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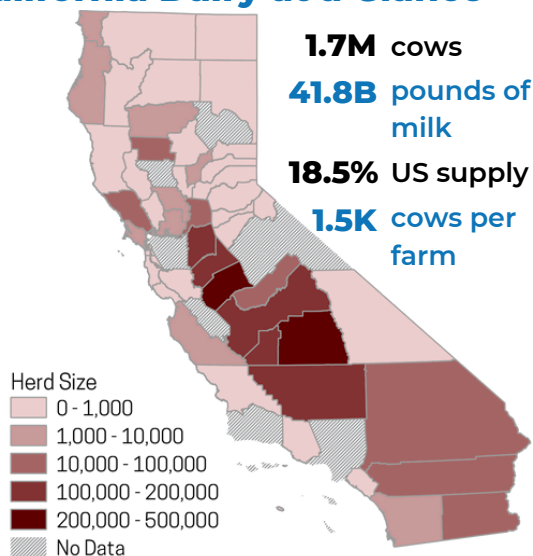
# Economic Analysis of California Dairy Consolidation, Attrition, and Policy Leakage



# Overview

California is the leading dairy producing state with nearly 1.69 million cows producing almost 42 billion pounds of raw milk, accounting for nearly one-fifth of total U.S. supply. Operating in one of the most environmentally progressive states, California dairies are constantly innovating and improving management practices for environmental stewardship. Innovation increases costs for California dairies. This and other economic pressures are causing consolidation and attrition in the dairy sector. In response, producers are shifting to states with more favorable regulatory, policy, and business conditions to lower production costs.

## California Dairy at a Glance



California is developing policies and regulations targeting greenhouse gas (GHG) emissions. This includes regulations for methane emissions from dairies. Senate Bill 1383 sets a target to reduce methane emissions by 2030. In response, the dairy industry has partnered with private investment to develop alternative revenue streams that help offset compliance costs. Anaerobic digesters generate Low Carbon Fuel Standards (LCFS) credits and reduce GHG emissions. Potential changes to LCFS would affect the financial viability of anaerobic digesters, which have emerged as the most effective method to reduce methane emissions from dairies.

A series of data-driven economic analyses were developed to evaluate:

- California dairy industry trends, market conditions, regulations, and consolidation and attrition.
- Whether anaerobic digesters are causing industry consolidation.
- GHG emissions leakage (milk production shifting to other states/countries without California standards) in response to direct methane regulations in California.

The economic analyses show that:

- California dairies have been consolidating and leaving the industry for many years.
- Statistical tests find no evidence that digesters are causing consolidation to larger dairies. Consolidation is driven by other factors.
- Eliminating LCFS credits and directly regulating methane emissions would cause up to \$675 million in annual net losses to California dairies. This does not include impacts to local communities or other businesses. Impacts to small dairies are substantially greater.
- Policy leakage would be up to 1.43 MMTCO<sub>2e</sub> as milk production shifts to other states.
- Abandoned digester projects would forgo an additional 2.44-3.51 MMTCO<sub>2e</sub>.

**Direct regulation would likely expedite the loss of small dairy farms, leading to further consolidation to larger dairies and attrition as dairies leave the state, which results in emissions leakage and counteracts progress toward state GHG emission reduction goals.**

# Dairy Industry Trends

Both the California and U.S. dairy sectors have experienced rapid consolidation over the last several decades. From 1997 to 2022:

- Dairy farms in the United States decreased from 125,000 to 36,000,
- Average U.S. farm size increased from 73 to 258 cows,
- Number of California farms decreased from 2,922 to 1,117,
- Average California farm size increased 481 to 1,514 cows, and
- Cattle on small farms (<1,000 cows) in California decreased by 78%, from 667,000 to 144,000.

Dairy farms consolidate to realize economies of scale (lower average costs as the size of the dairy increases).

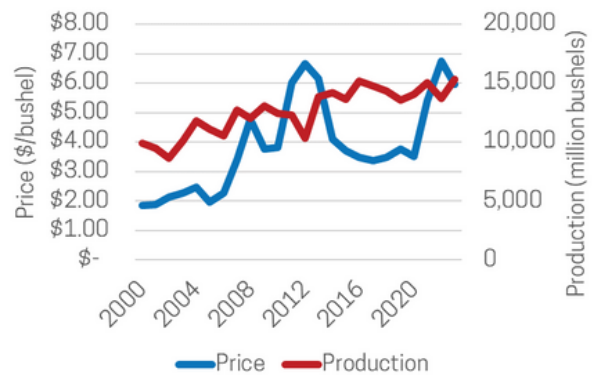
Feed prices have been increasing. U.S. corn for grain prices peaked in 2022 at \$6.76 per bushel (Figure 1). Smaller farms are less insulated from input cost volatility and are more likely to realize losses when feed prices are high.

Policies and regulations tend to favor larger farms. For example, the Dairy Margin Coverage program provides protection for producers based on the milk-feed price margin. This is most beneficial for farms with high feed cost shares (see Figure 2).

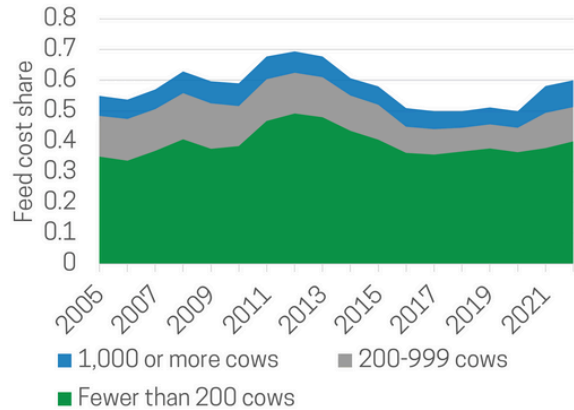
Data show that average net returns per cwt increase with herd size, illustrating the economies of scale for milk production. Figure 3 illustrates trends in net returns. 2012, the year with peak feed prices, shows greater losses for the smallest dairies.

California dairies' costs are greater than other states due to regulations, permitting, higher input costs (energy, etc.) and mandated wages. Despite competitive disadvantages, California has maintained its status as the top dairy state. This has been accomplished through investment, innovation, and adoption of new technologies. Innovation improves environmental stewardship. For example, California dairies have committed to GHG reductions that exceed requirements in other states.

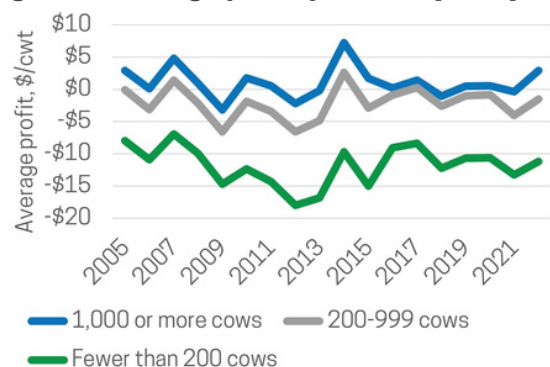
**Figure 1. U.S. Corn price and production**



**Figure 2. National average feed cost share by dairy size**



**Figure 3. Average profit per cwt by dairy size**



# Digesters and Consolidation

Large dairies, including those that have experienced consolidation, make capital intensive projects, such as anaerobic digesters, financially viable. A digester is typically developed in partnership between a dairy and operator/investor. Digesters have a dual benefit to dairies: substantially reducing methane emissions from manure (80% on average) and providing a small additional revenue stream.

There is concern that digesters are causing consolidation. However, this concern is based on the flawed assumption that dairies receive all revenue generated by a digester and therefore increase cows to increase revenues. In practice, digesters are substantial capital investments that are not fully financed, operated, and owned by the dairy. Most digesters are owned by specialized companies and investors that have access to capital, technology, and current natural gas infrastructure. Without these partners, dairies would not be able to install and run digesters.

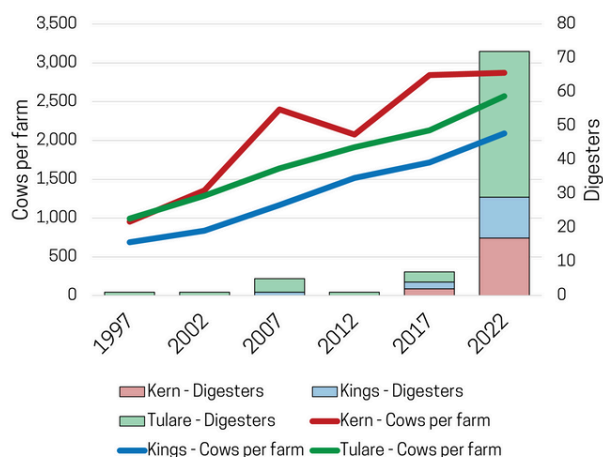
Digester revenue is generated from California LCFS credits, Federal Renewable Identification Numbers (RINs), and sales of renewable natural gas (RNG). Agreements between digester operators and dairies typically entail a revenue share agreement in which dairies receive \$50-\$100 per cow per year. This value is in the range of 10-20 percent of LCFS credits generated by digesters.

The ownership and revenue share structure of digesters casts doubt on the theory that digesters are causing consolidation. Econometric analysis of county- and state-level farm digester data provides empirical evidence that digesters are not causing consolidation.

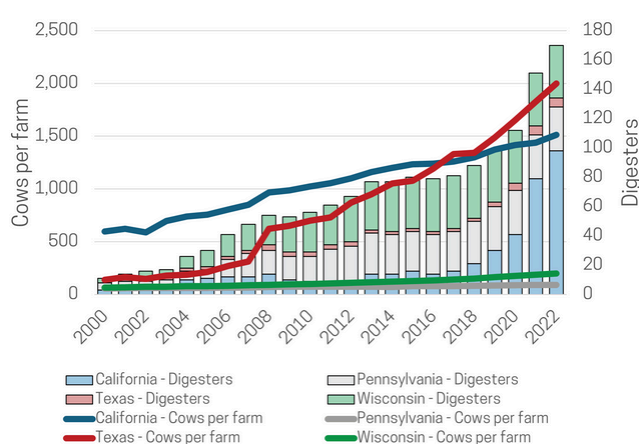
- Kern, Kings, and Tulare, counties with high adoption rate of digesters from 2017 to 2022, each saw a slower rate of consolidation than the recent historic average (Figure 4).
- Texas and Kansas have realized rapid consolidation but have few operational digesters.
- Wisconsin and Pennsylvania have seen a large increase in the number of digesters, but have realized considerably less consolidation compared to California (Figure 5).
- Statistical causation testing reveals that consolidation historically enables adoption of digesters; however, digesters are not driving additional growth.

There is no evidence that digesters are causing industry consolidation. The California dairy sector has consolidated over the last several decades, but the underlying drivers for consolidation are broad and pre-date digesters. The argument that dairies consolidate to make digesters feasible is unlikely, as capital costs are high, and LCFS credits increase revenue to dairies by only 0.5%-2.0%.

**Figure 4. Average cows per farm and number of digesters by county**



**Figure 5. Average cows per farm and number of digesters by state**



# Emission Reduction and Policy Change

California is continually expanding its water quality and environmental regulations affecting dairies. Meeting the state’s environmental objectives significantly increases the costs of operating a dairy in California relative to the rest of the country, especially for small farms. The dairy sector responds to the evolving regulatory environment by contracting, consolidating, and embracing new technologies, such as anaerobic digesters, that can help offset compliance costs.

Substantial investments have been made to reduce dairy methane emissions. Management practices (Table 1) include digesters and alternative manure management program (AMMP) practices. Per cow costs are greater for small dairies. Without state funding and financing/technical partners, these practices would not be possible.

Limits to LCFS credits and/or direct regulation of methane emissions would increase costs for California dairies. Without credits, digesters are not financially viable, and dairies would have to switch to more costly alternatives. As costs increase, this causes economic impacts to the dairy sector, including further contraction, consolidation, and losses in income, jobs, regional taxes, and other businesses. Some milk production would shift out of California to areas with lower environmental standards (policy leakage). The following scenarios were developed to analyze economic impacts and leakage:

**Table 1. Average emissions reductions and net emissions by management practice**

Practice	Average Reduction	Net Emissions (MTCO <sub>2</sub> e per cow)
Anaerobic lagoon	0%	8.60
Solid separation or AMMP	20%	6.88
AMMP + composting or open solar drying	25%	6.45
Flaring	55%	3.87
Scraping/vacuum + open solar drying or composting	60%	3.44
Anaerobic digester	80%	1.72

- **Scenario 1.** Dairies without digesters or AMMP practices must adopt solid separation and composting, or an equally effective methane-reducing technology, by 2030. Dairies with solid separation AMMP practices must also adopt composting or open solar drying; dairies with digesters and other AMMP practices are not required to make changes. LCFS credits are generated only for avoided emissions beyond the 40 percent target.
- **Scenario 2.** Dairies without digesters or AMMP practices must meet the target of a 40 percent reduction in emissions from manure by 2030 and convert to scraping/vacuum with solar drying or composting to achieve this target. Dairies with solid separation AMMP practices must also adopt composting or open solar drying; dairies with digesters and other AMMP practices are not required to make changes. LCFS crediting is entirely eliminated. Digesters are not economically viable.
- **Scenario 3.** All dairies meet a minimum 40 percent reduction in emissions by 2030. LCFS credits are generated only for avoided emissions beyond 40 percent. Digesters are not financially viable, and dairies convert to flaring (where feasible due to additional air quality impacts).

# Economic Impact Analysis and Leakage

Eliminating LCFS credits and/or directly regulating methane emissions would cause substantial economic impacts and leakage. Without credit revenue digesters are not financially viable. This would curtail new digester development and push existing digesters out. Regulatory impacts are greatest for small dairies. This causes additional industry consolidation and attrition.

There are 40 CDFA grant-funded digesters in California being developed. There are an additional 46 digesters being developed in other states. Abandoned projects cause an additional loss of 2.44 - 3.51 million MTCO<sub>2</sub>e emission reduction, over \$58 million in state funding, and over \$200 million in private equity.

Economic impacts and leakage are summarized for each scenario (Table 2). Small dairies contract by 20 to 25 percent. Net income losses are up to \$675 million per year.

- **Scenario 1.** California milk production decreases by 988.5 million pounds, and net income for California dairies decreases by \$317.4 million. Milk production shifts to farms with digesters and outside of California. This results in regulatory leakage of 238 thousand MTCO<sub>2</sub>e. Total herd size for small California dairies decreases by 24.1%.
- **Scenario 2.** California milk production decreases by 1,890.5 million pounds, and net income for California dairies decreases by \$623.5 million. Milk production shifts to farms with AMMP practices and outside of California. This results in regulatory leakage of 1.43 million MTCO<sub>2</sub>e. Total herd size on small California dairies decreases by 19.9%.
- **Scenario 3.** California milk production decreases by 2,025.5 million pounds, and net income for California dairies decreases by \$675.2 million. Milk production shifts to large farms without digesters or AMMP practices and out-of-state farms. This results in regulatory leakage of 1.42 million MTCO<sub>2</sub>e. Total herd size on small California dairies decreases by 19.2 %.

**Table 2. Average annual long-run changes in milk, cows, net income, and emissions**

Impact Measures	Scenario 1	Scenario 2	Scenario 3
<b>Change in Production:</b>			
CA raw milk supply, lbs., millions	(988.5)	(1,890.5)	(2,025.5)
CA dairy herd size, cows	(39,976.6)	(76,410.9)	(81,862.6)
Small dairy impact, %	(24.1%)	(19.9%)	(19.2%)
<b>Change in Revenue:</b>			
CA dairy net income, million \$	(\$317.4)	(\$623.5)	(\$675.2)
<b>GHG Impacts:</b>			
Leakage, MMTCO <sub>2</sub> e	0.24	1.43	1.42
Abandoned future digesters, MMTCO <sub>2</sub> e	0.00	2.44 - 3.51	2.44 - 3.51

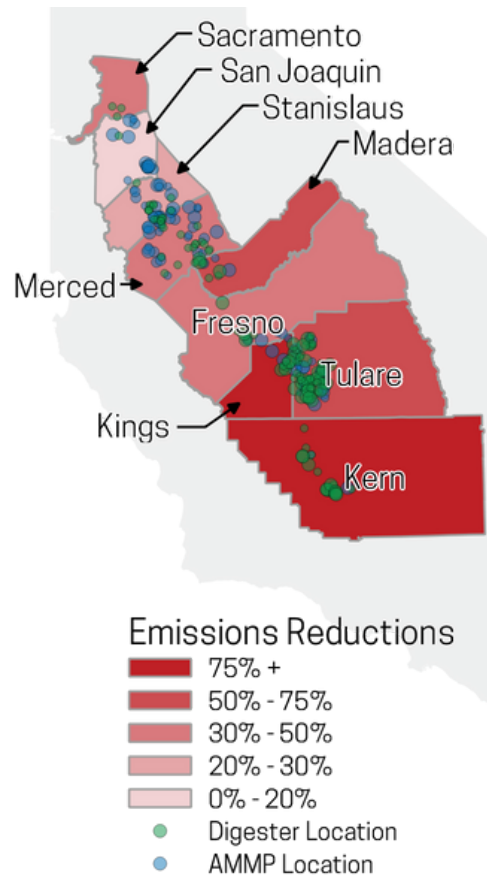
# Central Valley Dairy Impacts

Eliminating LCFS credits and increasing emissions standards results in economic impacts and leakage. Under Scenario 3, the impacts are greatest for small farms and farms with existing digesters or AMMP practices.

Economic impacts vary across counties. Under current conditions, Kings, Tulare, and Kern counties have the greatest emission reductions from digesters and AMMP projects (Figure 6). These are also counties with a substantial share of the residential population below the poverty line. Without LCFS credits and with direct methane regulation, emissions increase in Kern, Kings, and Tulare counties as dairies convert from digesters to other less efficient methane reduction practices.

Milk processing capacity is limited. Eight San Joaquin Valley counties account for 90 percent of California dairy herd, and 29 percent of fluid milk, 33 percent of solid milk, and 73 percent of dry milk processing. As costs increase production and processing shifts between counties. This results in different local economic impacts (Table 3).

**Figure 6. Current Emissions Reductions**



**Table 3. Baseline and Scenario 3 emissions reductions per cow and milk production**

County	Total herd size, thousands		Herd size, small dairies, thousands		Total processed milk, pounds, millions		
	Base	Scenario 3	Base	Scenario 3	Base	Scenario 3	Change
Fresno	112	108	4.1	3.3	971	941	-3.1%
Kern	136	118	0.5	0.4	94	86	-8.5%
Kings	155	138	8.7	7.0	1,106	1,041	-8.3%
Madera	76	77	2.5	2.0	0	0	0.0%
Merced	272	281	30.4	24.6	1,012	982	-2.9%
San Joaquin	124	128	20.4	16.5	322	308	-4.3%
Stanislaus	144	145	28.0	22.7	1,837	1,762	-4.1%
Tulare	483	457	12.7	10.3	1,878	1,785	-4.9%

# Economic Impact Summary

The California dairy sector has experienced considerable consolidation and attrition over the last several decades.

- In 2002, there were 2,800 dairy farms with an average herd size of less than 600 cows.
- As of 2022, there are 1,117 farms with an average herd size of more than 1,500 cows.
- Production costs, economies of scale, age of farms, dairy policy, and other economic pressures caused consolidation and attrition.

Anaerobic digesters have been increasingly developed since the early 2010's and there are concerns that digesters are causing consolidation in California's dairy industry.

- Statistical evidence contradicts this theory, instead suggesting consolidation is a prerequisite for digester construction.
- Digesters require a large and consistent feedstock to guarantee a revenue stream—without a large dairy herd or clustering of several smaller dairies, digesters are not financially viable and are not constructed.

Economic impact analysis focused on three direct methane emission policy scenarios to meet the target established under SB 1383 of a 40% reduction in manure methane by 2030. The economic analyses show:

- LCFS credits and digester technology are critical for meeting the state's methane reduction requirements. **Average direct economic losses are \$300 to \$675 million per year.** A sensitivity analysis shows impacts of \$400 to \$955 million per year. This does not include multiplier effects to indirectly impacted industries, to workers, and to consumers.
- Regulatory compliance costs are significantly higher for small California dairies, resulting in substantial consolidation from small farms to large dairy farms. That is, **the policies cause consolidation and drive small dairies out. Between 20 and 25% of small dairies are driven out of business.**
- **There is no empirical evidence that digesters are causing consolidation. Rather, consolidation is a result of other forces. Direct regulation would accelerate consolidation.**
- Regulatory leakage occurs as production moves from California to out-of-state dairies with inferior methane management. **Up to 1.43 MMTCO<sub>2</sub>e in leakage is estimated.**
- There are 40 new California dairy digesters in process or just starting operation using financial assistance from CDFA DDRDP grants. **Without LCFS credits, digesters are not financially viable and would be abandoned** (Scenarios 2 and 3). This results in non-recoupable capital losses of \$58.5 million in state grant dollars and \$200 million in private equity. It also eliminates 2.44–3.51 MMTCO<sub>2</sub>e reduction nationally from projects under construction.
- Imposing direct regulations on dairies causes small dairies to consolidate to large farms. **Compliance costs also lead to increased attrition, resulting in emissions leakage out-of-state, and hindering progress towards the state's GHG reduction goals.**

Directly regulating methane emissions has high cost implications for small dairies, leading to further consolidation. Eliminating LCFS crediting would cause digesters to shut down, dairies to leave the state, and policy leakage. Economic impacts would be greater in low-income counties like Fresno, Kern, and Tulare.



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