Agricultural and Resource Economics
ARE UPDATE

Giannini Foundation of Agricultural Economics, University of California Vol. 20, No. 2 Nov/Dec 2016

ALSO IN THIS ISSUE

State Regulation on Livestock Methane and Challenges Faced by the California Dairy Industry

Hyunok Lee

Methane emission from livestock manure will be, for the first time, subject to regulation under a new state law. Enforcement of regulations on livestock manure will begin on January 1, 2024. Compliance with new regulations on manure handling is likely to become a major factor determining dairy economics in California.

On Sept 19, 2016, Governor Brown signed into law Senate Bill (SB) 1383, the latest California state government effort to set policies that will allow California to meet its greenhouse gas (GHG) reduction targets. SB 1383 authorizes the state to regulate the release of short-lived climate pollutants (SLCPs) such as methane, black carbon, and fluorinated gases. The California livestock industry is a significant contributor to methane emissions in the state.

Ruminants (primarily cattle, sheep and goats) release methane from enteric (digestive) activity and from manure, while other livestock (primarily poultry in California) generate methane mostly only from manure. Livestock manure handling in California is subject to many environmental regulations. But, under SB 1383, methane emission from livestock manure will be, for the first time, subject to detailed regulation. Enforcement of regulations on livestock manure will begin on January 1, 2024, but several regulatory steps occur before then.

Methane is generated from manure when it decomposes in anaerobic conditions like those used in confined animal feeding operations rather than pasture-based operations. In California, over 90% of methane from livestock manure is generated by the dairy industry. Thus, the upcoming regulations have potentially important implications for the California dairy industry.

SB 1383 specifies a target reduction of 40% by 2030 for methane emissions from California livestock manure. The California Air Resources Board (CARB) has proposed manure digester technology as a chief strategy to reduce methane emission from dairy manure.

Short-Lived Climate Pollutants and SB 1383

SB 1383 deals with short-lived climate pollutants (SLCPs) across many sectors of the economy. The major emission sources of SLCPs include: diesel combustion that emits black carbon; refrigeration and air-conditioning systems that emit hydrofluorocarbons; and livestock operations, waste treatment, oil and natural gas systems that emit methane. Of these three, methane has the largest share of GHG emissions in California, accounting for 60% of the total. SB 1383 targets emission reductions of 40% for methane, 40% for hydrofluorocarbon and 50% for black carbon by 2030 from their 2013 levels.

The life spans of SLCPs in the atmosphere are relatively short, less than 20 years. Climate scientists measure the near-term climate impacts of SLCPs using global warming potential (GWP) based on a 20-year timeframe (GWP20) instead of the 100-year timeframe (GWP100), which is usually used for carbon dioxide (CO_2). Since all GWPs are measured relative to CO_2, the GWP20s of SLCPs are much larger than their GWP100s. For example, for methane, the GWP20 of 72 is almost three times the GWP100 of 25 (IPCC 4th Assessment Report).

Given the potency of SLCPs in the near term, controlling SLCP emissions plays an important role in the state's effort toward meeting the overall GHG reduction goals called for by AB 32. An earlier senate bill directed CARB to develop a plan to rapidly reduce emissions of SLCPs. This plan was

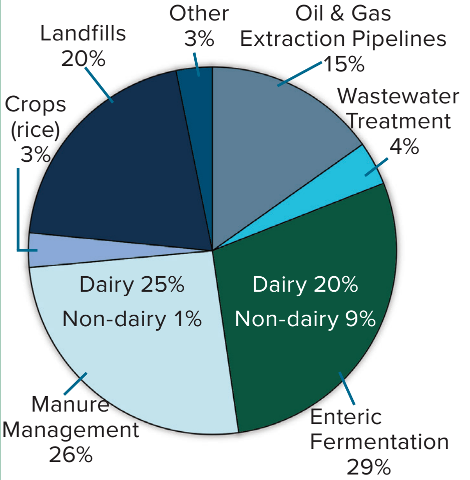

Figure 1. Short-Lived Climate Pollutant Methane by Source in 2013 (Total=118 MMTCO2e)

Source: CARB, www.arb.ca.gov/cc/inventory/slcp/slcp.htm

Note: Emission calculations use GWP20.

published as "Proposed Short-Lived Climate Pollutant Reduction Strategy," on April 11, 2016 (referred to as the Strategy hereafter), and provided the guidance for the specific mandates in SB 1383. Most importantly for our topic, methane emissions from livestock manure will be regulated beginning in 2024, and CARB is directed to set its comprehensive SLCP emission reduction strategy by January 1, 2018.

Methane Emissions

Figure 1 provides estimates of California methane emissions by source in 2013—the benchmark year for SB1383. Agriculture accounts for almost 60% of the total. Within agriculture, livestock accounts for almost all methane emissions. Livestock operations generate methane in two basic ways: enteric fermentation and manure decomposition. Enteric fermentation takes place in the digestive systems of ruminants and methane, produced in the rumen during the fermentation process, is released mostly through animal belches.

Methane is also produced during the decomposition of manure under anaerobic conditions. Such conditions are common in confined animal facilities, where manure is stored in large piles or processed in lagoons. Dairies are almost the sole source for manure-based methane (Figure 1). In California's large dairy industry, cows are mostly confined, fed a high-energy, concentrated diet, and manure is kept in conditions leading to anaerobic fermentation. Emissions from enteric fermentation can be reduced by changing animal diets, but considerable uncertainty exists about the long-term consequences. This is partly why enteric fermentation is not subject to regulation under SB 1383.

The Proposed Strategy to Reduce Methane Emissions

CARB and others have recognized several possible ways to reduce methane emissions from dairy manure. The Strategy by CARB recommends that dairy manure management be changed from current lagoon systems without methane capture.

The Strategy documents five pathways: 1) scrape conversion and onsite digestion for pipeline-injected natural gas vehicle fuel; 2) scrape conversion and centralized digestion for pipeline-injected natural gas vehicle fuel; 3) solar drying of manure onsite; 4) digestion for onsite renewable electricity; and 5) conversion of dairy operations to pasture-based management.

Pathway 3, solar drying, is expensive for dairies even though it is less capital intensive than other options. Solar drying generates no bio-energy output and thus no energy-related revenue. Pathway 4, electricity generation, is also very costly for farms in the Central Valley, where 90% of milk in California is produced. A major cost of using methane from manure to generate electricity on farms is in meeting Central Valley air quality standards. Combustion of methane, which is required for electricity generation, emits nitrogen oxides (NOx), a pollutant regulated in this region. Complying with Central Valley air quality rules on NOx requires using high-cost micro-turbines, making generation of electricity on farms in the Central Valley very expensive.

Pathway 5, the pasture-based operation, is also expensive and difficult for Central Valley dairies without a large conversion of cropland to irrigated pasture. In fact, California currently produces a tiny fraction of its milk from pasture-based dairies, mostly along the North Coast, where high-cost organic production methods are practiced.

CARB devoted most attention in its strategy to pipeline-injected natural gas production. This method produces pipeline-quality natural gas which can be used in natural gas vehicles. Biogas produced from a methane digester has to be processed to purity standards before it is injected into the pipeline. In the CARB cost analysis, pipeline-injected natural gas, especially pathway 2 which calls for a large centralized system, was found to be most favorable in net present value analysis. In addition to this advantage, to curtail methane by as much as 40%, the pathway must be feasible for commercial dairies in the Central Valley, and, according to the CARB calculations, a pipeline-injected natural gas system may meet this criterion.

SB 1383 includes specific provisions related to natural gas production from dairy manure. SB 1383 directs CARB to plan for potential infrastructure development that could facilitate widespread adoption of digester technology. By January 1, 2018, CARB, together with the Public Utilities Commission and the California Energy Commission, is required to adopt policies and incentives to increase renewable gas production and to implement at least five dairy bio-methane pilot projects to demonstrate interconnection to the common carrier pipeline system.

Financial Profile of a Pipeline-Injected Digester Investment for a Dairy Farm

Digesters have been proposed for manure management on California dairies for decades. Substantial federal and state government subsidies and incentives have been available. Nevertheless, only 13 digesters operate in California (as of Aug 2016) and many more have been abandoned (US EPA). All existing digesters produce electricity or thermal energy with none producing natural gas that is injected into pipelines.

Pipeline-injected natural gas production is highly capital-intensive, and thus this option makes economic sense only when the project is large enough to fully exploit economies of scale. The centralized digester system that CARB explored is based on this rationale, and our discussion below focuses on the CARB analysis of a centralized digester that turns methane from dairy manure to natural gas that is injected into a pipeline.

For a centralized digester, manure is collected from a group of farms. The hypothetical scenario considered by CARB assumes manure is transported from one million cows (500 farms with 2,000 cows each), which is about two-thirds of the Central Valley cows. The digester would be located in the Southern San Joaquin Valley where the greatest number of dairy cows are located within the smallest radius. Costs and revenue can be developed on a per-farm basis (2,000 cows).

The initial capital costs include conversion to a manure scrape system and the farm's share related to the central operation, which includes trucks, the digester, a pipeline, interconnection, etc. According to CARB calculations, these add up to about $3 million per farm. The annual operating and maintenance costs (O&M) for the farm share of the centralized digester are about $158 million.

To put these numbers in context, a 2,000 cow farm in the Southern San Joaquin Valley would produce about 500,000 hundredweight of milk. The price of milk has recently been in the range of $15 per hundredweight. Such a farm would generate $7.5 million in milk revenue on a total asset value (cows and other capital) of about $5.6 million based on CDFA data. (In 2015 and 2016, a typical dairy in California had operating cost above milk revenue.) Thus, a $3 million capital investment in manure handling alone would be a substantial investment relative to the investment in the dairy operations themselves.

Table 1. Net Present Value of Pipeline-Injected Digester by Eligibility for Carbon Destruction Credits in LCFS Carbon Intensity Calculation

	Full Carbon Destruction Credit	No Carbon Destruction Credit
	LCFS credit price = $100/MT CO2e	
LCFS credits (revenue per year)	**$0.845 Mil**	**$0.163 Mil**
Net Present Value	**$5.5 Mil**	**$0.3 Mil***

Source: CARB and author's calculation

Additional data used in NPV calculations include: capital cost=$3.026 mil, annual O&M=$0.315 mil, annual fuel revenue=$0.083 mil, annual RIN=$0.537 mil, interest rate=7%, discount rate=5%. These data are adopted from Appendix D of the Strategy.

*Author's calculation. All other numbers are adopted from CARB (2016).

Of course, a capital investment must be evaluated in relation to the stream of both benefits and costs during the lifetime of the investment. Using the 10-year horizon, CARB calculated the net present value (NPV) of this digestion system to be about $5.5 million. This positive net return hinges, especially, on details of the revenue stream.

CARB assumes that the natural gas will be used for transportation fuel which creates three revenue sources: natural gas sales plus two types of government credits available for biofuels. The California low-carbon fuel standard (LCFS) credits and the federal renewable fuel standard credits (also known as renewable identification number (RIN) credits) provide the bulk of the revenue. Of the total annual revenue of about $1.5 million per farm, only $83,000 comes from sales of the natural gas. Almost all the revenue (94%) comes from the government-created fuel credits.

Thus, the economic feasibility of the project hinges fully on a continuation of these two fuel credit policies and ensuring that natural gas from the digester qualifies fully under both programs. Any change in these policies, or in specifics of the regulations, could fundamentally alter the viability of the digester project. For example, the federal renewable fuels credits are under intense political pressure as environmental contributions of ethanol are challenged. Policy risk is a major component in evaluating the economic feasibility.

The reliance on government-created credits for revenue deserves further discussion. First, LCFS credits, which account for more than half of revenue, are not guaranteed to continue for 10 years. Unless regulations specify otherwise, once methane regulations take effect on dairies, their baseline in carbon accounting would be updated to include shipping manure to the digester as the "baseline" practice. The carbon intensity of the manure-based fuel would increase in LCFS accounting, causing a large reduction in LCFS credits, by as much as 80%, from $845,000 to $163,000, according to the CARB estimate (Table 1). If we use this lower LCFS credit revenue, the NPV falls to $0.3 million (Table 1).

The second issue with LCFS credits relates to the volatility of the LCFS credit market. Figure 2 shows the historical monthly prices of LCFS credits since the inception of the program. The monthly average price of credits has fluctuated from $20 to $120, with a

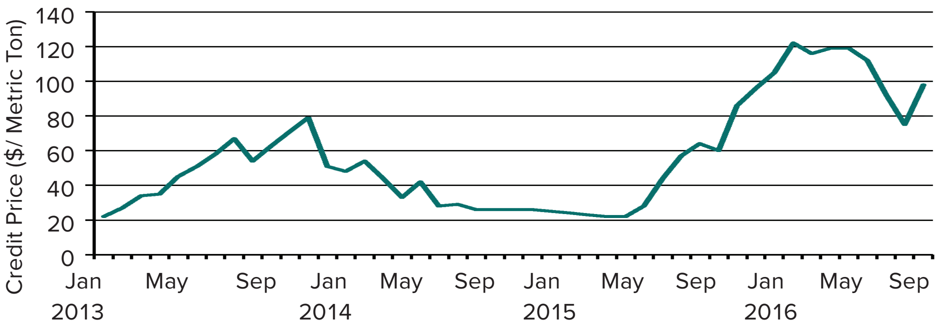

Figure 2. Monthly Average Low Carbon Fuel Credit Price, January 2013 - September 2016

Source: CARB, https://www.arb.ca.gov/fuels/lcfs/dashboard/dashboard.htm

mean of $56 from January 2013 to September 2016. Over the past 12 months, the prices have averaged about $100 per ton—after rising from $60 to $122 and then falling back to $75. Calculations in Table 1 are based on $100 per ton.

Historical prices of LCFS credits are highly volatile with a coefficient of variation of 56%, which can be compared to 19% for the coefficient of variation of monthly milk prices for the same period. Counterbalancing such variability of credit prices would require a substantial risk premium in the present value calculation.

Implications

Based on current law, methane emissions from dairy cows must be reduced. The law also requires detailed assessment of the economic feasibility of options. Compliance with new regulations on manure handling is likely to become a major factor determining dairy economics in California. Important questions are: will methane emission rules raise milk production costs or generate new revenue, and will this help or hinder efforts of the California dairy industry to remain competitive?

The California dairy industry grew rapidly for decades until about a decade ago, and has had no growth since 2007. California's milk production and processing costs used to be below those of industries in most other states because of scale economies and high-quality management. However, as dairy operations in other states have become larger and cost reductions in California have not kept pace, California's advantage has eroded. California remains a large net exporter of dairy products to the rest of the country and the world and, as a source of shipments of dairy products, California milk prices remain low.

The California dairy industry is already under economic pressure. If new methane regulations further erode the economic position of dairy farms in California, we would expect substantial exit from the industry with resultant reduction in economic activity, especially in the San Joaquin Valley.

SB 1383, in fact, stipulates that regulations on dairy methane be implemented only after evaluating whether the regulations are economically feasible and whether the regulations mitigate potential "leakage" to other states or countries. Implementing the new regulations will be a challenge for both the government and the industry. Government regulators must meet the environmental targets while minimizing any negative economic impacts. The dairy industry must struggle to comply with new regulations while maintaining economic viability in the face of many other challenges, including other environmental demands. Economists can help in this process with careful, objective analysis of the costs and benefits of alternative regulatory approaches.

AUTHOR'S BIO

Hyunok Lee is a research economist in the ARE department at UC Davis. She can be reached by email at hyunok@primal.ucdavis.edu.

Suggested Citation:

Lee, Hyunok. "State Regulation on Livestock Methane and Challenges Faced by the California Dairy Industry." *ARE Update* 20(2) (2016): 1-4. University of California Giannini Foundation of Agricultural Economics.

For additional information, the author recommends:

California Air Resources Board (CARB). 2016. "Proposed short-lived climate pollutant reduction strategy," April 11, 2016, CARB, Sacramento, CA. www.arb.ca.gov/cc/shortlived/meetings/04112016/proposedstrategy.pdf

California legislative information. 2016. Senate Bill No. 1383, https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201520160SB1383

Kaffka, S., T. Barzee, H. El Mashad, R. Williams, S. Zicari and R. Zhang. 2015. "Evaluation of Dairy Manure Management Practices for Greenhouse Gas Emissions Mitigation in California," "Report to CARB Contract # 14-456. http://biomass.ucdavis.edu/wp-content/uploads/2016/06/ARB-Report-Final-Draft-Transmittal-Feb-26-2016.pdf

Lee, H. and D. Sumner. 2014. Greenhouse Gas Mitigation Opportunities in California Agriculture: Review of Economics, Nicholas Institute Report NI GGMOCA R7, Duke Nicholas Institute for Environmental Policy Solutions. https://nicholasinstitute.duke.edu/sites/default/files/publications/ni_ggmoca_r_7.pdf