologies, such as anaerobic digestion, have been proposed to reduce the emissions from manure; however, there are only about 20 digesters on CA dairies at this time.

Alternative manure management technologies and practices (AMMP) need to be evaluated with respect to reducing the emissions of different gases. There is a great need to understand and quantify existing (baseline) methane- and other air emissions on dairies that are considering the use of CDFA's Alternative Manure Management Program (AMMP) practices given the fact that the dairy industry will have to show a 40% reduction within the 2030 period. Assessing emissions from commercial dairy open sources is not a trivial task due to a large number of complicating variables.

At the present time, the candidate dairies that will be measured and monitored for manure emissions are unknown; thus it is not possible to describe exact monitoring plans as of now. However candidate dairies for this study will be selected by the project leader from those dairies who are awarded CDFA AMMP funding and agree to participate in this study. No costs will be borne by the dairy producer for participation.

Project Objectives

The specific objectives of this project are to:

Objective 1: Evaluation of Farm-Scale Dairy Manure Management Emissions Modeling Tools.

Task 1a: Literature review of existing modeling tools. Many emission modeling tools have been developed, including several with significant involvement from the

present research team. A summary of selected model types and examples are provided for reference below. These and other modeling tools will be identified and investigated for their strengths and weaknesses pertaining to their utility, accuracy, complexity, or other relevant information regarding applicability to farm sites in California.

Task 1b: Recommend a model for validation on selected dairies. Completion of Task 1a will follow with a recommendation of a model to be validated on selected AMMP project dairies. Selection will be dependent on careful consideration of decision making goals determined by the project team in collaboration with the CDFA ad hoc advisory panel.

Task 1c: Estimate baseline pre-AMMP emissions using the proposed model. Using available project and literature data, baseline emissions will be estimated with the proposed model for the selected dairy sites. Additional information not initially provided by the project dairies will be collected during this task. Modeled emissions will be compared with those calculated using the default quantification methodology being developed by the CDFA and the California Air Resources Board as part of the AMMP program.

Task 1d: Estimate post-AMMP emissions using the proposed model. Modeled post-AMMP emissions will be calculated and compared with those from the default quantification methodology. A discussion of model uncertainty and future research or development needs will be included in the project final report. Additional information not initially provided by the project dairies or pertaining to the AMMP project implementation will be collected during this task.

Objective 2: Conduct Baseline Emissions Measurements for Selected Dairies.

Task 2a: Literature review of best measurement practices for farm-scale dairy manure emissions monitoring.

Task 2b: Selection of study sites and development of recommended measurement plans. Once candidate AMMP project dairies are selected, detailed monitoring plans with recommended measurement methods will be developed. The plan will include the locations for on-line measurements of the composition of different gases, and the collection procedures, sample size, sampling frequency, and sample handling and preservation for air and manure. Other considerations such as farm activities that might affect emissions or sampling and monitoring schedules will be considered in site selection. Measurement details will be dependent on careful consideration of goals determined by the project team in collaboration with the CDFA ad hoc advisory panel. It is expected that 4-6 sites will be selected as project study sites.

An example of a hypothetical monitoring plan might include measurement of emissions across various manure management areas (housing, processing, storage, field) over a 3-7 day period at a certain or multiple times per year and include monitoring of average

and peak concentrations and gas fluxes of CH_4, N_2O, NH_3, H_2S, PM_{10}, $PM_{2.5}$, and major VOCs; and ambient temperature, relative humidity, pressure, wind speed, wind direction, and solar radiation. Pertinent farm information such as animal numbers, feed rations, water use, mass flow estimates of manure management streams. Sample measurements to be analyzed in a lab would include compositional analyses of the respective manure and soil sample for such components as total-, volatile-, and suspended-solids, and nitrogen, carbon, ammonia, and perhaps volatile fatty acids (VFAs), pH, or redox potentials.

Task 2c: **Measurement of baseline (pre-AMMP) emissions from study dairies.** Emission data will be collected from the selected project dairies according to the approved measurement plans in order to benchmark pre-AMMP project emissions. Measurements from solid and liquid manure throughout various stages of the manure management train (housing, processing, storage, field application) will be collected as deemed appropriate.

Objective 3: **Data analysis and reporting.** Data from the modeling and measurement objectives will be synthesized to characterize and benchmark the baseline (pre-AMMP) emissions from the selected study sites. Quarterly project meetings and reports to CDFA will be performed and a final report will be generated to summarize project findings and recommendations for future research, dairy manure management practices, or policy consideration.