Chapter 6. California Dairy: Resilience in a Challenging Environment

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Abstract

Milk is the top farm commodity (by farm revenue) in California, and California is the top dairy producer in the United States. The California dairy industry is central to the agricultural economy and environment in California. The California dairy industry had a record of remarkable expansion that lasted many decades before ending abruptly 2007. For these earlier decades, California dairy had some remarkable advantages relative to farms and processors in the rest of the United States. Dairy farms capitalized on California's climate, topography, and economic openness to create large dairies that provided opportunities for the best farms to thrive by accessing capital, advanced genetics, and exceptional managerial practices. Processors also captured scale economies and new technology to lower processing costs, improve returns for further innovation, and to incentivize the expansion of raw milk production. In the more recent period, growth has stopped as other regions in the United States adopted much of what had made California distinctive while California farms and processors have grappled with costs of increased environmental, farm labor, and other cost-side pressures. This chapter explains the recent history and the current situation and outlook for California dairy.

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The California dairy industry emerged as the largest milk producer in the U.S. in the early 1990s and continues as the largest dairy industry among the states and the largest farm industry by revenue in California.

Photo Credit: Karen Higgins, UC Davis

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Introduction

Milk has long been significant in California agriculture, and the California dairy industry has a unique place in U.S. dairy history. The California dairy industry emerged as the largest milk producer in the United States in the 1990s after a remarkable period of transformation. It continues to be the largest dairy industry among the states and the largest farm industry by revenue in California.

In the late 1940s and early 1950s, when most U.S. farms had at least one milk cow, California milk production held a significant but moderate place in the national totals. In 1949, California accounted for about 4.5 percent of U.S. milk production, compared to California's 7.9 percent of the U.S. value of all farm products. By 1954, California's shares had grown to 7.5 percent of U.S. milk production and 9.2 percent of U.S. value of all farm products. During this period, milk accounted for about 12 percent of the value of California farm products.

The late 1940s through 2008 was a period of incredibly rapid growth for the California dairy industry. By 1975, California had grown to No. 2 among dairy states, behind Wisconsin, with about 9.4 percent of U.S. milk output. In the next 25 years to 2000, California milk output tripled again, so California produced 50 percent more milk than Wisconsin and about 19 percent of all milk in the United States. In the next seven years, California milk production grew by one-third to hit its peak, in 2007 and 2008, of about 41 billion pounds of milk and about 22 percent of the U.S. total. Since then, California milk production has bounced up and down a little, while the share of U.S. production has declined to about 18.6 percent in 2019.

The California dairy industry continues to be large, dynamic and closely linked to other parts of agriculture and the California economy. Almost all of the milk produced in California is processed in California, and almost all of the milk processed in California is produced on dairy farms in the state. Much of California's processed dairy product (about half) leaves California in the form of cheese, whey, lactose, milk powders, butter, and other processed products.

California milk production depends on feed, mostly hay and silage, produced in California or shipped in from other western states, such as Utah or Idaho. The economic health of the California dairy industry depends crucially on a healthy local forage industry to supply much of its silage, hay, and other forages that are expensive to haul long distances. Concentrate feeds, based on grains and oilseeds, are mostly shipped in from other states and Canadian provinces. California cows also consume a wide variety of feed by-products, from almond hulls to tomato pumice, from the huge diversity of California crop agriculture. California dairy farming depends on a viable local milk-processing industry because raw milk is costly to move long distances. Likewise, although the California dairy-processing industry ships cheese, milk powders, and other products across the country and around the world, its viability requires milk production on nearby farms.

This chapter reviews the recent economic history, situation, and outlook of the California dairy industry. The chapter begins with on-farm milk production and illustrates the size, productivity, and growth of the industry. It compares recent trends in California milk production and productivity with data from other states.

Dairy farm consolidation has proceeded rapidly in California and elsewhere. Dairy farm numbers have dropped, and herd size has grown. This chapter reviews data from successive U.S. Censuses of Agriculture to document the evolution over time of the size distribution of California dairy farms. They show that fewer farms are in small farm categories, and more are in the larger size categories over time. This evolution has accompanied more concentration of the industry into the San Joaquin Valley.

Feed inputs dominate farm costs of milk production—concentrates and some hay are shipped into California, while much hay and silage are grown locally. These forage crops compete with tree and vine crops in the Central Valley for land, and increasingly, scarce irrigation water, which places pressure on the production cost of milk. Other challenges for farm costs relate to regulatory compliance with local air and water quality regulations, as well as California labor and greenhouse gas regulations.

Demand for milk comes from processors, the largest of which are farm-owned cooperatives. The milk products comprise the full range from milk beverages through soft and frozen products to butter, dry milk powder, and cheese. Most of California milk output ships to the rest of the United States and world markets, with beverage milk and 15 percent or so of other milk products remaining in California. Exports are an important part of demand for California dairy production.

Milk price policy is complicated and pervasive. In November 2018, California ended more than 80 years of state milk price regulations and joined the Federal Milk Marketing Order (FMMO) system. The FMMO system is similar to the old California marketing order in continuing to set minimum prices for farm milk based on the product made from that milk. The FMMO system also continues to require pooling the minimum payments before distributing revenue to farms as a weighted average "pooled price." This chapter explains the consequences of federal milk price policy, the federal Dairy Margin Coverage program—which is a kind of net revenue insurance available to dairy farms—and recent ad hoc policy designed to support dairy farm income. This chapter also explains a unique California "quota" policy, that redistributes milk revenue among farms.

This chapter concludes with a look at the future prospects for the California dairy industry, given a set of significant challenges but, at the same time, a legacy of innovation and resilience.

The current COVID-19 pandemic put immediate pressure on the industry in 2020 from low prices and then price variability. Milk prices collapsed, then price of milk used for cheese jumped, fell again, and rose again. Overall, dairy prices have risen from their springtime lows and are likely to be above recent year averages in 2020. After the U.S. and global recession pass, the California dairy industry is likely to return to its long-term outlook.

California Milk Production, Productivity, and Costs

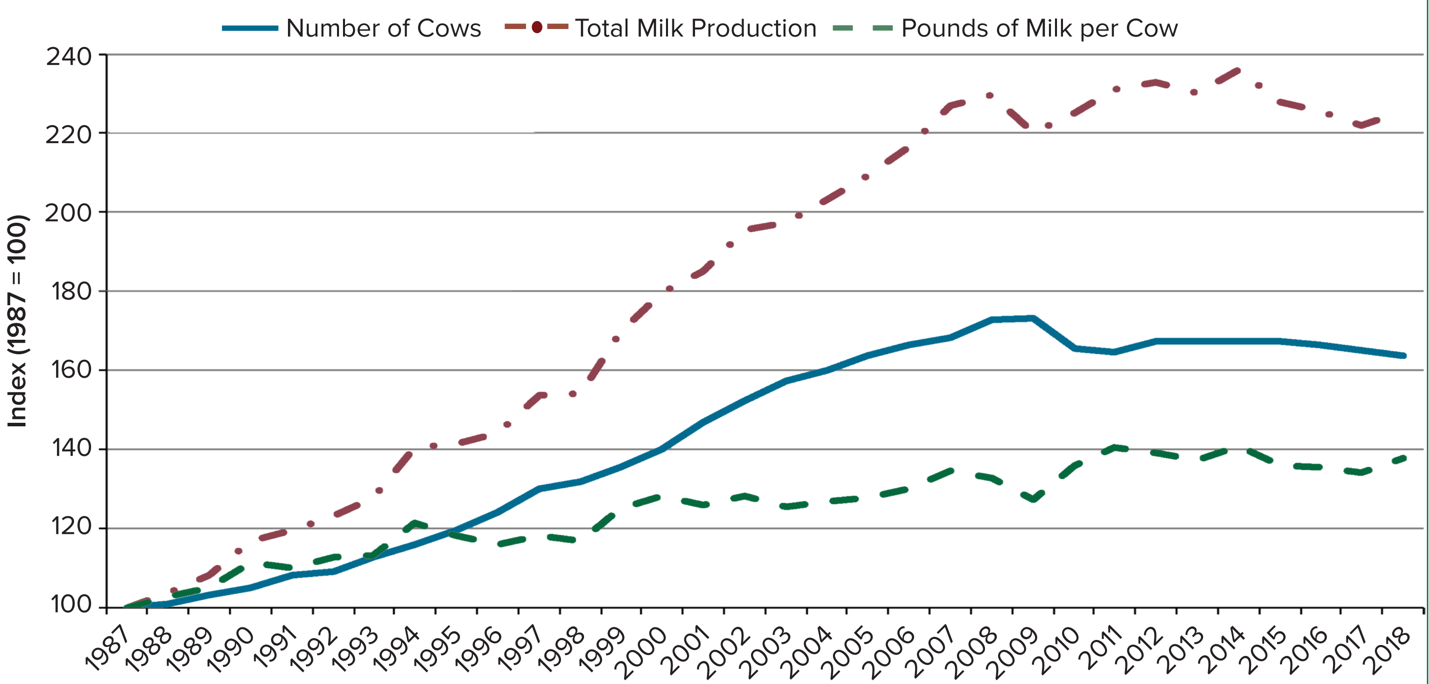
Technology, management, the underlying economics that determine expected input prices and milk prices drive milk production in California. A later section of this chapter will provide details on the demand side. This section focuses on California milk supply, including how dairy farm economics in California has changed and changed relative to competitive regions and U.S. states (Matthews and Sumner, 2019). Increasing dairy farm size, typically measured by numbers of cows per herd, has long been important in California and elsewhere. California continues to have relatively large herd sizes, but herd size in other regions has grown relative to California. As the dairy industry expanded, it also concentrated geographically into the San Joaquin Valley, where dairy farms are larger and costs are lower. Exceptions are a specialized and heavily organic dairy industry in the coastal counties north of San Francisco and a remaining concentration of dairies east of Los Angeles.

Milk production costs rise gradually with increases in wages and input prices but fluctuate from month-to-month with feed prices. Dairy cow feed accounts for more than half of total costs and affect dairy farm margins, returns to invested capital, and farm family labor. In particular, periods of high feed costs that are not matched by high milk prices cause severe financial pressures.

Overview of California and U.S. Production Trends

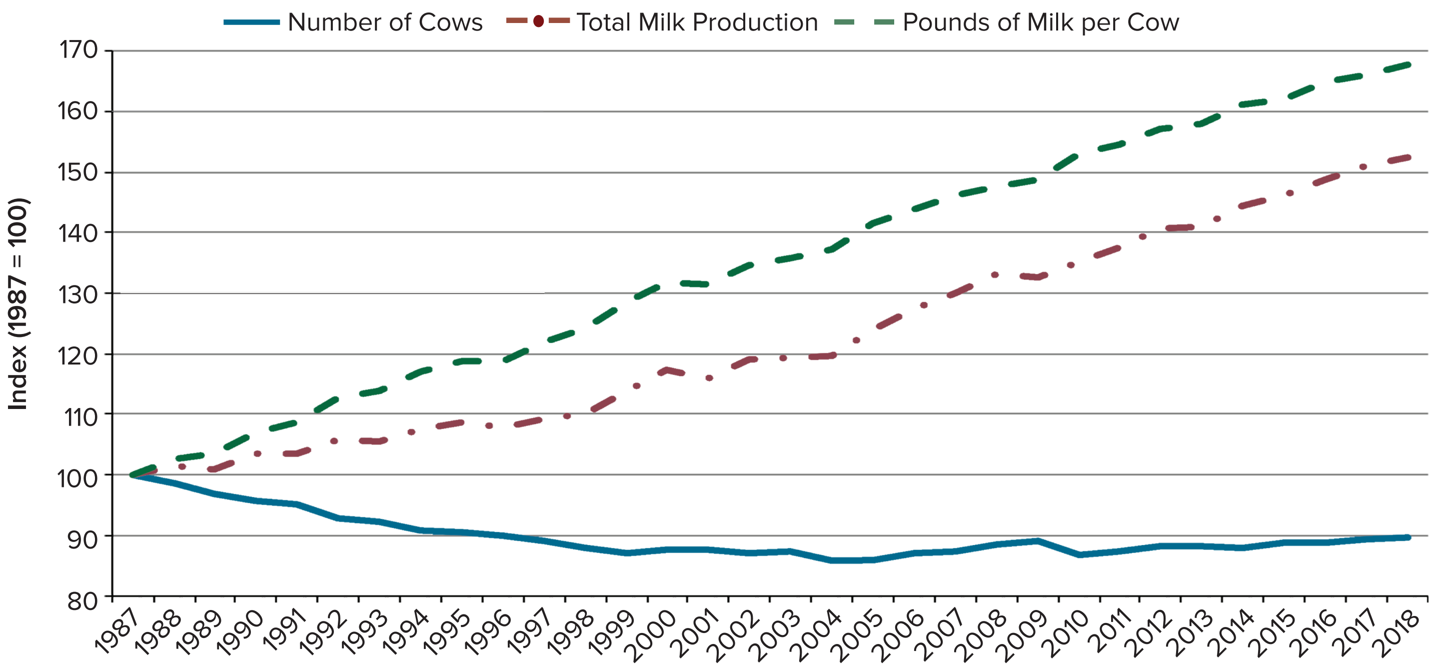
Figure 6.1 illustrates well the recent production history and situation of the California dairy industry. The vertical axis represents an index where the value 100 represents statewide milk production, number of cows, and production per cow in 1987. In 1987, California produced 17.9 billion pounds of milk from 1.06 million cows for an average of 16,881 pounds per cow. By 2018, milk production had risen by 120 percent to 40.4 billion pounds, while the number of cows had risen by about 64 percent to 1.74 billion, and milk per cows had risen by about 37 percent, to 23,239 pounds per cow. These are impressive growth rates, but the three-decade change hides that there has been little or no growth

Figure 6.1. California Milk Production and Productivity Trends, 1987–2018



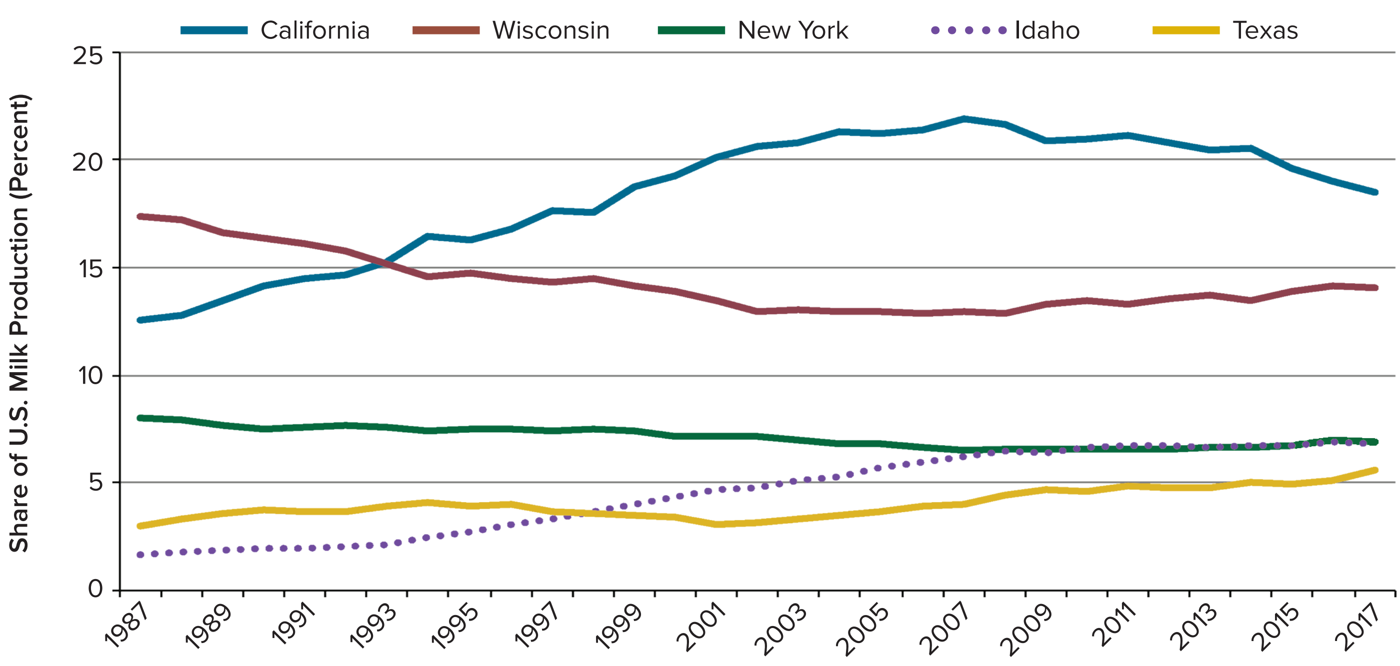
Source: USDA/NASS Quickstats. Available at: https://www.nass.usda.gov/Quick_Stats/

Figure 6.2. U.S. Milk Production and Productivity Trends, 1987–2018



Source: USDA/NASS Quickstats. Available at: https://www.nass.usda.gov/Quick_Stats/

Figure 6.3. Share of U.S. Milk Production in Major Dairy States, 1987–2017



Source: USDA/NASS. Available at: https://www.nass.usda.gov/

for a decade or more. The number of cows peaked in 2007–2008 and has fallen gradually by about 1 percent per year since then. Milk per cow fell from 2007 to 2009 as milk prices and profitability collapsed. It reached a high in 2014, when dairy profits were exceptional, and then has fallen by a few percent since then. The result for milk production has been some small ups and downs, with total milk production a couple of percent below where it stood more than a decade ago. The industry expected milk production to rise in 2020, but now may be lower than any year since 2009.

It is important to compare these California trends to the national trends. Figure 6.2 shows that national growth in the number of cows, production per cow, and milk production were all below California growth in the first 20 years; yet, all three have grown relative to California in the most recent decade. Indeed, national cow numbers declined rapidly and were 13 percent below 1987 in 2007, but have grown by about 3 percent in the past decade. Production per cow has grown steadily by almost 70 percent over the three decades, and after starting about 18 percent below California, it has caught up. After having a growing share of U.S. milk production, California's share of the national total has gradually declined for a decade as national production, and especially production in a few other major dairy states, has continued to grow rapidly.

Table 6.1 displays cow numbers in five major dairy states in 2004, when U.S. cow numbers bottomed out, and in 2018. The national milk cow herd grew about 2 percent over these 15 years, as did the Wisconsin and California herds. New York, had fewer cows, whereas Idaho and especially Texas added cows rapidly during this period. Several other states, such as New Mexico, also added to their milk cow herds.

Table 6.2 compares milk per cow in California to other major dairy states. California's milk per cow increased gradually. In contrast, it grew at a rapid pace in all other major states such that now California is at the bottom of this productivity metric. Of course, milk per cow depends on many contributing factors. For example, the increase in the share of Jersey cows in California, which produce higher solid content per pound of milk but less milk per cow, is one reason growth in average milk per cow has slowed in California. Nonetheless, the relative changes in milk per cow over the past 15 years indicates that dairies in other states have improved on this productivity metric.

Table 6.1. Cow Numbers in California and Major Dairy States

	Number of Cows (Thousands)		Change
	2004	2018	Percent
California	1,700	1,740	2
Wisconsin	1,245	1,275	2
New York	658	625	-5
Idaho	412	600	46
Texas	317	515	62
U.S. Total	8,988	9,400	2

Source: USDA NASS Quickstats. Available at: https://bit.ly/36FAhoV

Table 6.2. Milk per Cow in California and Major Dairy States

	Milk per Cow (in pounds)	
	2004	2018
California	21,450	23,239
Wisconsin	17,739	23,974
New York	17,705	23,842
Idaho	22,070	25,077
Texas	18,956	24,955
U.S. Average	19,008	23,137

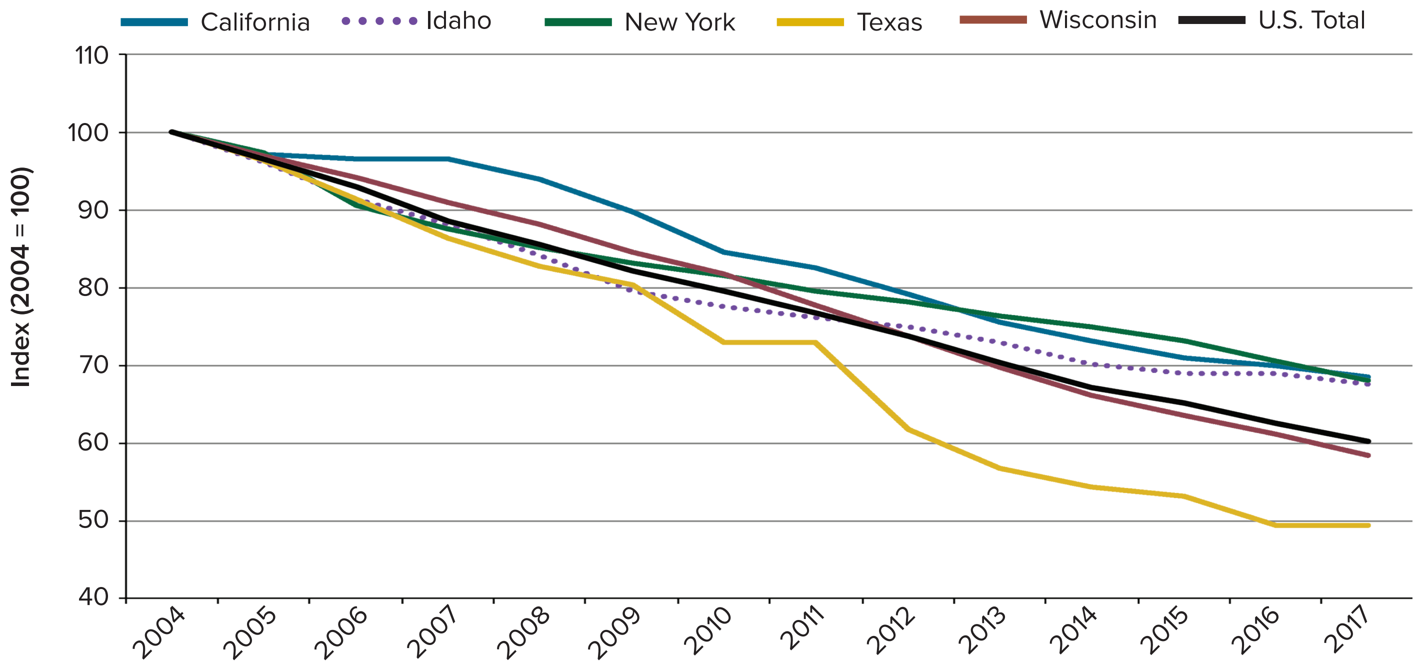
Source: USDA NASS Quickstats. Available at:https://bit.ly/36FAhoV

California's share of national milk production matched Wisconsin in 1993 at about 15 percent and reached 21.9 percent in 2007, by which time the Wisconsin share had slid to 13 percent (Figure 6.3). From 2007 forward, the national shares of Texas, Idaho, and Wisconsin have grown, and that of New York has stabilized. The decline in California's share exceeds the gains in the other listed states, indicating gains in states such as Michigan and New Mexico.

Dairy Farm Consolidation

The number of dairy farms has been falling rapidly in California and throughout the United States for many decades—in good times and bad (MacDonald et al., 2016). For example, California had rapidly declining farm numbers even as the aggregate number of milk cows and milk

Figure 6.4. Index of Number of Dairy Farms in California and Major Dairy States, 2004–2017



Source: USDA/NASS Quickstats. Available at: https://www.nass.usda.gov/Quick_Stats/

production was growing rapidly. On a year-to-year basis, farm numbers decline more in years with low milk prices. However, even high milk prices do not stop the farm consolidation process, in which more farms exit the industry than enter, and farms that remain increase in both numbers of cows and milk production. Figure 6.4, which sets 2004 data equal to 100, shows that the number of dairy farms in California fell by about 30 percent from 2004 to 2017, with a similar decline for Idaho and New York. Farm numbers declined by 40 percent in Wisconsin and the United States as a whole, and by 50 percent in Texas. And as we saw in Tables 6.1 and 6.2, milk production rose in Texas at the most rapid rate among the top dairy states.

Table 6.3. Average Number of Cows per Dairy in California and Major Dairy States

	Number of Cows per Dairy		Change
	2004	2017	Percent
California	837	1,263	51
Wisconsin	80	141	76
New York	100	138	38
Idaho	546	1,176	116
Texas	391	1,225	213
U.S. Average	134	232	73

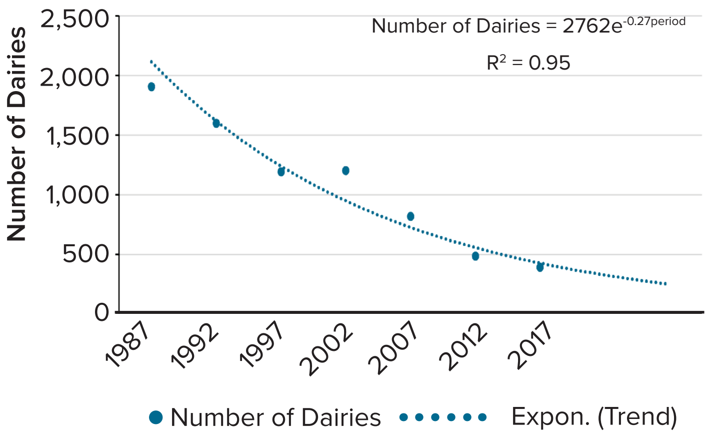
Source: USDA/NASS Quickstats
Available at: https://www.nass.usda.gov/Quick_Stats/

Table 6.3 shows the number of dairies in 2004 and 2017 for major U.S. dairy states and the U.S. average. California had the largest average herd size in 2004. But, herd size in Idaho and Texas almost equaled California by 2017. Herd size in New York, and especially Wisconsin, also grew rapidly in percentage terms but still lagged far behind the western states. These data, together with those in Figure 6.4, show how dairy industries in other states have become more like those in California.

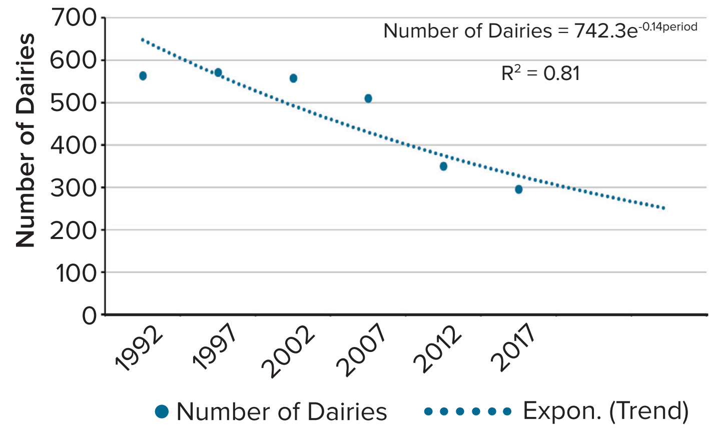
Dairy farm consolidation has been underway for decades, and there are many drivers of this pattern. In addition to scale economies in production and input purchases, the high degree of human capital demands of dairy farm management seems to be important (Sumner and Leiby, 1987). Operating a modern dairy farm demands substantial managerial ability, and individuals with these talents command relatively high salaries. Therefore, to attract those with sufficient human capital requires a competitive return to human capital (Sumner, 2014).

Figures 6.5a–6.5d. Dairy Size Trends

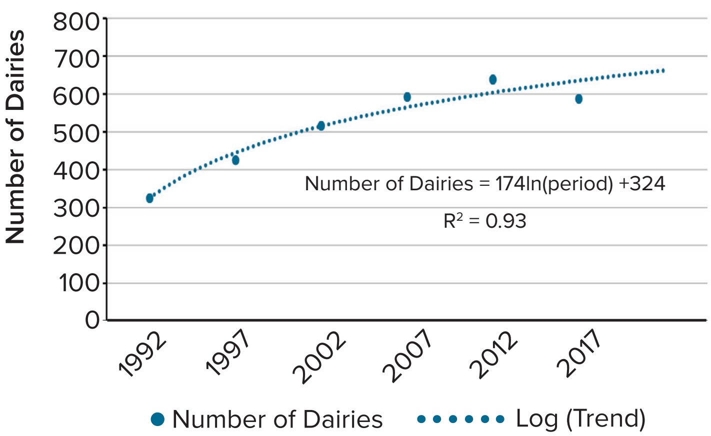
6.5a. Number of California Dairies with Less Than 500 Cows



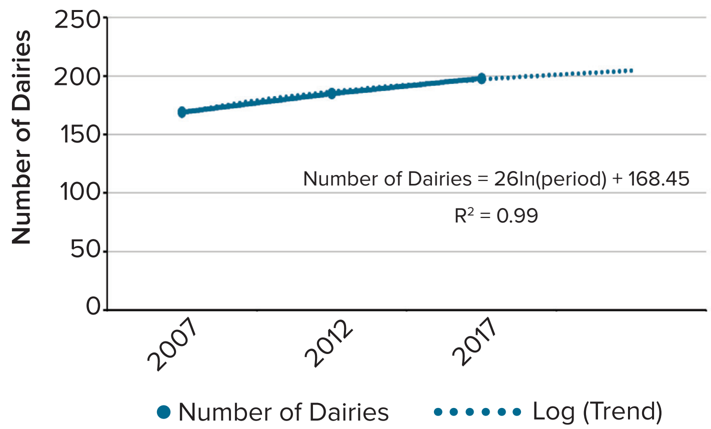
6.5b. Number of California Dairies with 500–999 Cows



6.5c. Number of California Dairies with 1,000 Cows or More



6.5d. Number of California Dairies with 2,500 Cows or More



Source: U.S. Census of Agriculture, various years

Figures 6.5a through 6.5d display herd size trends for the California dairy industry over a three-decade period using data at five-year intervals from each Census of Agriculture 1987 through 2017 (NASS, 2017). Herd size is the most common measure of dairy farm size, but does not capture some interesting patterns (Sumner and Wolf, 2002). For example, a vertically integrated dairy farm that produces much of its own feed may have fewer cows but generates more profit within the farm than a farm with more cows that does not produce feed. Vertical integration into value-added marketing, as practiced by some of the small-herd dairies in the North Coast region, may indicate a larger dairy business even with fewer cows. Similarly, a farm that operates intensely to produce more milk or higher-quality milk may have more farm revenue than a farm with more cows. In California, dairy farms tend to be specialized in milk production more than those in most of the United States, which is one reason California herd sizes are relatively large.

Figures 6.5a through 6.5d use data on cows per herd for those farms that report milk sales during the year. This sample choice eliminates many farms that have a few milk cows; for example, milk cows used to nurse calves, but are not in the commercial dairy business. Figure 6.5a demonstrates that there were almost 2,000 herds with fewer than 500 cows in 1987 but less than 400 herds in this category by 2017. The rate of decline is about 27 percent every five years, and this trend alone accounts for 95 percent of the variation over the thirty years. If this trend continues,

Table 6.4. Distributions of Farms, Revenue, and Cows by Herd Size, 2017

	Dairy Farms		Milk Revenue		Milk Cows	
Cows/Farm	Number	Percent	$ Millions	Percent	Thousands	Percent
1 to 499	395	30.9	364	5.6	94	5.4
500 to 999	296	23.1	829	12.8	210	12.0
1,000 to 2,499	390	30.5	2,385	36.8	638	36.5
2,500 to 4,999	163	12.7	1,968	30.4	547	31.2
5,000 or more	35	2.7	931	14.4	262	15.0
Total	1,279	100	6,477	100	1,750	100

Source: NASS/USDA. U.S. Census of Agriculture 2017. Available at: https://www.nass.usda.gov/Publications/AgCensus/2017/Full_Report/Census_by_State/California/

California would have about 250 herds with fewer than 500 cows by 2027.

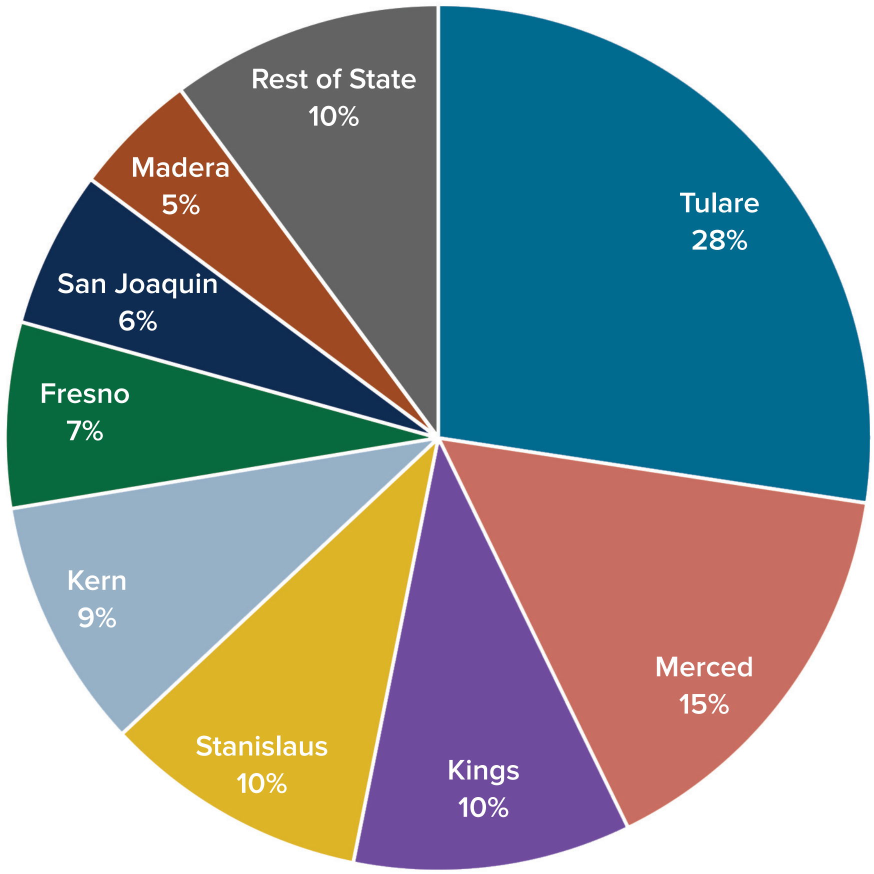
Figure 6.5b shows the trend in the next size category of 500 to 999 cows, starting in 1992—the first year the data were available. Prior to this date, the census provided no breakdown of herds larger than 500 cows. This trend shows a gradual decline of about 14 percent per five-year interval, starting with about 550 herds with between 500 and 999 cows in 1992 and declining to 300 herds 25 years later. For herds with 1,000 cows or more, the number doubled in 25 years from about 300 herds in 1992 to about 600 herds in 2017. For this size category, a logarithmic trend fits the data to reflect a rise at a declining rate over time. Finally, for the last three censuses, we only have data for the larger category of dairies with 2,500 cows or more. Clearly, the trend is upward.

Table 6.4 documents the California dairy farm size distribution using census categories in 2017. There were 395 dairies, accounting for about 31 percent of all dairy farms, with fewer than 500 cows. These farms represented only 5.6 percent of milk revenue. The next larger category included 23.1 percent of farms and 12.8 percent of the milk revenue. What is now the mid-size category, 1,000 to 2,499 cows per farm, had 30.5 percent of the farms and 36.8 percent of the milk revenue. The category of herd sizes between 2,500 and 4,999 had 12.7 percent of the farms and about 30.4 percent of the milk revenue. Finally, the category with more than 5,000 cows comprised only 35 farms—about 2.7 percent of the total— but generated about 14.4 percent of milk revenue.

The distribution of milk cows, shown in Table 6.4, closely matches the distribution of revenue but shows slightly more average revenue per cows for the smaller dairies. Milk revenue per cow in 2017 was about $3,705 for the statewide average. Milk revenue averaged about $3,952 per cow for herds with 500 to 999 cows and only $3,557 for herds with more than 5,000 cows. Some of the higher revenue per cows for small herds is due to a significant number of organic herds that receive an average farm price that is almost double the price of conventional milk. For conventional dairies, the milk per cow and market price of milk tend to be slightly higher for mid-sized dairies. The larger dairies benefit from lower fixed cost and less management time per dollar of revenue.

Some observers have suggested that mid-sized dairies have been especially vulnerable to trends of fewer and larger farms. These census trends do not support that hypothesis. The number of herds in the smallest category of farms has been declining fastest in both absolute and percentage terms, which is consistent with the econometric tests for bimodal distributions of Wolf and Sumner (2001). They reject the hypothesis of bimodal distributions. An emerging exception may be in the continued presence of organic dairies with relatively small herd sizes in California, but even among organic farms, average herd size is growing.

Figure 6.6. Shares of California Milk Production by County, 2017



Source: CDFA, California Dairy Statistics. Now available from author

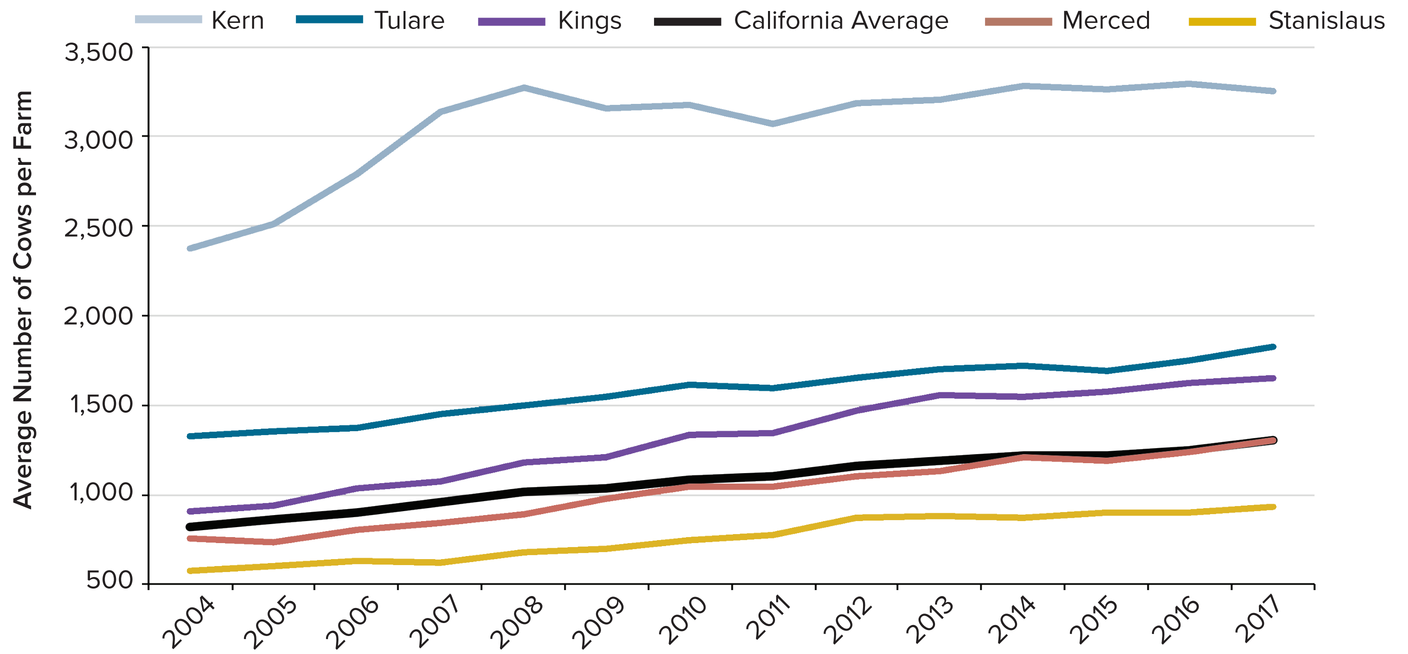
Location, Cost, and Seasonality of Milk Production

The San Joaquin Valley has been the major milk-producing region in California for decades, and about 90 percent of milk output and dairy revenue come from that large region, from Kern County to the south and San Joaquin County to the north (Figure 6.6). The dairy farms in this region are almost all confinement-style dairies. Figure 6.6 documents that more than 40 percent of milk production comes from Tulare and Merced counties.

Beyond the San Joaquin Valley, two areas account for almost all the rest of California's milk production. First, a few large dairies remain in western San Bernardino and Riverside counties. The number of farms and the amount of milk production in this small region have declined steadily in the face of suburban population growth. Remaining dairies have a transport cost advantage to serve some of the demand for fluid milk use in the Southern California region. Second, the coastal area north of San Francisco continues to support a significant dairy industry that focuses on pasture-based and organic dairies in Marin, Sonoma, and Humboldt counties. Organic and other pasture-based dairies in this region yield less milk per cow (about two-thirds the state average), but receive much higher prices per pound of milk. They also tend to have herd sizes about one-quarter of the state average.

After growing rapidly until 2007, the number of cows in the San Joaquin Valley has remained constant for more than a decade. In Tulare County, cow numbers have fallen by about 10 percent since a peak in 2010, offset by slight growth in some of the less dairy-intensive counties. The number of dairy farms continued to decline in all counties except Kern County. Herd size differs by county, with larger herds in the Southern San Joaquin Valley. Figure 6.7 shows that the average herd size in Kern County has been about 3,500 for more than a decade. The average herd size in Kings and Tulare counties has steadily grown and now

Figure 6.7. Average Cows per Farm for Top Five Counties and State, 2004–2017



Source: CDFA. Now available from author

exceeds 1,600 cows per farm. Herd size is also growing rapidly in the Northern San Joaquin Valley, but it remains below 1,000 cows per farm as shown by Stanislaus County data in Figure 6.7.

Dairy production costs vary from year to year, largely depending on the cost of feed, which accounts for more than half of total costs (Table 6.5). In 2014, grain, oilseed, and other livestock feed prices were very high, as were milk prices. Feed accounted for 63 percent of costs in that year, but despite high feed costs, the milk price margin over the production costs was almost $5 per hundredweight (cwt). In subsequent years, milk prices and feed prices were lower, but other costs rose. In 2017, the last complete year for which data is available, feed costs had fallen and were 54 percent of total costs, but because of low milk prices, the margin of milk revenue over costs was only $0.86 per cwt.

Dairy feed rations are comprised of a mixture of forages, such as hay and silage; concentrates, such as corn and other grains, and high-protein oilseed meals. Farms produce corn silage and small grain silage near the dairies where it is fed because hauling costs are high relative to the value of the feed. Much California-fed grain and oilseed meal comes from the Midwest. But significant amounts are by-products such as cottonseed. By-products, especially almond hulls, are also important forages.

California farms produce most of the hay and silage used on California dairies, but some is shipped in from other western states such as Idaho, Nevada, and Utah. A challenge for California dairies is the high cost of forage feeds. Competition with tree nuts and other crops for land and irrigation water has reduced the production and raised the cost of hay and silage in the San Joaquin Valley (Sumner and Pan, 2019).

Hired labor rates account for about 12 percent of milk production costs and have been rising for two reasons. As farms get larger, the share of labor on the farm that can be performed by unpaid family labor declines and, therefore, the ratio of hired labor to revenue rises. More important in recent years is the increase in wages of hired farm workers, who may have opportunities at non-farm jobs. Dairy farm work, mainly feeding and milking cows, is a relatively low-wage occupation and dairy farms are sensitive to having workers who treat animals well, while also having the ability to use increasingly sophisticated technology.

Table 6.5. Farm Costs of California Milk Production

	2014		2017	
Dairy Input	$/cwt	Percent Share	$/cwt	Percent Share
Feed	11.05	63	8.77	54
Hired Labor	1.56	9	1.87	12
Herd Replacement	1.37	8	1.88	12
Other Operating Costs	2.88	17	3.06	19
Milk Marketing	0.56	3	0.55	3
Total Costs	17.42	100	16.13	100
Average Mailbox Price	22.37		16.99	
Price – Costs (Residual)	4.95		0.86	

Source: CDFA California Dairy Statistics, available from the author

Note: Operating costs include utilities, supplies, veterinary and medicine, outside services, repairs and maintenance, bedding and manure hauling, fuel and oil, miscellaneous expenses, interest, lease expense, depreciation, taxes and insurance. Milk marketing costs include hauling milk from farm to plant, State of California assessments, Federal assessments, and miscellaneous deductions.

Automation is growing, but technologies such as robotic milking are not yet dominant in the industry.

Dairy farms produce milk every day and receive their revenue in a monthly milk check. The individual cows are typically milked twice a day (three times per day on some farms) about 305 days per year. The cows are "dry" about two months per year during the last two months of a nine-month pregnancy. They re-enter the lactating herd shortly after giving birth. The typical cow lasts about two lactations with some healthy, high-productivity cows lasting longer.

Although farms produce milk every day, production does vary seasonally. The milk production in California is about 10 percent higher in the spring than in the later summer and fall, when it reaches a season-low, before gradually climbing in the winter. Milk prices tend to be lower in the spring because of the peak supply during this period. Milk production declines in periods of extreme heat. Many California dairies have installed misters and other technology to reduce cow discomfort during high-temperature days. Generally, cows are more productive where humidity is low, which is not an issue in California. So far, there is little evidence of climate change reducing milk cow productivity enough to cause problems for dairies in the San Joaquin Valley (Key and Sneeringer, 2014).

Regulations that Affect Farm Production and Costs

California has many environmental, labor, zoning, and other business regulations that affect dairy farm operations as well as milk transport and processing. Among the most prominent of the environmental regulations are those related to methane emissions in the context of greenhouse gas programs, local air quality concerns, and groundwater quality and quantity.

California regulations designed to improve air quality in the San Joaquin Valley specify practices on dairy farms that limit local air pollutants from manure, animal feed storage, and other potential sources such as dust. Zhang (2018) conducted a detailed evaluation of changes in farm practices indicated by some specific California air quality regulations, and used econometric estimation of data from the farm cost surveys that are summarized above. Her empirical investigation finds little or no measurable cost impact of the regulations she studies. Of course, some potential costs, such as the demands on the time and attention of the farm operators, are difficult to measure.

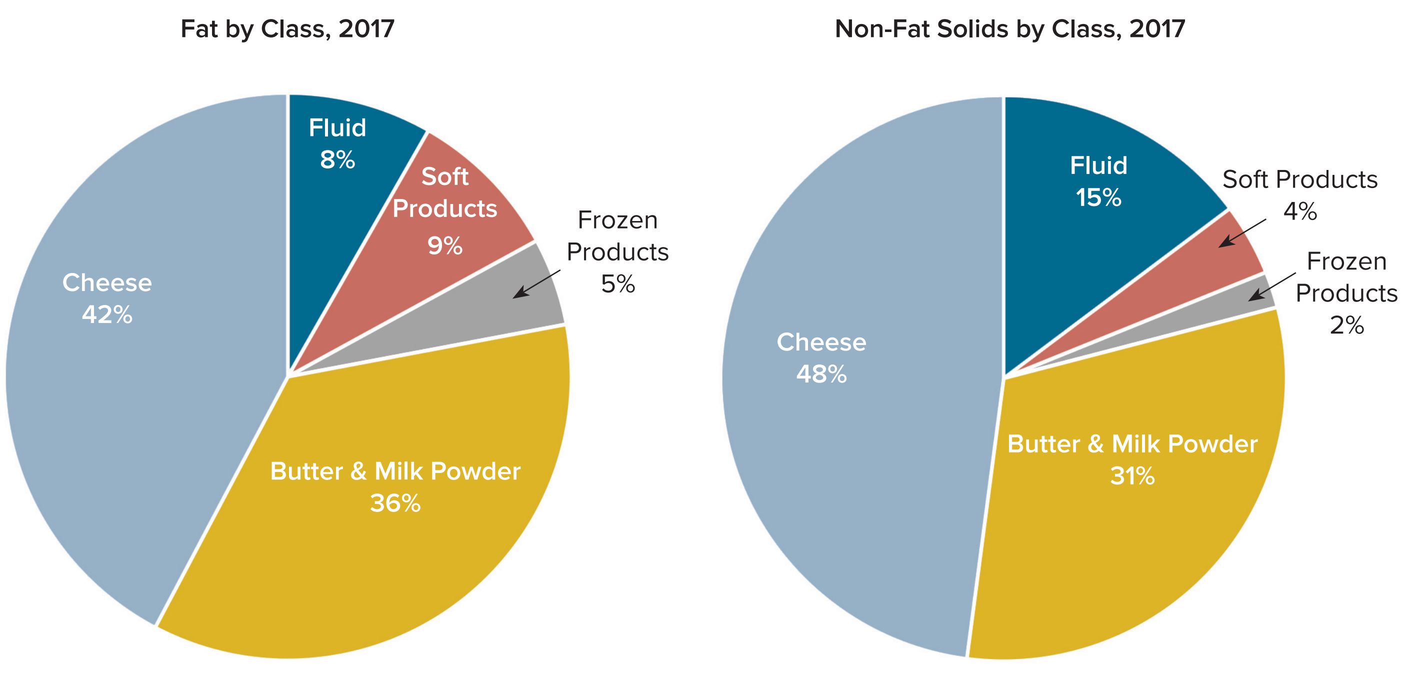
Regulations related to groundwater quality have required changes in manure handling to reduce the seepage of pollutants that affect the water in residential wells, among other concerns. Nitrate pollution of groundwater has been a particular concern for rural towns that do not have access to costly water treatment. Dairy manure has been a source of some of that pollution. Regulations now require sealing the bottoms of manure lagoons and controlling when, where, and how manure is spread on fields.

The issue of dairy manure handling impacts on methane emissions as a short-lived greenhouse gas has become prominent in California in the last decade (Kaffka et al., 2016; Lee and Sumner, 2018). With legislation in 2016 (Senate Bill 1383), California began an effort to achieve a 40 percent reduction in short-lived greenhouse gas emissions by 2030. Because dairy farms contribute significantly to the state methane emission total, reduction of methane emissions from dairy farm manure is a prominent component of that effort. For several years, the California Department of Food and Agriculture has been subsidizing efforts to reduce methane emission with methane digesters and alternative manure management practices. If considered feasible, regulations would begin in 2024.

Manure flushed from dairy barns into lagoons decomposes anaerobically and generates methane in the process. One strategy to reduce methane emissions uses alternatives that move less manure into lagoons and facilitates drying and aerobic decomposition. These are considered more appropriate on farms with smaller herd sizes. Another strategy is to allow the anaerobic digestion of manure in covered lagoons that seal in methane before it is emitted. Then the methane, which is the energy component of natural gas, can be cleaned and used to generate electricity, or what is now more common in California, piped to substitute as a motor fuel. With sufficient subsidy for digestion, piping, and cleaning, biogas as it is sometimes called, can compete with natural gas, so long as there are subsidies for "renewable fuels" in general (Lee and Sumner, 2018).

Substantial investment, subsidized by the California state government, has recently developed a series of centralized facilities to produce and sell renewable fuel from clusters of large dairies in the San Joaquin Valley. This fuel has qualified for both the federal renewable fuels subsidies and the California Low Carbon Fuels subsidy. If fuel subsidy rates continue, the investments will likely be profitable (Lee and Sumner, 2018). However, the Spring 2020 collapse in petroleum and other energy prices, severe recession with reduced fuel demand, and the new challenges for the California state government budget may make such investments more difficult to sustain.

Figure 6.8. Utilization of California Milk Components, Shares by Product Class



Source: CDFA Statistics and Trends Annual Tables and Data, 2017

Processing Issues and Costs

Almost all milk produced on California farms is processed in California and almost all milk processed in the state is produced in California. Transport costs are high relative to the unit value of milk. Therefore, before shipping, most milk in California is transformed into cheese, whey, milk powder, and butter. Such processing removes most of the water, reduces perishability, and increases the value of the product to be shipped. Fluid milk products processed in California tend to be used near to where the products are produced, again because of perishability and transport costs. Soft products, such as yogurt and cottage cheese, and frozen products such as ice cream, are intermediate in terms of perishability and transport costs relative to product value and tend to be shipped further than fluid milk products. These practical considerations about milk transport costs are key to understanding the relationship between farm production and milk processing in California.

More than 80 percent of California milk is produced by members of farmer-owned cooperatives that represent their members in bargaining, and process much of their members' milk as well. Members of California Dairies, Inc. (CDI) produce just under half of all milk in California and members of two large national cooperatives, Dairy Farmers of America and Land O' Lakes, each produce about twenty percent.

In California, cooperatives mainly process milk into dry milk powder and butter, while proprietary firms produce fluid milk, soft and frozen products, and cheese. This may be changing in 2020 as Dairy Farmers of America is acquiring California fluid milk processing plants owned by the now-bankrupt Dean Foods. Cheese processing in California continues to be mainly by larger proprietary firms such as Hilmar, Leprino, and Saputo, and many smaller cheese makers.

The Use of California Components

There are four major components in raw milk from the farm: fat (about 3.9 percent), protein (about 3.2 percent), other solids (about 5.8 percent), and fluid (about 87.1 percent). The milk's value is mainly in the fat and protein with some marketable value associated with the other solids, which are mostly lactose and minerals. The subsequent section discusses milk pricing regulations; here, we discuss the use of these milk components in California. The regulatory framework groups milk products into "classes." Products use milk components differently.

Figure 6.8 shows the 2017 utilization of California milk fat and nonfat solids by product class. Fluid products used about 15 percent of the nonfat solid component, and soft and frozen products used about 6 percent. In contrast, fluid products used only 8 percent of milk fat whereas soft and frozen products used 14 percent. Cheese plants use about 48 percent of the nonfat solids and 42 percent of the fat. Cheese making also produces whey products, including whey protein powders used as a food ingredient and an important export product. Butter and milk powder are listed together as a product class because they are processed together. A butter-powder processing plant uses most of the fat component in raw milk to produce butter and butter oils and uses the nonfat solids to make nonfat dry milk and similar products. Some plants also make whole milk powders.

Milk is delivered from farms to the manufacturing plant that is expected to use most of the milk. Except in the case of fluid milk, plants remove most of the fluid. Processing plants, including fluid milk plants, use components required for their product and send excess components to processing plants that make other products. Fluid milk products average about 2 percent fat, so almost half the fat received by those plants will be sent to another plant, such as an ice cream operation. Since butter-powder plants make distinct products with either zero fat or very high fat content, they can accept whatever component other plants have in excess.

Product shares and component shares by product have evolved over time in California and in other markets. In particular, fluid milk products used more than 30 percent of milk fat in the early 1980s. That share fell steadily as total milk production rose, and a small share of all milk went to fluid products. At the same time, however, California consumers used less fluid milk per capita. U.S. average

Table 6.6. California Dairy Processing Costs, 2016

	Butter	Nonfat Dry Milk	Cheese
		Dollars per Pound	
Processing Labor	0.0754	0.0538	0.0626
Processing Non-Labor	0.0724	0.1129	0.0882
Packaging	0.0138	0.0152	0.0244
Other Ingredients	0.0038	N/A	0.0286
General and Administrative	0.0193	0.0140	0.0355
Return on Investment	0.0101	0.0123	0.0061
Total Cost	0.1938	0.2082	0.2454

Source: CDFA Manufacturing Costs Exhibit; the background data for 2016 are available from the author
Note: Costs are the weighted average cost for all plants in California.

consumption of fluid milk fell from 26 gallons per capita in 1987 to 17 gallons in 2018. Over the same 30-year period, the share of whole milk fell from half to about one-third.

Milk Processing Costs and Concerns

California's milk processing industry supplies California, the rest of the United States, and the rest of the world. As discussed, milk and milk components comprise the main input into making dairy products, but other inputs are also important in the manufacturing process. For fluid milk products used by consumers in California, the payments for farm milk comprise about half the retail price. For cheddar cheese, the farm share of U.S. consumer expenditure is about 28 percent, reflecting in part that more cheese is consumed away from home.

Milk processing uses labor and other material, which is a part of the cost of moving milk from the farm to customers, whether they be retailers, food service establishments, or further processors. Table 6.6 provides the most recent data on input costs for making butter, nonfat dry milk, and cheese in California. The total non-milk costs range from about $0.194 per pound for butter to $0.245 for cheese. The biggest cost aggregate is the direct processing costs other than labor, which includes utilities and equipment costs. The cost of energy for drying milk is significant, especially for nonfat dry milk. Processing labor is about one-quarter of total costs for nonfat dry milk and cheese. California has high construction, energy, and labor costs relative to other major dairy states, which tends to raise processing costs. Because California processors compete in national and global markets for these products, the consequence of higher processing costs in California is lower farm milk prices.

Demand for California Dairy Products

We have discussed several demand issues in the previous sections. The most important factor is that most California milk is destined for national and global markets or competes with shipments of products into the state for customers in California. Of course, demand from California customers is important for California-produced fluid milk products, but these products now use only about 12 percent of the milk produced in California.

Demand for milk components has trended gradually over time with income, and food and nutrition information. The decline in demand for milk fat caused in part by concerns about obesity in children and adults, has moderated as nutritional information has shifted to raise more concern about carbohydrate consumption and place less emphasis on fat consumption. While the shift to plant-based foods has continued to place pressure on dairy consumption, current nutritional information has reduced the stigma of milk fat in fluid milk products, yogurt, and butter.

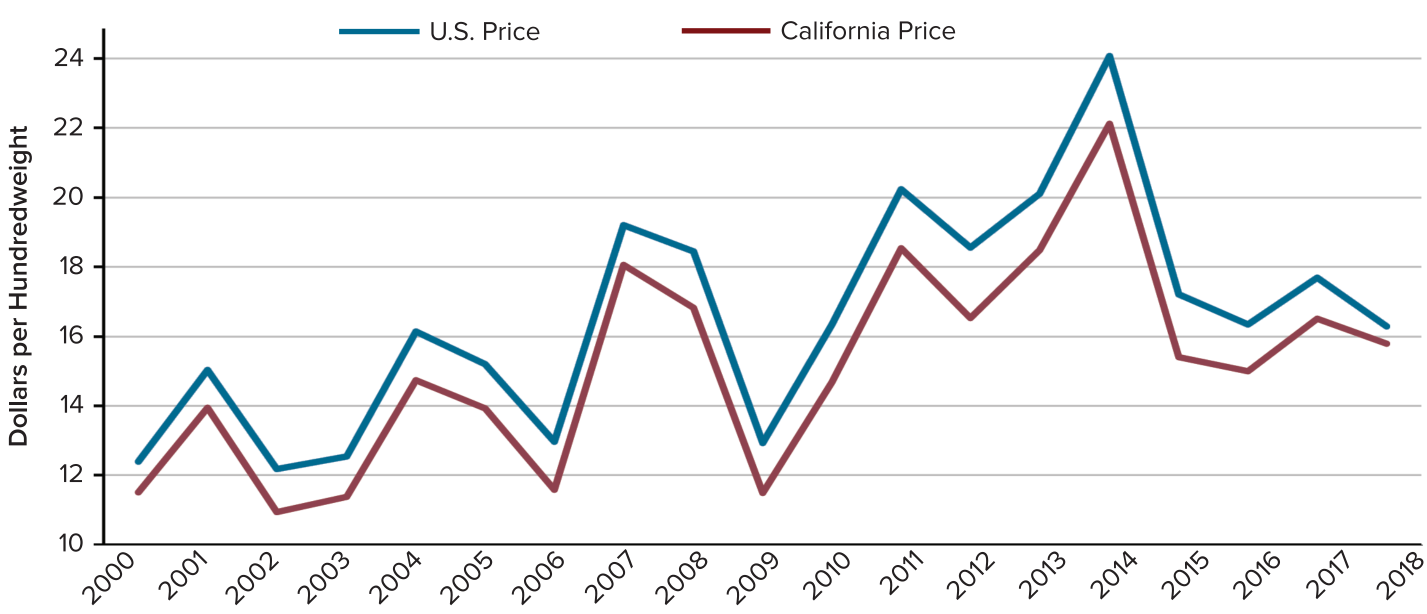
Per capita fluid milk consumption has fallen by one-third since 1990, while per capita butter consumption has risen by one-third, and per capita cheese consumption has risen by 42 percent. Yogurt consumption rose by a remarkable 244 percent over this period. Since 1990, U.S. consumption of per capita milk fat has risen by 14 percent. Overall, domestic commercial use of milk fat has risen by 42 percent since 1995 while domestic commercial use of nonfat solids has risen by 22 percent. Exports of the nonfat solid milk component have grown much more rapidly over this period.

Price Trends and Issues

Against these steady trends in domestic milk demand, milk price variations are driven by variations in milk supply and cost of production and export demand for U.S. and California milk. Demand for exports depend mainly on global dairy product demand trends and variation in conditions among competing milk suppliers.

Figure 6.9 shows the annual average U.S. and California farm milk prices (nominal) over the period from 2000 through 2018. Notice first that the California price is consistently slightly below the U.S. price, but follows the same trend and has the same annual ups and downs. In recent

Figure 6.9. California and U.S. Farm Price of Milk, 2000–2018



Source: USDA/NASS Quickstats. Available at: https://www.nass.usda.gov/Quick_Stats/

Table 6.7. Organic Milk Sales in California

	Gallons (Per Capita)	Share of Fluid Milk Sales (Percent)
2009	31.3	4.16
2010	35.7	4.83
2011	42	5.80
2012	46	6.40
2013	54	7.65
2014	54	7.98
2015	49	7.54
2016	47	7.61
2017	51	8.45
2018	41	8.52

Source: CDFA, Retail milk sales

years, the correlation between the two series on a monthly basis has been about 0.98. Notice the extreme price swings such as the $6/cwt increase from 2006 to 2007, followed by a $5/cwt decline from 2008 to 2009, and then a gain of more than $6/cwt over the two-year period from 2009 to 2011. The high milk prices in 2014 were followed by a period of low prices since 2015. Recent monthly data show that milk prices rose gradually through the beginning of 2020, before the collapse in the spring of 2020, by about $7 per cwt to a price level not seen since 2009.

As shown above, feed costs are more than half of the cost of milk production. USDA economists created an index of prices of common milk cow feeds, which include corn, soybeans, and alfalfa hay that they use to compute the cost of a common dairy cow feed ration. The often-cited ratio of milk price to dairy ration cost ranged between 2.5 and 3.5 in the 1990s, before spiking to about 3.6 in 1999. The ratio remained above 2.5 until a feed price spike in 2008 drove the ratio to 2.01. This precipitated a collapse in milk prices in 2009, leaving the ratio at 1.78, which was the lowest in at least 30 years. With feed prices again high in 2012, the ratio of milk price to dairy ration cost was even lower at 1.52. Even with peak milk prices in 2014, the milk price to feed cost ratio was only 2.54, less than what the industry considered a moderate ratio two decades before. Given these relatively low milk prices, technical and managerial productivity allowed the U.S. and California dairy industries to remain in business.

The organic segment of the California milk industry is distinct in several ways, including the situation and outlook for demand. California organic sales tend to be dominated by fluid milk, where the organic share has been growing. Table 6.7 shows that the organic share of California fluid milk quantity has risen from about 4 percent in 2009 to about 8.5 percent in 2018. However, the decline of overall fluid milk sales meant that the peak quantity per capita was 2013 and 2014. The organic share of fluid milk revenue is much higher than the share of volume because the retail price of organic fluid milk is about double the retail price of conventionally produced fluid milk. About 12 percent of California milk quantity sells as fluid products, which implies that about 1.3 percent of California milk sells as organic fluid milk. Based on cow numbers and productivity, about 2 percent of California-produced farm milk is organic, which leaves about 0.7 percent of California milk or about one-third of organic milk to sell as organic yogurt and other products.

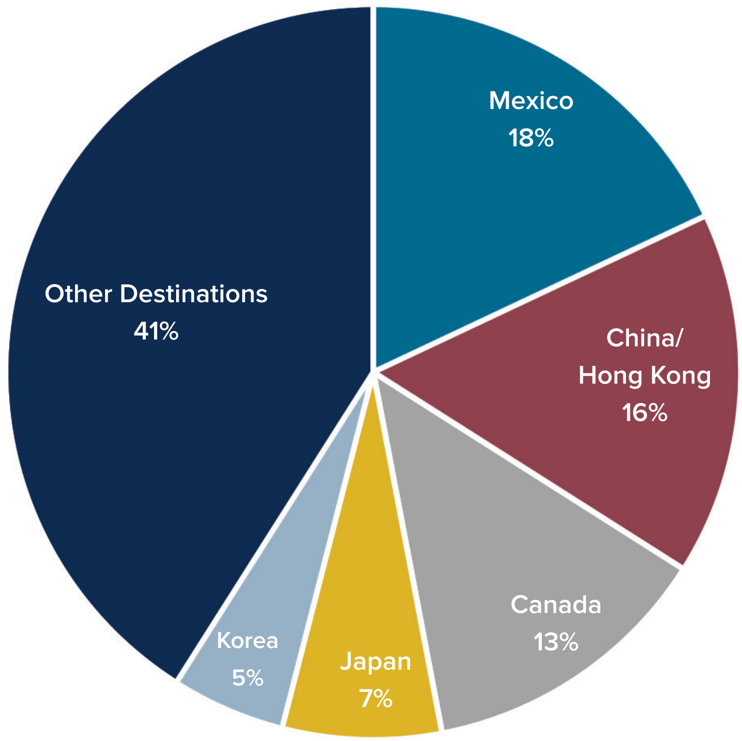
Exports

Dairy products were California's third-largest farm export category in 2018 measured by export value, following almonds, and about equal to pistachios and wine. Based on port data, product mix, and industry sources, UC Agricultural Issues Center estimates that about $1.7 billion in dairy exports were shipped outside the United States in 2018, up marginally from 2017, even though milk prices were down. As a share of farm production, the UC Agricultural Issues Center estimates that about 35 percent of California-produced milk is exported, which is more than 40 percent of the dairy products other than fluid milk. California exports about a third of all U.S. dairy exports, about twice its share of national production.

California exports a portfolio of products; however, like the U.S. as a whole, nonfat solids comprise a larger share of exports than they do in domestic consumption. Nonfat dry milk, whey and other milk powders, and lactose are major export items. California also produces and exports substantial quantities of cheese, and the whey and lactose by-products of cheese production are prominent among exports.

Figure 6.10 documents the broad portfolio of California dairy export product destinations, by value share. Even

Figure 6.10. California Dairy Product Destinations, Share of 2018 Exports



Source: University of California Agricultural Issues Center

though 2018 was a down year for exports to Mexico, it remained the top destination for dairy product exports. Exports increased to China and Hong Kong (considered together) and to Canada. Exports to Japan and Korea depends in part on the market opening accomplished by multilateral and bilateral trade agreements (Lee, Sumner, and Ahn, 2006). Exports to these markets have been relatively steady, and they have remained among the top five export destinations. Partly because of locational advantages and reflecting competitive conditions, the major destinations for dairy exports are North America or Northeast Asia (Matthews et al., 2016).

Dairy Policy

The dairy industry is subsidized and regulated through a series of state and federal commodity policies that date back to the Great Depression of the 1930s. Government dairy programs have been influencing dairy farm prices, revenues, and costs for almost 90 years. This section first considers the current set of federal government support policies, some of which disadvantage California dairy farms. I then turn to the Federal Milk Marketing Order (FMMO) for California that replaced the state-government marketing order in November 2018. Finally, recent data and analysis on the California milk pool "quota" program describes impacts of what remains of the California marketing order.

Federal Support for Dairy Farms

For many decades, until about 20 years ago, the United States maintained high internal milk prices using a government-set price of manufactured dairy products at which USDA would purchase standardized butter, cheese, and nonfat dry milk. The resultant milk prices were periodically well above market-clearing prices, and the government acquired substantial stocks of dairy products, which it subsequently attempted to dispose of through foreign and domestic food assistance. To maintain high internal prices, the government established detailed and elaborate tariffs and import quotas. As recently as the negotiations of the Free Trade Agreement with Australia in the early 2000s, the United States resisted relaxing import barriers for dairy products (Alston et al., 2006).

As U.S. dairy productivity improved, federal milk policy gradually shifted. Congress allowed government-set prices to decline relative to market prices, domestic food assistance programs bought dairy products, and export subsidies faded away. For most of a decade, the support price program was ineffectual in that the minimum price was so low it provided little income support. For much of the recent period, high feed prices and a low margin of milk price over feed cost were the main concerns of the dairy industry. At the same time, there was little interest in raising the purchase price for milk products. Neither Congress nor industry groups wanted the federal government to again acquire substantial stock of milk products (Balagtas and Sumner, 2012). The farm bill of 2014 eliminated the federal program supporting milk prices with purchases of manufactured dairy products, and was the authority for export subsidies (Sumner, 2018b).

The U.S. federal dairy policy in the 2018 Farm Bill has at its centerpiece the Dairy Margin Coverage (DMC) program, which is a revision of the Margin Protection Program that had been operating with relatively little farm participation (Sumner, 2018; Lee and Sumner, 2019). Like the program it replaced, the new DMC offers payments to make up the differences in milk price-feed cost margins. The coverage starts at $4.00 margins, which is free, but rare and so low as to be disastrous for most dairy farms. The program makes available highly subsidized coverage up to $9.50 per cwt for the first 5 million pounds of milk produced on a farm (the annual milk production from a bit more than 200 cows). For more than 5 million pounds of milk, the maximum coverage is $8.00 per cwt, and premium rates have much less subsidy. Margins of less than $9.50 per cwt are quite common, and thus, the "insurance" is likely to payout regularly (see Table 6.8 for 2019 margins).

Since premiums are highly subsidized for the first 5 million pounds of milk, the program is essentially a production subsidy that provides smaller dairy farms an incentive to expand. This means that for smaller farms, that predominate in the East and Midwest, the program is likely to generate substantial positive returns relative to revenue. It is likely to stimulate additions to the herd and more milk production on these farms. The result is more milk production from smaller farms and a lower national milk price than would otherwise prevail. A simple example, based on that in Lee and Sumner (2019), will help explain the operation of the program and illustrate the concern for conventional dairy farms in California. This example is similar in some ways to the impact of the Northeast Dairy Compact that was operating temporarily about 20 years ago (Balagtas and Sumner, 2003)

Consider two farms that enrolled in the DMC. The San Joaquin Valley farm has 1,600 cows and produces 40 million pounds of milk per year, which is somewhat above the

California average herd size shown in Table 6.3. The New York farm, in our example, has 160 cows and produces 4 million pounds of milk per year, which is somewhat larger than average shown in Table 6.3. The California farm has milk revenue of about $6 million, but negative net revenue based on a California price of $15 per cwt. The New York farm has revenue of $680,000, but negative net revenue based on the New York prices of $17 per cwt. As an example, assume both farms enroll 3.8 million pounds of milk at the $9 coverage level and pay the low premium of $0.11 per cwt or $4,180 for each farm.

The DMC bases the margin used for payment on national average milk prices and feed costs. Assume for simplicity that the actual margin is $8.00. Both farms get a payment of $38,000 for the investment of $4,180. For the California farm, this is a small addition to revenue and is intramarginal and thus does not add to the incentive to maintain or expand the herd. For the New York farm, the higher revenue is about $0.89 per cwt or about 5 percent and applies to all the milk production. This 5 percent increase in expected revenue is more than a 10 percent increase in the margin. If we assume the average response is a 10 percent increase in milk production on these smaller farms, which produce about 20 percent of U.S. milk, we get a 2 percent total U.S. milk output, even if moderate-sized and larger farms have no change in milk output. If the demand elasticity is -0.5, the price of milk falls by about 4 percent. In our example, this is $0.60 per cwt or $240,000 in lost milk revenue on the California dairy farm.

Table 6.8 shows that the milk price-feed cost margin in the DMC program was in the range to make payments in each of the first seven months of 2019 of between $1.29/cwt in January and $0.23/cwt in July. The margin coverage at $8.00, available for milk above 5 million pounds per farm, was unattractive given that premium rates were high and payout unlikely. The rest of 2019 had margins above the $9.50 maximum margin. The 2020 year started with margins above the $9.50 maximum, but that was set to change for months after April, and a farm that paid the very small premium for the DMC coverage for 5 million pounds again received a significant subsidy.

The point of this illustration is to indicate that a "subsidy" program such as the DMC that is structured to benefit selected farms in a way to stimulate production can be a net loss for the unfavored farms. Federal dairy programs routinely favor small, mostly eastern, dairy farms in this way. Further, the recently enacted COVID-19 farm subsidies seem likely to have a similar impact because total payment limits per farm will leave most California milk production outside the benefit range.

Table 6.8. Dairy Margin Coverage, Milk Price, Feed Cost, and Margins for 2019

Month	All Milk Price	Feed Costs for DMC	Margin for DMC
	Dollars per Hundredweight ($/cwt)		
January	16.60	8.89	7.71
February	16.80	8.89	7.91
March	17.50	8.84	8.66
April	17.70	8.88	8.82
May	18.00	9.00	9.00
June	18.10	9.47	8.63
July	18.70	9.43	9.27
August	18.90	9.05	9.85
September	19.30	8.89	10.41
October	19.90	9.02	10.88
November	21.00	8.79	12.21
December	20.70	8.75	11.95

Source: USDA Farm Service Agency. Available at: https://bit.ly/36KykYa
Note: Payments were possible at margins below $9.50/cwt, depending on the level of coverage chosen.

California Federal Milk Marketing Order

In November 2018, the federal milk marketing order (FMMO) system began to regulate milk markets in California after a three-year formal rule-making process. The details of the new order differ from the California state government policy that had regulated prices paid by milk processors and prices received by farmers in California since the 1930s. However, the basic purpose and form of the regulations have not changed. Under the goal of "orderly marketing," government regulators set minimum prices paid by processors within the order for milk components that differ by the end use of the milk components purchased. To be eligible for the program, milk must be classified as Grade A, meaning it meets sanitary requirements for fluid uses. In the early days, that was a significant restriction, but is no longer a binding constraint, in

Table 6.9. FMMO Milk Classes Used in Pricing by "End Use"

FMMO Pricing Class	"End Use" Products Within Class
Class I	Fluid milk products
Class II	Soft and frozen products such as cottage cheese, yogurt, cheese and ice cream
Classes III	Cheese, including cream cheese
Class IV	Butter, nonfat dry milk, and other dry milk products,

Source: USDA Agricultural Marketing Service
Available at: https://bit.ly/36LvJNK
Adapted and simplified from Section 1051.40

part because of the incentives created by the marketing orders (Balagtas, Smith, and Sumner, 2007). The marketing order provides for pooling the revenue generated by these minimum prices before the order distributes revenue to dairy farms in proportion to each farm's delivery of milk components.

Specific rules and regulations have changed a bit over the decades, but the principle of end-use prices paid by processors and pooled prices received by dairy farms has long been central to the marketing order system. In the current system, the minimum prices paid by processors apply to milk components—fat, protein, and other solids—with these prices linked to selected market prices received for specified dairy products. In particular, national market prices of butter, nonfat dry milk, cheese, and whey powder determine component values used in minimum price formulas. These price formulas set minimum prices that change each month based on movements in product market prices and differ by end-use class (Table 6.9).

The FMMO can generate added revenue for dairy farms because the minimum prices of milk components used for fluid products (designated Class I) in California are higher than they would otherwise be by a fixed price differential of an average of about $2.00 per cwt. The size of the Class I differential is limited by political limits on how much additional revenue can be extracted from local fluid milk users (Ahn and Sumner, 2009). Thus, there is little scope to raise the payoff to the marketing order by raising the Class I differential.

The change in program rules and program administration from the California Milk Marketing Order followed several years, during which California milk producers became especially concerned about low prices in the state relative to prices in many other regions of the country. As was shown above in Figure 6.9, California milk prices are lower than those in many other regions of the United States and have been lower for many decades. But, the lower California prices are due to the fact that California is a net exporter of milk products to the rest of the United States and the world, and not because of identified deficiencies in government regulations. The new federal regulations do not change the supply and demand fundamentals for milk produced and processed in California. Therefore, the rules leave little scope for the federal order to cause major increases in milk prices compared to the California program that it replaced.

An important change from the California regulations is that under FMMO rules, Class III and Class IV processors, which previously had been required to remain in the marketing order, may opt out of the regulations if they find doing so to be financially advantageous. Fluid milk processors are required to remain in the pool, so there will always be a small Class I differential in the pool. "Depooling" has become common in California because the $2.00 differential is small and only about 12 percent of milk solids receive the differential. That means the Class I differential only adds about $0.24 per cwt (about 1.5 percent) to the pool price, and the difference between the additional payments required for processors of different products can easily exceed that difference.

A processor of cheese will tend to remain in the order when the Class III minimum price is near to or below the Class IV minimum price. Similarly, a processor of butter and dry milk powder will tend to remain in the order when the Class IV minimum price is near to or below the Class III minimum price. The reasoning is straightforward. When the market price of butter and milk powder has been low so that Class IV minimum price is sufficiently low, the price that a Class III processor must pay into the pool will be above what the farms that deliver to that Class III processor will receive as a pool price. That means the

Class III processor will be able to pay more for milk and have higher profits if they are outside the FMMO and pay farmers directly. A further complication is that once out of the order, a processor is allowed to re-enter only gradually. That means processors base decisions to exit or re-enter on long-term projections.

In fact, in November 2018, when the FMMO pricing began in California, the Class III minimum price was well below the Class IV minimum, and the Class IV processors stayed out of the order. Then, as the Class III price rose relative to the Class IV price, the roles reversed and much of the milk volume of Class III processors left the FMMO and has remained out of the order through May of 2020, the last month available as this chapter was finalized.

The complications of processors entering and leaving the order, make interpreting price minimums and pool prices complicated, which makes understanding the impacts of the FMMO more difficult to interpret. Nonetheless, the simple economic relationships and incentives are clear. The scope to raise the average market price of milk for farmers through a Class I differential is severely limited in a market such as California, where less than 15 percent of milk is used for Class I products and the Class I differential is only about 15 percent of typical average market price (Sumner, 2018a).

The FMMO system has small effects on milk price in California, but it can have larger impacts in other regions, raising further complications. By encouraging additional milk production and reducing the amount of milk used for local Class I products, the FMMO system encourages more production of butter, milk powder and cheese that are distributed nationally and internationally. The Class I differential reduces the prices of tradable dairy products to the disadvantage of producers in regions that specialize in these products, such as California and some international competitors (Sumner, 1999; Sumner, 2018a).

Two additional factors make the FMMO system more flexible and more complicated. First, the minimum pricing rules do not apply to the payments from cooperatives to their members. As owners of their cooperatives, payments to members are internal transactions, and farmers share broadly in gains and losses of the cooperative roughly in proportion to the milk they deliver. Therefore, to regulate the price of milk paid to a cooperative member would not regulate the return for milk that a member would receive. Of course, in order to maintain its membership, the expected returns to a cooperative member must be competitive with what that farm could expect to receive by selling directly to proprietary processors or to being a member of a different cooperative. These same competitive pressures affect milk contracts offered by proprietary processors and cooperative alike, but the FMMO more directly regulates prices of the proprietary firm.

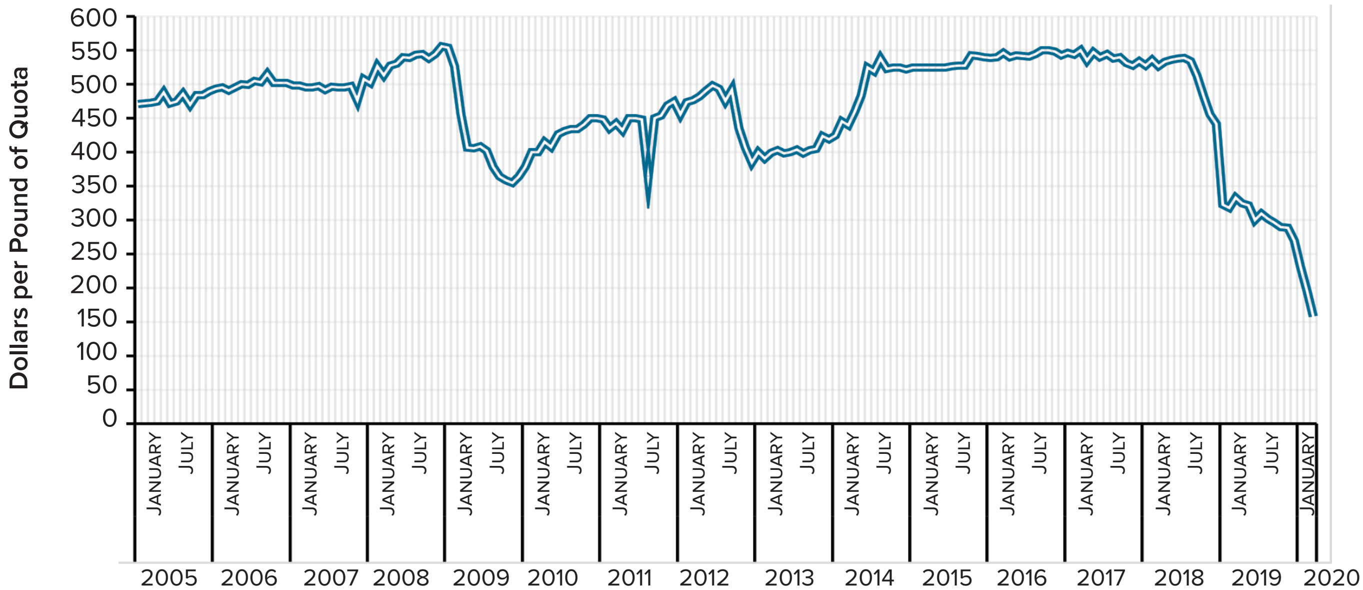
Second, the enforcement of government-set minimums does not preclude processors from paying more. These additional payments, called over-order premiums, are common. They are based in part of the quality characteristics of milk delivered and in part on competitive conditions prevailing in the market. Naturally, milk purchase and delivery contracts are complex. They have many features specifying bonuses for delivered quality and quantity as well as prices generally set as some amount over the minimum required under the FMMO in order to attract producer milk. Overall, market supply and demand conditions drive the processed product prices that determine FMMO minimum prices for each component in each end-use. Therefore, expected competition among processors, including cooperatives, determines over-order premiums that are written into contracts.

Milk Pool Quota in California

A unique feature of the California milk marketing order was a system, going back to 1969, under which some producers drew funds out of the pool based on their ownership of "pool quota." During the California milk marketing order, quota operations were incorporated as an implicit revenue transfer from all California producers to those who owned quota.

The FMMO has no provisions for the quota program. Therefore, in order to maintain the quota, producers voted in favor of keeping the quota program essentially unchanged after the shift to the California FMMO. The administration of the quota assessments and payments would remain with the California Department of Food and Agriculture. For the past 18 months, under the FMMO, state regulations specify an assessment of about $0.35 per cwt that is deducted before milk revenue is distributed to

Figure 6.11. California Milk "Quota" Transfer Prices, 2005–2020



Source: CDFA Milk Pool Data and UC AIC

producers. The assessment collected is then paid to quota owners in proportion to their quota ownership.

When California established the program about five decades ago, farms received quota roughly according to how much of their milk had been delivered for fluid uses. In the early days, the value of quota moved up and down with the demand for fluid milk products in California (Sumner and Wolf, 1998). However, the program also allocated additional quota for a few years to new producers (Sumner and Wilson, 2000). For most of the past five decades, the quota has been bought and sold, in a market where California milk producers could own quota up to the quantity of their milk production.

To be very clear, the ownership of quota places no restrictions on milk production or marketing. It simply conveys to the quota owner the right to receive a specified amount of revenue each month. Annual revenue per unit of quota is $71.25 payable monthly. Since the amount of revenue per unit of quota is fixed, the value of quota is simply the capitalized value of this revenue flow over the expected horizon of the payments (Wilson and Sumner, 2004; Sumner and Wilson, 2005).

Variation in the capitalized value of the quota depends on how long the payments are expected to last and any chance that they may be reduced or increased. Moreover, since only dairy farms can participate in the market, the price of quota depends on the discount rate relevant to California dairy farms (Wilson and Sumner, 2004; Sumner and Yu, 2014). In times of financial stress, more dairies will sell quota to raise liquidity, and fewer will have the ready cash or credit to buy quota; therefore, the price of quota will fall.

Figure 6.11 shows the capital value of quota over the 15-year period from January 2005 through March of 2020. Since quota ownership generated income on $71.25 per year, a price of $500 implies an annual return of about 14 percent, if no capital gains or losses are expected. A quota owner that purchased quota at that price in 1995 would have experienced that remarkably high rate of return year after year for 25 years. Generally, high returns are associated with high risk, and in this case, the applicable risk is that the program will not last or that the owner will sell the quota at a time of lower quota prices. Given the amount of quota, at $500 per unit, the total capital value of all quota was about $1 billion.

Quota price dropped to about $350 per unit in 2009 when milk prices were low, and dairy feed costs were high and dropped again in 2012, before rising in 2014 as economic conditions improved. There were no obvious changes in the likelihood of program termination during these periods. However, the precipitous drop in the price of quota from more than $500 in the summer of 2018 to less than $350 in early 2019 was clearly associated with a subtle change in the program.

For the first time in November 2018, the assessment that paid for quota benefits was listed explicitly on the milk checks of all California dairy farms. Each producer could then see precisely how much the quota program reduced milk revenue. For example, a dairy farm with 2,000 cows and average productivity and prices would pay about $16,000 per month or close to $200,000 per year into the quota program. While this amounted to a small share of total revenue for the farm, as a transfer to other dairies with no obvious benefit to the farm making the payment, the heightened awareness of the quota assessment caused agitation for change. Dairy operators filed a petition to end the program, while quota beneficiaries have moved to build support to keep the program. This activity has reduced the perceived expectation that the program will continue for many more years, and the price fell to about $150 in June 2020, with very few transactions so far this year.

Prospects for the Future

After remarkable growth for a half century, during which it supplied milk products for California's expanding population and began to ship products around the world, the California dairy industry abruptly stopped growing about a dozen years ago. Given expected economic pressures and environmental constraints, the prospects for renewed rapid expansion seem limited, at least under probable scenarios. The more likely outcome is for California dairy to continue as a mature industry that competes effectively by adopting innovative technologies and management strategies to deal with challenges. To maintain production, the California dairy industry, and the forage crop industry upon which it depends, must compete locally for land, water, and labor with other industries in the San Joaquin Valley. On the demand side, the California dairy industry must compete with milk production and processing industries for dairy product markets nationally and globally.

The California dairy industry has faced many economic pressures related to state, national, and global markets for milk, national and global markets for grain and oilseeds, and local costs of forage and labor, among other challenges. The costs of dairy farming and dairy product manufacturing have risen in California during the same period over which global economic competition has become stronger. These California cost challenges relate to costs of land, water, electricity, and labor (among others) that are due, in part, to California regulatory choices.

The industry was an early adopter of large-scale milk production and processing that lowered costs and attracted top managers. With rapid consolidation and strong economic incentives, only the best managers have remained in the business. These economic incentives and pressures continue, and consolidation continues. Table 6.10 summarizes the projection of continued farm consolidation. It suggests that the number of milk cows on dairy farms with less than 500 cows will decline by more than 64 percent over the next two decades. The rate of decline might be even faster, except that small organic farms remain to serve that specialty local market. The number of cows on dairies with between 500 and 2,000 cows is projected to decline by about 26 percent and the number of cows on the farms with more than 2,000 is projected to rise by 26 percent. The model calibrated these growth rates with current cow numbers such that the overall size of the industry remains roughly constant, in terms of milk production.

A significant cost pressure on milk production is related to the success of the tree nut industry in the San Joaquin Valley, which has increased the demand for land and irrigation water and caused a shift away from field crops. Reduced availability and higher costs of irrigation water have reduced regional acreage of hay and silage. Local silage production has declined, and more high-quality hay has shipped in from regions such as Northern California and Idaho, which causes the price of feed for California dairies to be higher than that of competitors.

One benefit to the California industry has been the increased availability of by-product forage feeds, led by almond hulls, but including grape pomace and many other by-products from fruit and vegetable production and food processing. Nonetheless, the California dairy industry will likely continue to have more expensive feed than its low-cost competitors.

As emphasized above, only a small share of California milk is used to make locally-consumed fluid milk products that sell in markets insulated from other dairy milk competition. However, the California and national trends toward less beverage milk consumption have been continuing for decades, with no indication of any reversal. Recently, plant-based alternatives to cow's milk have further diverted some demand. This shift has been significant and long-lasting enough that it seems likely to endure.

Therefore, most California milk will continue to be used to make processed products that compete in national and international markets. With relatively open borders, the prices in these markets are determined globally. As dairy production has become more efficient in other competitive regions, national and international prices are lower. Some of the efficiency gains in other parts of the United States

Table 6.10. A Projection of the Distribution of Cows Across Dairies by Herd Size

Size Category	Annual Rate of Change	Implied Accumulated Percentage Change Over Each Horizon		
	Percent	5 years	10 years	20 years
Number of Cows			Percent	
Less than 500	-5.0	-22.6	-40.1	-64.2
500–2,000	-1.5	-7.3	-14.0	-26.1
More than 2,000	NA	7.8	14.7	26.3
Organic	0	0	0	0

Source: Author's projections

Note: Based on annual rates of change consistent with historical changes over the past two or three decades. We expect the negative changes for smaller herd sizes to be mainly in farm exits, for midsize herd size some farms are moving to the larger size category. Increase in average herd sizes is likely to represent most of the growth in cow numbers for the larger groups. Assumes organic production associated with smaller herds remains. The percentage shifts in each size category are consistent with almost no change in numbers of cows.

have been due to their adoption of scale and management for which California was long known. In other places, pasture-based, seasonal milk production is the lower-cost alternative. Growing efficiency among competitors means that the inflation-adjusted prices of dairy products are likely to continue to decline even as demand grows, especially with income growth in developing countries.

Because California remains a large net exporter of dairy products and the costs of dairy product manufacturing have risen in California, the price of raw milk is relatively low compared to places where California dairy products are shipped. This straightforward price relationship has been a source of frustration for milk producers, who point to higher farm prices elsewhere. The other reason for lower farm milk prices in California is the cost pressure on milk processors here. These processors have innovated, but much of that effort has been in response to increasing demands for regulatory compliance. Given that they sell as price takers in national and international markets, where non-milk costs rise for processors, their demand for raw milk shifts down, and they offer lower prices to farms. These cost pressures on processors seem likely to continue.

None of the underlying cost pressures seem likely to change materially in the next few decades; hence, a return to rapid growth of California milk production seems unlikely. However, the inherent strengths of the California dairy industry remain. Therefore, it also seems unlikely that significant aggregate declines in California milk production are on the horizon. California milk output has been roughly constant, with many moderate ups and downs, for about 13 years. That aggregate pattern seems likely to continue. Of course, unforeseeable events may be on the horizon. As this is written, in May 2020, expecting the unexpected seems more appropriate than ever. Any projections, therefore, must be handled with caution.

Conclusion

This chapter describes the economic relationships driving the largest of California farm industries as measured by farm sales. However, we have also examined many challenges. The uncertain conditions in the spring of 2020 makes the concept of resilience even more salient for the California dairy industry.

At the end of 2019 and beginning of 2020, milk prices were rising and forecasts projected a return to profitability for much of the dairy industry. Demand for dairy products was rising and feed costs were moderate. The situation changed dramatically in February and March as the economic lock-downs accompanying the pandemic began to disrupt markets. Processing and packaging were misaligned to service consumers who were no longer consuming away from home. Some milk was dumped at farms because of a lack of processing and storage capacity. A looming global recession and disrupted export markets caused milk prices to collapse by one-third from $17/cwt to $11/cwt for milk used to process cheese or butter and milk powder. An expected recovery for the dairy industry turned into an economic disaster.

In response to these economic pressures, farm subsidies ramped up. The Dairy Margin Coverage program, developed to deal with unexpected declines in the milk price-feed cost margins, did not replace enough revenue to maintain dairy incomes. The federal government responded with supplemental direct payments to milk producers. The fund of about $3 billion, about 7 percent of annual industry revenue, was designated for the national dairy industry. This political response, however, focused support on the most politically powerful parts of the dairy industry, which tend to be the small and numerous farms in the east. Limits on payments per farm mean that for a typical eastern dairy, payments will cover most losses. In contrast, for a typical California dairy, payments may be limited to about $0.25 per cwt, even though the two farms faced the same decline in milk prices.

As the pandemic continued, demand for cheese expanded, partly from government programs, and the price of cheese rose to record heights. Dairy farm incomes improved such that, when government subsidies are included, dairy farm revenues for 2020 are likely to be above that in recent years.

Despite the pandemic and policy responses that curtailed much economic activity, food consumption continues, and dairy product demand remains substantial. Global demand growth has slowed, and it will be a few years before we catch up to where milk demand would have been. Nonetheless, those dairy farms and processors that weather the storm will face growing markets and the same challenges they faced before the 2020 disaster. The California dairy industry is positioned to remain a major part of California agriculture for decades to come.

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