

CALIFORNIA AGRICULTURE DIMENSIONS AND ISSUES

Philip L. Martin, Rachael E. Goodhue, and Brian D. Wright, Editors



This publication is a summary of essays by leading agricultural economists to provide an introduction to California agriculture. Each chapter includes basic data, trends over time, and current issues. The project was supported by the Giannini Foundation of Agricultural Economics, which was established in 1928 to analyze and propose policies to improve California agriculture. We are grateful to the researchers at UC Berkeley, UC Davis, and UC Riverside who contributed to this book. Each chapter is self-contained, which means that some basic parameters of the state's agriculture may be found in several chapters. The book is posted online at <https://giannini.ucop.edu/publications/cal-ag-book/>

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Cover Illustration: Over 40 percent of California's \$46 billion in farm sales in 2016 were fruits and nuts, followed by 22 percent for dairy and livestock, 16 percent for vegetables and melons, 15 percent for nursery and other horticultural specialties, and 5 percent for field crops.

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Division of Natural Resources

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Chapter 1. Introduction to California Agriculture

Abstract

California has led the nation in farm sales since 1948, when Los Angeles County had more farm sales than any other U.S. county. The major reason that California's farm sales of \$46 billion in 2016 were almost \$20 billion higher than No. 2 Iowa at \$27 billion is the dominance of high-value fruit, nut, and vegetable crops. Three-fourths of the state's farm sales are fruits and nuts, vegetables and melons, and horticultural specialties such as floriculture, nurseries, and mushrooms, so-called FVH crops.

The value of California crops was \$35.4 billion in 2016 and the value of livestock was \$10.5 billion. California's leading commodities in 2016 were milk with sales of \$6.1 billion, grapes with \$5.6 billion, almonds with \$5.2 billion, cattle with \$2.5 billion, and lettuce with \$2 billion in sales. These five commodities accounted for almost half of California's farm sales. California exported farm commodities worth \$20 billion in 2016, led by \$4.5 billion worth of almonds, \$1.5 billion worth of wine, and \$1.4 billion worth of dairy products.

The four leading farm counties accounted for 52 percent of the state's farm sales: Kern had farm sales of \$7.2 billion; Tulare \$6.4 billion; Fresno \$6.2 billion; and Monterey \$4.3 billion. Kern County accounted for 25 percent of the state's grape sales, 21 percent of almonds, and 42 percent of pistachios.

This introduction to California agriculture was written by the editors. It reflects the major contributions of each chapter, but was not reviewed by chapter authors.

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History, Land, Labor, and Water

History

California’s agricultural history differs from that of most states, beginning with the distribution of land. The Spanish and Mexican governments granted large parcels or ranchos of 50,000 or more acres to selected individuals. When California became a U.S. state in 1850, farming consisted largely of cattle grazing and dryland, or non-irrigated wheat farming, on vast ranchos.

There were fewer than 10,000 non-indigenous people in California when gold was discovered in 1848, but over 300,000 settlers arrived over the next decade, increasing the local demand for food. The same entrepreneurial spirit animating those who were mechanizing gold mining led to an expansion of wheat production. Instead of Midwestern-style farming, where one family farmed 160 acres, California developed giant bonanza farms that saw almost no activity except during seeding and harvesting. California wheat farms planted Mediterranean-variety wheat in the fall and harvested the grain in the spring.

Acreage of wheat and barley peaked at almost 4 million in the late 1880s, when the value of fruit began a rapid ascent. There were an estimated 4 million fruit trees in the state in 1880 and almost seven times more in 1900, reflecting new plantings of oranges, peaches, plums, and pears. Fruit trees had to be irrigated, and irrigation expanded quickly. There were fewer than 350,000 irrigated acres in 1880, 1.5 million in 1900, almost 5 million in 1930, and 8 million irrigated acres today.

Many factors helped to transform California agriculture from grains to fruit, including the completion of the transcontinental railroad in 1869, which lowered transport and capital costs, biological learning that improved crops, irrigation from groundwater, labor-saving mechanization, and marketing cooperatives to sell California fruit outside the state. California’s population rose from a million in 1890 to 5 million in 1930, increasing the demand for a wide range of commodities to feed residents and those outside the state.

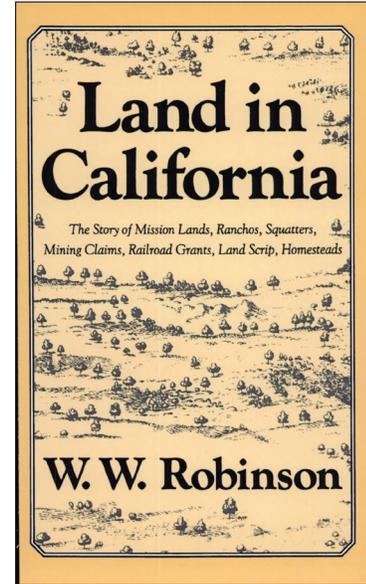


Biological innovations allowed California farmers to plant the grains, fruits, and cotton best suited for the state's Mediterranean climate. Labor-saving machines were developed to handle first grain, and later cotton production, on large-acreage farms. In the switch from wheat to perennial fruits in the 1880s was motivated by biological innovations that were optimal for California's conditions, and lower interest rates allowed farmers to wait several years for a return on their investment. California farmers were able to produce higher-quality fruit than farmers in the Mediterranean basin, and they expanded fruit production behind tariffs that protected them from foreign competition despite high transport costs to Eastern U.S. markets.

The Depression of the 1930s led to an agricultural crisis marked by low prices for farm commodities, the construction of dams and canals to move water from Northern California to the San Joaquin Valley, and the arrival of Dust Bowl farmers symbolized by John Steinbeck's *The Grapes of Wrath*. California's population expanded to over 10 million by 1950, and California agriculture imported Mexican Bracero workers under a series of agreements between 1942 and 1964.

Since 1960, the state's major agricultural developments include the growing importance of Fruit, Vegetable, and Horticultural (FVH) commodities in the state's farm sales, the rise of the dairy industry, and the expansion and contraction of particular commodities, including the spectacular rise of tree nuts and strawberries and the contraction of cotton and asparagus acreage. California was a pioneer in separating the locations of production from the consumption of fresh commodities, enabling the state to become a leading exporter of high-value fresh fruits and vegetables. California agriculture faces many challenges, from the availability of labor and water to coping with increased competition from other states and countries.

A perennial question is how to view the relationship between the relatively few farmers and the many seasonal farm workers in California agriculture. As on Southern plantations, farmers and farm workers in California came from different social classes with different political rights and influence. Unlike family farming in the Midwest, where occasional hired hands hoped to move up the agricultural ladder from worker to farmer, few seasonal



Spain and Mexico granted land to missions and to individuals; these ranchos were often 50,000 to 100,000 acres.

Source: University of California Press

farm workers in California became successful farmers. Instead, most found upward mobility in the nonfarm economy.

Land

California has over 100 million acres of land, almost half publicly owned and another quarter in farms. The United States Department of Agriculture (USDA) considers 9.6 million acres, less than 10 percent, to be cropland, and over 70 percent of this cropland is in the Central Valley between Redding in the north and Bakersfield in the south.

Under Spanish rule, all land was owned by the government. After Mexican independence in 1821, land was granted to private owners in ranchos of 50,000 acres or more; only some of these rancho land grants were honored when California became part of the United States in 1848. Most California land was owned by the federal government, which implemented policies to dispose of some of this land, including making land grants to homesteaders, 10.5 million acres, and grants of land to private firms that built railroads, some 11.6 million acres.

California farmland has always been among the most expensive in the United States. High land prices reflect the high-value commodities that predominate in

California and the profits from alternative uses, such as developing land for housing and the related needs of a rapidly growing population. The California chapter of the American Society of Farm Managers and Rural Appraisers in March 2018 reported that prime Napa vineyard acreage was worth \$400,000 an acre, while Sonoma vineyards were worth \$150,000 an acre, and Fresno vineyards were worth \$30,000 an acre. Almond orchards ranged from \$30,000 to \$40,000 an acre, depending on soil quality and access to water.¹ By contrast, the average value of farmland in Iowa is \$4,750 an acre.

Policymakers have tried to slow the conversion of farmland to urban uses by allowing farmers to enroll their land under Williamson Act contracts with local governments. In exchange for not developing their land, farmers pay taxes on the agricultural value of the land rather than its potential nonfarm uses. Governments can also zone land for farm or nonfarm uses, limiting the conversion of farmland into housing.

About 8 million acres of cropland were harvested in 2012, and 98 percent of harvested cropland was irrigated.

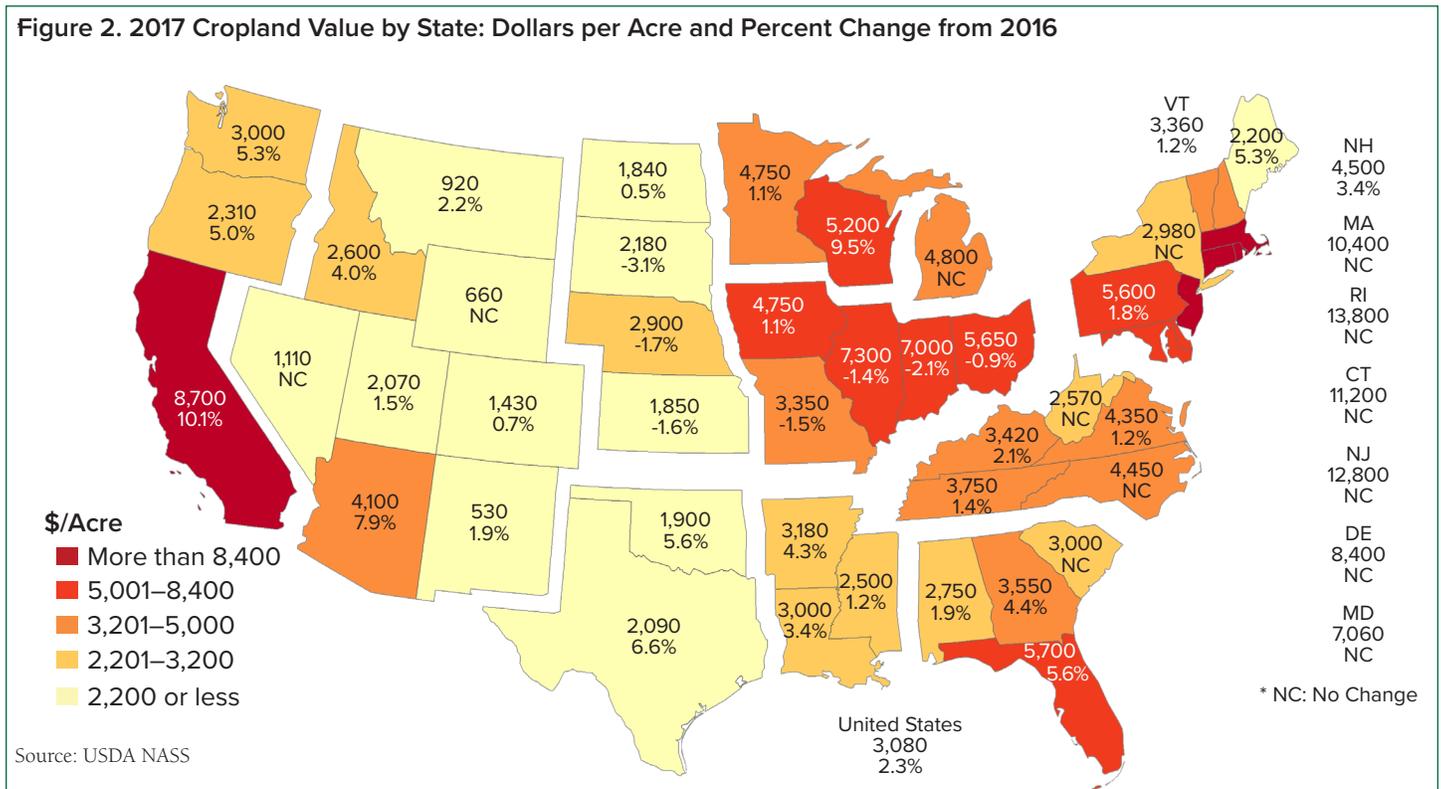
1 Todd Fitchette, "California Farmland Values Decline in 2017," *Western Farm Press*, March 29, 2018 <http://www.westernfarmpress.com/crops/california-farmland-values-decline-2017>

California's irrigated land is expensive, with an average price of \$13,000 an acre in 2017, according to USDA. Land prices reflect the profits that can be generated by growing crops on them, and the availability of water for irrigation is an important determinant of land values. The availability of an additional acre-foot of water can add from \$500 to the value of an acre of land.

The fertility of the soil in some areas is threatened by farming practices, and could reduce the value of the land. On the west side of the San Joaquin Valley, a clay layer under the soil traps salt from irrigation water, reducing yields enough so that some farmers stop planting crops. Excess irrigation water was supposed to drain to the ocean, but instead drained into the Kesterson National Wildlife Refuge and the Tulare Basin, where salty water laced with minerals led to wildlife deformities.

The amount of irrigated land in California fell from 9 to 8 million acres between 1982 and 2012. Population growth in the Central Valley, soil salinity, and water scarcity may accelerate the rate at which irrigated cropland is converted to other uses.

Figure 2. 2017 Cropland Value by State: Dollars per Acre and Percent Change from 2016



Source: USDA NASS

Labor

There are two major types of workers employed on farms. Farm operators and unpaid family workers have incomes that reflect the difference between farm revenues and costs. Hired workers, on the other hand, are paid wages that are independent of farm revenues and costs. Hired workers can be categorized in many ways, whether they are employed on farms producing crops or animals, whether the workers were hired directly by the farmer where they work or brought to the farm by a nonfarm employer such as a labor contractor, and whether they are legally authorized to work in the United States.

In 2015, the average annual agricultural employment of hired workers on California farms, a measure of year-round equivalent jobs, was 421,000, including over 90 percent on crop farms and less than 10 percent in animal agriculture. There are far more workers than jobs due to seasonality and turnover; the state’s agricultural employment peaks in August and is 30 percent lower in January, and many workers are employed in farm jobs for only a few weeks. As a result, there are two unique workers for each year-round job, a total of 848,000. Both the number of year-round equivalent jobs and the number of workers filling them have been increasing.

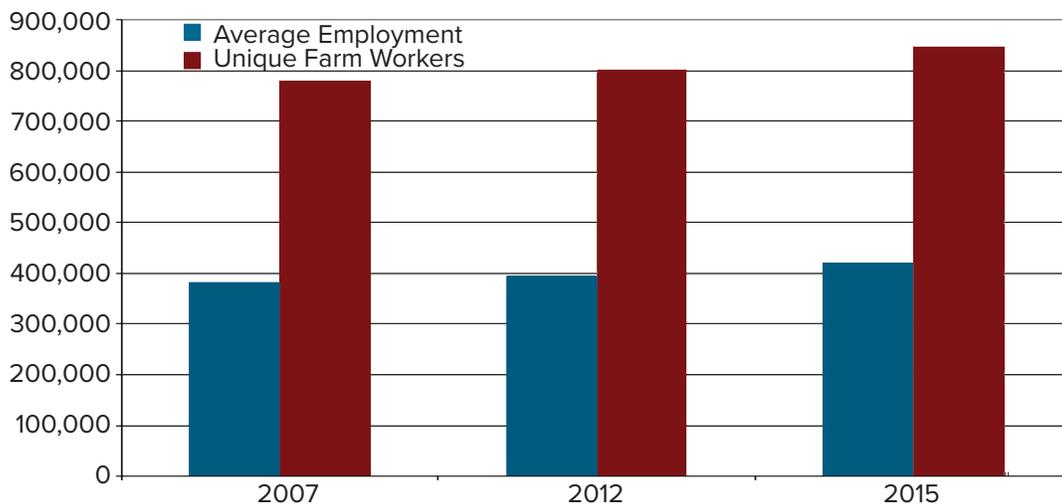
California is unusual in having more workers brought to crop farms by nonfarm employers known as crop support services than are hired directly by the farms where they work. Most crop support service workers are brought to

farms by farm labor contractors (FLCs), the intermediaries who have long been blamed for many farm labor woes. FLCs should improve farm labor market efficiency, assuring farmers that they will have workers when needed and arranging a series of jobs for workers. In practice, FLCs sometimes agree to bring workers to farms for very low commissions, and seek to turn a profit by not paying required payroll taxes or underpaying workers.

Union activities made headlines in the 1960s, when the United Farm Workers led by Cesar Chavez mounted a grape boycott that resulted in most of the state’s table grape pickers being represented by the UFW by 1970. Competition between the UFW and the Teamsters, as well as conflicts with growers, persuaded Governor Jerry Brown to sign the Agricultural Labor Relations Act of 1975, which gave California farm workers the right to organize and required employers to bargain with the unions elected by their workers. Intense union activity in the late 1970s was followed by a decline that has left the UFW today with fewer than 10,000 members and 50 contracts.

Today’s new entrants to California’s farm workforce are mostly legal Mexican guest workers admitted under the H-2A program. California was the major employer of Mexican Bracero guest workers between 1942 and 1964, and the major employer of unauthorized farm workers since. The slowdown in unauthorized Mexico-U.S. migration since the 2008–09 recession has prompted many farmers to turn to the H-2A guest worker program to obtain workers. Many

Figure 3. California: Average Employment and Unique Farm Workers: 2007, 2012, 2015



Source: California EDD analysis of unemployment insurance payroll tax data.

farmers use FLCs to recruit, house, and supervise legal Mexican guest workers.

Water

California farmers normally use about 33 million acre-feet of water to produce crops on 8 million acres of irrigated farmland, an average of 4 acre-feet. An acre-foot is 43,560 square feet or about a football field covered with one foot of water.

In “normal” water years, about 60 percent of the water used by farmers is surface water, which is water stored in dams or reservoirs and conveyed via canals to farmers. In dry years, farmers increase the use of groundwater, pump water from underground aquifers, sometimes fallow land that is used to produce lower-value crops (such as cotton), and buy water for high-value crops such as nuts. These adjustments helped California’s farm sales to rise each year during the 2012–15 drought.

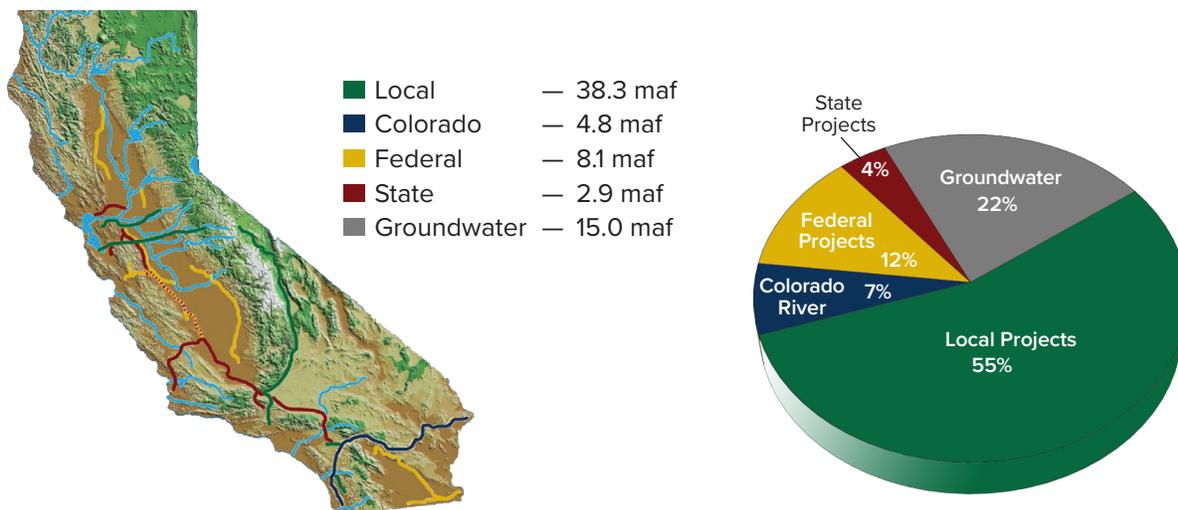
Three factors shape the longer-term outlook for agricultural water. First, most climate-change models predict warmer winters that are less well-suited to California’s water storage and transport system. If more precipitation falls as rain rather than snow, the capacity of dams and reservoirs to store winter precipitation for summer irrigation is reduced. Agriculture could cope by changing crops and farming practices to use less water, but such changes could lower farm revenues. For example, lower-value forage crops, such

as alfalfa for dairy cows, could be grown outside California, raising transport costs to move hay into the state and freeing up water for higher-value crops. However, some dairies may elect to leave the state to be closer to feed for their animals.

A second factor is the hardening of the demand for water, as trees and vines that must be watered for 20 to 30 years replace annual crops on land that in the past could be fallowed in dry years. For example, the acreage of almonds, which requires 3 to 4 acre-feet of water a year, more than doubled over the past three decades to over a million acres, while cotton declined from 1.6 million acres in 1980 to 160,000 acres in 2015.

A third factor is water marketing to shift water around the state. Governor Jerry Brown has endorsed a tunnel to move fresh water from Northern California 35 miles around the Delta and into reservoirs and groundwater recharge aquifers in the San Joaquin Valley. This so-called WaterFix could allow some of the farmers who grow rice and other water-intensive crops in the Sacramento Valley to fallow their land and sell water to farmers who grow high-value crops further south. San Joaquin Valley farmers have been reluctant to contribute to the \$17 billion cost of the tunnels, but the Metropolitan Water District of Southern California in April 2018 agreed to contribute \$11 billion, reasoning that it can recoup its investment by selling water to farmers and other users. If farmers were to acquire property rights in groundwater, they would have incentives to buy water and recharge aquifers in wet years.

Figure 4. California Water Supply Systems



<http://www.watereducation.org/photo-gallery/california-water-101>

Major Commodities

Dairy

The U.S. has 9.2 million dairy cows, and half were on farms with 900 or more cows in 2012; the other half were on smaller dairies. Dairy farms exemplify the general agricultural trend of fewer and larger operations producing most of each commodity. Most U.S. milk is produced in the northern and western states, led by California, with 1.9 million cows and Wisconsin with 1.2 million.

Milk and cream constitute the most valuable commodity produced in California; sales of \$6.1 billion were 60 percent of the total \$10 billion in animal agriculture sales in 2016. Farm milk is an average 87.3 percent water, 8.9 percent skim solids, and 3.8 percent fat. Fluid milk consumption has been falling, while cheese and butter consumption has been rising.

The number of dairy farms is shrinking, reflecting economies of scale in milk production, but the fewer and larger dairies that remain have a stable number of cows

and employees. Tulare County accounted for a quarter of California's milk and cream. One-quarter of the state's milk and cream is exported.

About 1,200 California dairies hired an average 18,000 workers in 2015, and paid them an average \$675 a week; 4 percent of the state's average farm employment was on dairies. Dairy labor costs are rising with the state's minimum wage, scheduled to reach \$15 in 2022, with requirements to pay 1.5 times the usual wage to workers employed more than eight hours a day or 40 hours a week in 2022.

The result may be more automation on dairy farms. Most dairies hire one employee for each 75 cows and milk cows around the clock. Robotic milking systems can save on the labor needed for milking but require significant investments, which many California dairy farmers are reluctant to make at a time of low and uncertain milk prices. Some of the robotic systems entice cows to enter the milking box with food; cows are milked as they eat. Cows self-selecting when to eat and be milked average about 2.8 milkings a day.

Field or row crops are large-acreage annual crops grown for animals or humans, including corn, grains, hay, as well as cotton and rice. California field crops sales were \$2.8 billion in 2016, led by rice with sales of \$777 million; alfalfa hay, \$771 million; cotton, \$368 million; and potatoes, \$265 million. California produces many of the major grain crops, including corn and wheat, but the value of California's production of these mainstays of U.S. agriculture is less than \$100 million a year. The major changes over the past quarter century are the sharp decline in cotton acreage and the shrinking of sugar beets, reflecting the expansion of more valuable crops and the shifting of scarce water to higher-value crops.



Milk, cheese, and dairy products are the most valuable commodity produced in California, worth \$6 billion in 2016 or 13 percent of the state's farm sales.

<https://goo.gl/images/KBMkBy>

Fruits and Nuts

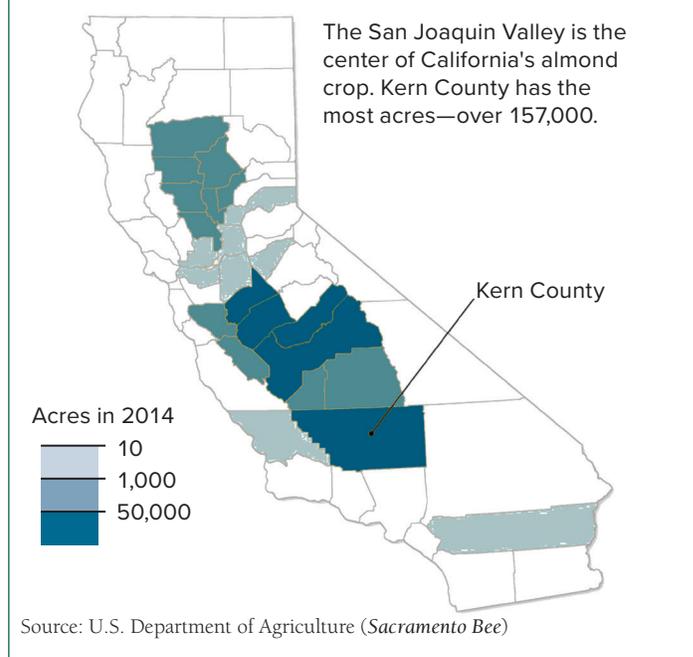
Tree fruits and nuts are some of the most valuable commodities grown in California: fruit and nut sales of \$18 billion in 2015 were almost 40 percent of farm sales of \$47 billion. The most valuable commodities were nuts, including almonds with \$5.2 billion in sales, walnuts, \$1.2 billion; and pistachios, \$1.5 billion. Grape sales were over \$5.6 billion, including half from wine grapes, one-third from table grapes, and one-seventh from raisins. Berries were worth \$2.5 billion, including three-fourths from strawberries, a fifth from raspberries, and 5 percent from blueberries.

The eight-county San Joaquin Valley is California's fruit and nut bowl, with most of the state's citrus, peaches and nectarines, and almonds, walnuts, and pistachios. The most valuable tree fruits are oranges, with sales of \$826 million in 2016, lemons with \$594 million, and peaches with \$350 million. Other tree fruits with sales of \$200–\$300 million each included avocados, cherries, and plums.

Fresh fruit consumption has been declining, reflecting reduced consumption of oranges and peaches and nectarines. Many fruit farms are relatively small, and many fruit growers belong to cooperatives such as Sunkist that market their fruit. Fruit farmers often use labor contractors to recruit workers for the most labor-intensive phases of production, such as pruning and harvesting, so that orchards without workers most of the year can have crews of dozens or hundreds during these peak seasons. Cherries are an exception to the story of generally declining acreages of fresh fruit. Sweet cherry acreage quadrupled between 1985 and 2015 to 40,000 acres, producing over \$184 million worth of cherries.

California produces most U.S. tree nuts and exports many of them. Almonds are the most valuable crop grown in the state and two-thirds of the state's almonds are exported. Acreage of almonds almost tripled between 1985 and 2015, as some land previously planted to raisin grapes and fresh fruit was converted to almonds. A major challenge facing almond growers is water: most nuts are grown south of the Sacramento-San Joaquin Delta, and drought and restrictions on pumping water to preserve fish have made water for some nut growers scarce and expensive. Nut growers north of the Delta have much lower irrigation costs.

Figure 5. Almond Acreage in California



Labor accounted for half of the 80 issues identified by the California Fresh Fruit Association as top priorities between 2010 and 2017. The state's largest peach grower, Gerawan Farms, has been embroiled in a dispute with the United Farm Workers since the early 1990s, and unsuccessfully challenged the state's 2002 Mandatory Mediation and Conciliation (MMC) law. The California Supreme Court in November 2017 held that a union remains certified to represent farm workers until that union is decertified lawfully by current workers.

The major labor issue is that over half of seasonal fruit pickers are not authorized to work in the U.S., and labor costs are rising due to the state's minimum wage heading for \$15 an hour by 2022 and requirements to pay farm workers overtime pay after eight hours a day or 40 hours a week. Immigration reforms could lead to a spike in labor costs, which is why tree fruit farmers are experimenting with a variety of ways to harvest fruit with machines.

Pruning trees and harvesting nuts are already largely mechanized tasks, but nut farmers face other challenges, including water, dust, and invasive species. There are various programs to keep invasive species out of the state and to eradicate those that slip in, but the threat of pests and diseases requires constant monitoring and quick responses.

Grapes and Wine

California grapes were worth \$5.6 billion in 2016, including two-thirds from wine grapes, one-quarter from table grapes, and less than 10 percent from raisins. The state has almost 850,000 acres of grapes, with two-thirds devoted to wine grapes, one-fifth to raisin grapes, and one-eighth to table grapes. Wine grape acreage has been increasing rapidly, table grape acreage has increased slowly, and raisin grape acreage has been decreasing. Most grapes are in the Southern San Joaquin Valley—almost all of the raisin and table grapes, and a quarter of the wine grape acreage.

The largest 100 grape growers had one-third of the state's grape acreage, and most large vineyards are in the San Joaquin Valley and Central Coast. Over 80 percent of wine grapes are harvested by machine, about half of raisin grapes are machine harvested, but all table grapes are hand harvested and usually packed in bags in the field for retail

sale. Labor costs can be 45 percent of variable production costs to produce table grapes.

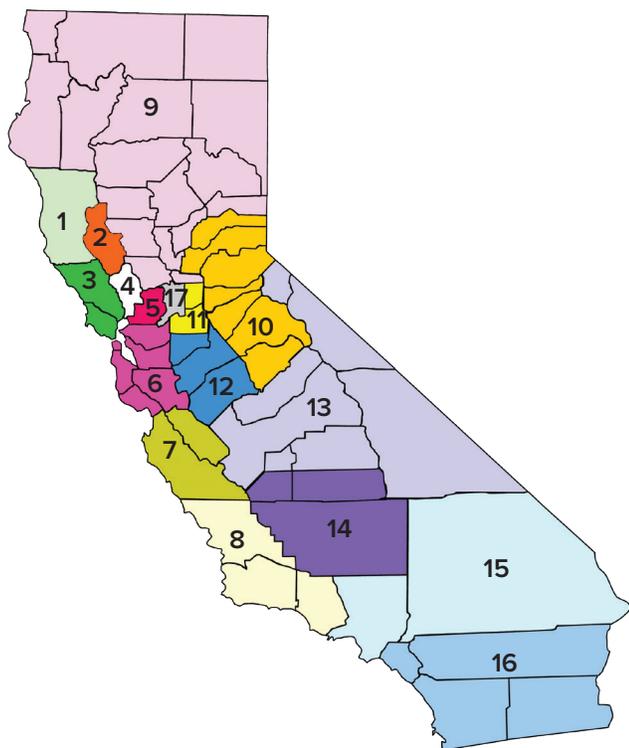
The value of California's table grapes quadrupled between 1987 and 2016, a period during which production rose by 50 percent. The big jump in farm gate revenue reflects new varieties for which consumers are willing to pay premium prices, such as Scarlet Royal. The acreage of raisin grapes is shrinking, as low prices encourage smaller growers of older vineyards to exit for other commodities, including almonds.

The U.S. produces 10 percent of the world's wine, and California accounts for 85 percent of U.S. wine production. California has 17 crush districts that can be grouped into five regions: North Coast, Central Coast, Northern San Joaquin, Southern San Joaquin, and other. The North Coast, including Napa and Sonoma counties, accounted for one-eighth of the state's 4 million tons of wine grapes crushed in 2016 but over 40 percent of the \$3.6 billion value of the state's wine grapes. The Southern San Joaquin region accounts for almost 40 percent of the state's wine grape tonnage but only one-eighth of the value of wine grapes.

Wine grapes can be grown by the winery that uses the grapes or by independent growers, most of whom have contracts with particular wineries. The largest wineries in 2016, as ranked by 12-bottle cases sold in the U.S., were E&J Gallo, 75 million cases; Wine Group, 58 million cases; and Constellation Brands, 50 million cases; these three wineries accounted for half of U.S. wine sales, including U.S.-produced wine and imports.² Most of the 12,000 U.S. wineries are very small, and some are virtual wineries, meaning that wine is made for the winery by another facility.

The U.S. is the world's largest wine market, and a third of U.S. wine is imported, often in bulk to be blended and bottled in the U.S. Most bulk wine is inexpensive, costing about \$4 a gallon, equivalent to \$0.80 a bottle. The U.S. exports about 10 percent of its wine, but imports far more, and is poised to become a major player in the world of wine for decades to come.

Figure 6. California Grape Pricing Districts



Over 560,000 acres produced 4 million tons of wine grapes in 2016. About 3.3 percent of these grapes were from District 4 (Napa), while 44 percent were from Districts 13 and 14 (Fresno, Tulare and Kern).

Source: USDA, NASS

² <https://www.winebusiness.com/wbm/?go=getArticle&dataId=163891>

Cattle and Sheep

California's \$10.5 billion in livestock sales in 2016 are about 6 percent of U.S. livestock sales. California's cattle and calves were worth \$2.5 billion and poultry and eggs were worth \$1.3 billion. The beef cattle industry has two distinct subsectors, with some ranches breeding cows to produce calves and others fattening cattle before slaughter. The major expense involved in fattening cattle, as well as in producing broiler chickens and eggs, is feed, which is often over half of production costs.

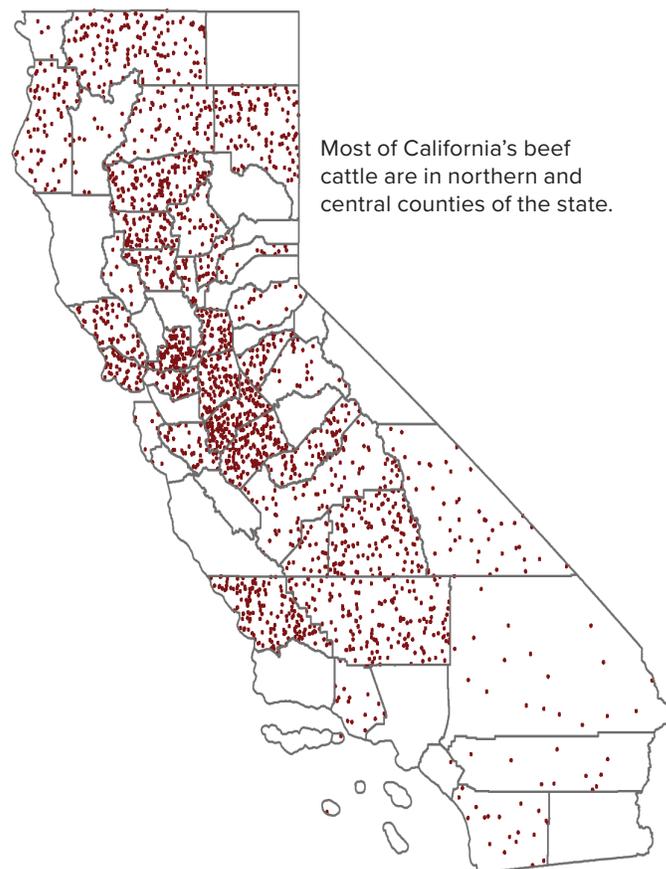
California had 2 percent of the 31 million beef cows in 2017. Three very different counties, Kern, San Luis Obispo, and Siskiyou, have large beef cow herds. There are several distinct attributes of California livestock: extensive reliance on public lands for forage for cattle, moving cattle to different pasture-based forage resources, limited in-state meat-processing facilities, and regulations on antibiotics and transportation that are increasing costs for California ranchers.

Cow-calf operations are the first stage in the beef supply chain, raising calves until they are about 7 months old and weigh 600 pounds. Calves are sold to stocker operations that feed them on pasture until they are 1-year old and weigh about 900 pounds. Yearling cattle are sold to feed lots, often in the Midwest, and fattened with grain before slaughter at 1,300 pounds. Almost three-fourths of "cattle on feed" in the U.S. were in Nebraska, Texas, Kansas, Iowa, and Colorado, meaning that many yearling cattle leave the state in trucks and return as beef.

California has about 10 percent of the 5.5 million sheep in the U.S., ranking second to Texas in sheep inventory, but first in wool production. Like cattle, lambs are raised on grass until they are moved to feed lots for fattening and slaughter.

Cattle and sheep ranchers need low-cost forage, which is disappearing with increased regulation of grazing on federal lands. Ranchers believe that the big four meatpackers who process over 85 percent of U.S. cattle are able to depress the prices they receive for their cattle, although research has failed to find convincing proof that meatpackers reduce farmers' prices. The use of antibiotics to prevent disease is being restricted in order to slow

Figure 7. Dot Density Plot of California Beef Cow Inventories by County, January 1, 2017



Source: California Department of Food and Agriculture

Note: Each dot represents 500 head.

antibiotic resistance, and new rest requirements for truck drivers may make it more expensive to ship California cattle to Midwest feedlots.

Vegetables

U.S. vegetable sales were \$14.6 billion in 2017, including \$8.3 billion worth of vegetables and melons from California, led by lettuce, \$2.2 billion; tomatoes, \$1.7 billion; and broccoli, \$865 million—these three commodities were almost half of the state's vegetable sales. U.S. and California vegetable sales are not strictly comparable because federal data include melons with fruits, while state data include melons with vegetables.

Americans have more vegetables available than ever, about 270 pounds a year, and a higher share of these vegetables are consumed fresh, 135 pounds per person in 2017 versus



Monterey County is often described as the U.S. salad bowl because it produces most leafy green vegetables, including lettuces, broccoli, and celery.

110 pounds of processed vegetables. The leading fresh vegetables are head, leaf, and romaine lettuce, 27 pounds per person per year; tomatoes, 22 pounds; onions, 18 pounds; bell peppers, 11 pounds; cucumbers, 8 pounds; and carrots, broccoli, and sweet corn, about 7 pounds each. Processed tomatoes dominate among processed vegetables.

There are about 1.4 million U.S. acres of fresh vegetables (excluding potatoes and dry beans) planted each year and about 1 million acres planted for processing vegetables. The USDA Economic Research Service (ERS) estimated the value of fresh vegetables to be \$10.8 billion in 2017 and the value of processing vegetables to be \$2 billion (ERS, 2017). Potatoes and dry beans are treated separately.

Other important vegetables in 2017 were carrots worth \$640 million; peppers, \$520 million; celery, \$435 million; cauliflower, \$315 million; melons, \$286 million; garlic, \$265 million; and onions, \$230 million. The production of lettuce and other leafy green vegetables is concentrated in the Salinas Valley, the nation's salad bowl, while melons, garlic, and onions are produced mainly in the San Joaquin Valley.

California produces over half of U.S. fresh vegetables. The six most valuable are broccoli, carrots, celery, lettuce, bell peppers, and fresh tomatoes, with broccoli and lettuce accounting for almost two-thirds of the value of the state's major fresh vegetables. These fresh vegetables are produced by a relative handful of large grower-shippers;

that is, businesses that plant and harvest crops and supply fresh vegetables to buyers year-round by moving production between California and Arizona. Many of the largest grower-shippers are not classified as farms in government statistics, including Dole Fresh Vegetables, which is considered a fruit and vegetable merchant wholesaler (NAICS 424480).

Large grower-shippers focus intensively on food safety, because many fresh vegetables are consumed raw. Bagged spinach on September 14, 2006, linked to an E. coli O157:H7 outbreak, killed three people and hospitalized over 100, setting in motion efforts to improve food safety practices on farms and packing plants that were codified in the Food Safety Modernization Act of 2011.

Harvest labor costs for major fresh vegetables range from 15 to 50 percent of production costs, with the higher percentages often including the cost of the container into which produce is packed for sale and marketing. Labor costs are often a third of variable production costs in fresh vegetables, and harvesting costs can be 70 to 90 percent of labor costs. Among the major fresh vegetables, tomatoes are the most unionized, with the United Farm Workers representing workers employed by three major growers.

The slowdown in unauthorized Mexico-U.S. migration and the state's minimum wage scheduled to be \$15 an hour in 2022 has prompted fresh vegetable growers to seek labor-saving mechanization and to employ more guest workers under the H-2A program. New plants that ripen uniformly are being developed to facilitate once-over machine harvesting, and some large vegetable growers are building housing in order to hire guest workers, who must be provided with free housing.

In addition to mechanization and guest workers, imports of fresh vegetables are rising. One-quarter of the fresh vegetables available to Americans are imported, up from less than 10 percent in the early 1990s, as California growers often partner with grower-shippers in Mexico and elsewhere to produce tomatoes and other vegetables for U.S. consumers. Farmers, who receive an average 25 percent of the retail price of fresh vegetables, are trying to raise their share of the retail produce dollar by differentiating their produce with labels and packaging, such as ready-to-eat salads.

Berries

California's berry industry generates 6 percent of California's farm sales from less than 1 percent of the state's farm land. The berry industry has traditionally included two subsectors: strawberries planted each year and perennial bush berries such as blueberries, raspberries, and blackberries. Demand for berries has been rising with perceived health benefits as well as year-round availability and convenient packaging, making berries the highest-revenue fresh produce item in U.S. supermarkets.

California produces over 85 percent of U.S. fresh strawberries, and plays a growing role in cane berry production. California's fresh berries were worth \$2.3 billion in 2016, 80 percent from strawberries, 15 percent from raspberries, and 5 percent from blueberries. Four firms market most fresh strawberries, led by market leader Driscoll's, which is also the dominant marketer of raspberries, accounting for 90 percent of U.S. sales from farms in California and Mexico. Naturipe Farms is the leading marketer of blueberries, and also markets other berries. Most blackberries are imported from Central Mexico and marketed by Driscoll's and Naturipe.

In 2016, the U.S. supply of fresh strawberries was 2.9 billion pounds, including 365 million or 12 percent imports. U.S. consumption was 2.6 billion pounds or about 8 pounds per person, and 277 million pounds of U.S. strawberries were exported, almost all to Canada. California strawberries are harvested almost year-round, with the harvest moving from south to north; during the January-March winter months, Florida supplies some strawberries. Some large Salinas vegetable growers have added strawberries, boosting the value of strawberries in Monterey County to \$725 million in 2016.

Strawberries are a high-value, high-risk, and high-labor-cost crop. Gross revenue per acre can be \$60,000 or more, but there are risks of disease and production peaking during periods of low grower prices. Growers want to plant strawberries in sterile soil, and used methyl bromide to fumigate soil before planting until 2016, when methyl bromide was phased out because of its ozone-depleting effects. Strawberries are often picked twice a week during the peak season, and labor costs are half or more of production costs.

U.S. consumption of fresh blueberries, most of which are imported, rose to 1.7 pounds per person in 2016. The major U.S. blueberry-producing states are Georgia, Michigan, Oregon, and Washington, accounting for two-thirds of U.S. blueberries in 2014. The major sources of blueberry imports are Canada, Chile, and Mexico. California's blueberry production is expanding rapidly, pushing the value of the state's blueberries to over \$100 million in 2016, more than the value of the state's pears.

California had 9,700 acres of red raspberries in 2016 that produced 2.1 million hundredweight of raspberries worth \$358 million. After expanding rapidly and generating revenues of \$547 million in 2015, raspberry prices fell 40 percent in 2016, reducing the value of the raspberry crop. California blackberry production is expanding rapidly, but the state does not publish data on blackberries. Most of the blackberries consumed in the U.S. are imported from Mexico.

Fresh berries are hand-picked, and berries are the state's leading employer of farm workers. Unions have tried and generally failed to organize berry workers, most notably after the UFW's Five Cents for Fairness campaign in the mid-1990s failed to secure long-term contracts with major growers. With Dole exiting strawberries, the UFW has a contract with organic strawberry grower Swanton Farms and is negotiating a contract in 2018 with Premiere Raspberries (Dutra Farms).



California produces 90 percent of U.S. strawberries, which are the leading crop in Monterey, Ventura, San Luis Obispo, and Santa Cruz.



Harvest Automation's robot moves plants in nurseries, replacing many workers. <https://www.public.harvestai.com/>

Source: Dina Rudick / The Boston Globe / Getty Images

As U.S. berry consumption continues to rise, will fresh berries be produced in the U.S. or imported? Most fresh strawberries are produced in the U.S., while most fresh blueberries, blackberries, and raspberries are imported; blueberries are mostly imported from Canada, Chile, and Peru, and the other berries mostly from Mexico. Marketers who develop proprietary varieties and contract with growers to produce berries for them may elect to move more production to Mexico and other lower-wage countries where there is fresh land to bring into berry production, reducing disease pressures.

While imports of fresh berries increase over the next decade, there could be progress to develop disease-resistant varieties in the U.S. and improvement in machines to harvest fresh berries, so that fresh berry production could return to the U.S. to be planted on land with fewer pest pressures from repeated berry plantings. New berry plantings under such a scenario would likely be amenable to machine harvesting, perhaps encouraging the fresh berry market to segment into hand-picked and machine-picked components, with different prices for berries handled by hand and machine.

Nurseries and Cannabis

California's nursery and floriculture sector had sales of \$3.8 billion in 2016, including 90 percent from nurseries that produce plants for sale to homeowners, businesses, and farmers. Nurseries are often located in metro areas near their customers. Nursery sales are linked to the housing industry, with new housing boosting the demand for plants. San Diego County accounted for one-third of the state's nursery and floriculture sales in 2016, and most of the other leading nursery counties were in coastal areas with favorable climates and most of the customers for plants. San Diego, Orange, and Los Angeles counties have over 16 million residents or 40 percent of the state's 39 million people.

The 2012 Census of Agriculture reported 3,400 nursery and floriculture farms in California with total sales of \$2.5 billion in 2012, down from 3,500 farms and \$3.6 billion in sales in 2007 due to the 2008–09 recession. Nursery sales are closely linked to new home construction, and the bursting of the housing bubble has slowed recovery of the sector.

The fact that nurseries are located near their customers in urban areas also raises labor costs, explaining why the average earnings of full-time nursery workers are \$30,000 a year, similar to full-time dairy employees. Land and water costs can also be higher for urban nurseries, which helps to explain why, once nurseries in urban areas are closed during downturns, they rarely reopen in urban areas.

The floriculture sector is smaller than the nursery sector. The leading cut flower in 2016 was lilies worth \$56 million, while the leading potted plant was orchids worth almost \$120 million. California florists reported \$560 million in sales in 2015, down over half from a peak \$1.2 billion in 2007. Most of the cut flowers sold in the U.S. are imported, with Columbia providing 60 percent and Ecuador 20 percent of imported cut flowers. Imported flowers are often flown to Miami and then trucked to customers around the United States.

California's fresh mushrooms were worth \$187 million in 2016. Mushrooms are grown in sealed houses that have wooden beds stacked three to five high. Grains of rye that contain invisible mushroom spores are planted in compost, a mixture of horse and chicken manure. Spawning takes about 12 days, and mushrooms can be harvested 18 days later.

Mushrooms are harvested by hand, and many mushroom workers are represented by the UFW at the largest producer, Monterey Mushrooms. California's mushroom production is concentrated in Monterey and Santa Clara counties.

California was the first state to legalize medical marijuana with Proposition 215 in 1996, which gave people suffering from cancer and other diseases the "legal right to obtain or grow, and use marijuana for medical purposes when recommended by a doctor." California did not regulate cannabis production for medical marijuana extensively, but federal drug laws continue to classify marijuana with heroin, calling for a minimum five-year prison sentence for growers with more than 100 plants and prohibiting marijuana from moving legally across state lines. There has been little enforcement of anti-cannabis laws in states where marijuana is legal, but federal agents enforce laws that prohibit marijuana from moving across state lines.

California voters approved Proposition 64 in November 2016 to legalize recreational marijuana after January 1, 2018. An estimated 13.5 million pounds of marijuana were produced in California in 2016, including 11 million pounds or over 80 percent produced illegally and sold outside the state. Most marijuana has been produced outdoors on plots of one-fourth acre or less. Outdoor farms produce an average 250 to 350 pounds a year, for a total of 8.1 million pounds or 60 percent of total production that was worth an average \$1,400 a pound or a total \$11 billion in 2016.

Trimming marijuana flowers to leave the buds requires 10 hours per pound and, at \$20 per hour, labor costs are in the range of \$600 per pound. Before legalization, most farm workers were paid in cash, and neither they nor farmers paid taxes. The cannabis labor force in the northern coast of California is unlike the rest of agriculture. Many "trim-immigrants" are friends and relatives of growers who arrive in the U.S. on legal tourist visas from Eastern European countries and earn \$200 to \$600 a day trimming marijuana leaves at piece-rate wages for up to 14 hours a day. Since wages are paid in cash, there are no taxes, making trimming jobs attractive to those seeking non-taxed earnings.

By some estimates, 100,000 people are employed in the state's cannabis industry, which would make cannabis a larger employer than strawberries, whose 60,000 workers



Workers who trim marijuana leaves often earn \$20 an hour or more.

are generally considered California's leading farm employer. The state law implementing Proposition 64 includes a labor provision that requires marijuana growers with 20 or more employees to give union organizers access to their employees. Employers and unions in cannabis, but not in other commodities, may negotiate collective bargaining agreements without an election to determine if workers want to be represented by a particular union.

Marijuana was traditionally grown in Northern California, in the Emerald Triangle of Humboldt, Mendocino, and Trinity counties. However, some large commercial have purchased greenhouses that once produced cut flowers in the Salinas area have been turned into cannabis farms. In April 2018, there were about 1,100 licenses issued to grow marijuana in the Emerald Triangle and another 1,100 in the Central Coast, including almost 800 in Santa Barbara County, where some farms combined 1-acre licenses to create farms with 5 to 10 acres, so-called license stacking.

Demand, Marketing, and Trade

Consumer Demand

Farmers produce what consumers want to buy, so consumer demand is the major factor influencing what farmers produce. The fundamental factor affecting the demand for food is the number of people, but many other factors also influence how much and which foods are purchased. Children and the elderly consume different quantities and kinds of foods than prime-aged adults, and demand for foods such as fresh berries rises with income.

The overall demand for food is inelastic, meaning that consumers spend a smaller share of their income on food as their incomes rise. Producers of various commodities often say they are competing for a “share of stomach,” so that successful efforts to promote beef may reduce the demand for pork, since these meats are substitutes. In some cases, commodities may be complements, as with wine and cheese, so that selling more wine increases the demand for cheese.

Americans spend relatively little on food, and farmers get a small share of what consumers spend. The U.S. Bureau of Labor Statistics’ Consumer Expenditure Survey measures the spending of the 130 million “consumer units” or households, which in 2016 had an average of 2.5 persons, 1.3 earners, and 1.9 motor vehicles. Average consumer unit income before taxes was \$74,665 and average annual expenditures were \$57,310. These expenditures included

\$7,200 for food, almost 13 percent of expenditures, and food spending was split 55–45 percent, with \$4,050 or \$78 a week spent for food eaten at home, and \$3,150 or \$60 a week for food bought away from home. Other significant consumer expenditures were \$18,900 for housing; \$9,050 for transportation; \$4,600 for health care; and \$2,900 for entertainment.

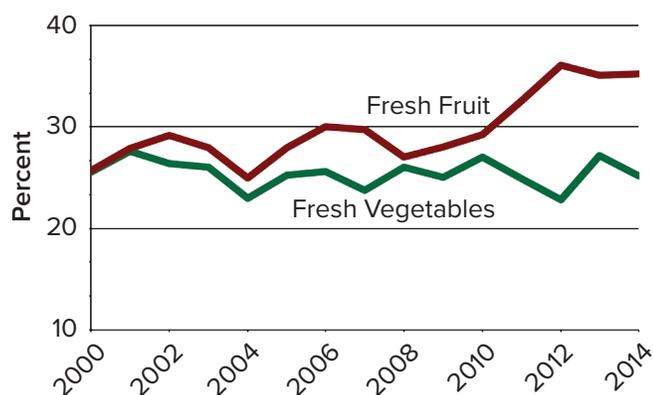
The cost of food away from home largely reflects convenience, service, atmosphere, and other factors; food costs are about 35 percent of the cost of food purchased in cafeteria-style restaurants, 30 percent in fast food, and 25 percent in fine dining. The largest food-at-home expenditures were for meat and poultry, an average of \$890 a year. Expenditures on cereal and bakery products, \$525, exceeded the \$410 spent on dairy products. Expenditures on fresh fruits (\$288) and fresh vegetables (\$254) were \$542 a year or \$10 a week, and consumer units spent an additional \$110 on processed fruits and \$130 on processed vegetables annually. Consumer units spent almost as much on alcoholic beverages, \$485 in 2016, as on fresh fruits and vegetables, \$542.

Most of the value-added in the food system occurs once food leaves the farm. Farmers get less than 20 percent of the average retail food dollar, but slightly more for fresh fruits and vegetables. Farmers received an average 38 percent of the retail price of fresh fruits in 2015 and 28 percent of the retail price of fresh vegetables, so average family expenditures on these items returned \$180 a year to the farm.

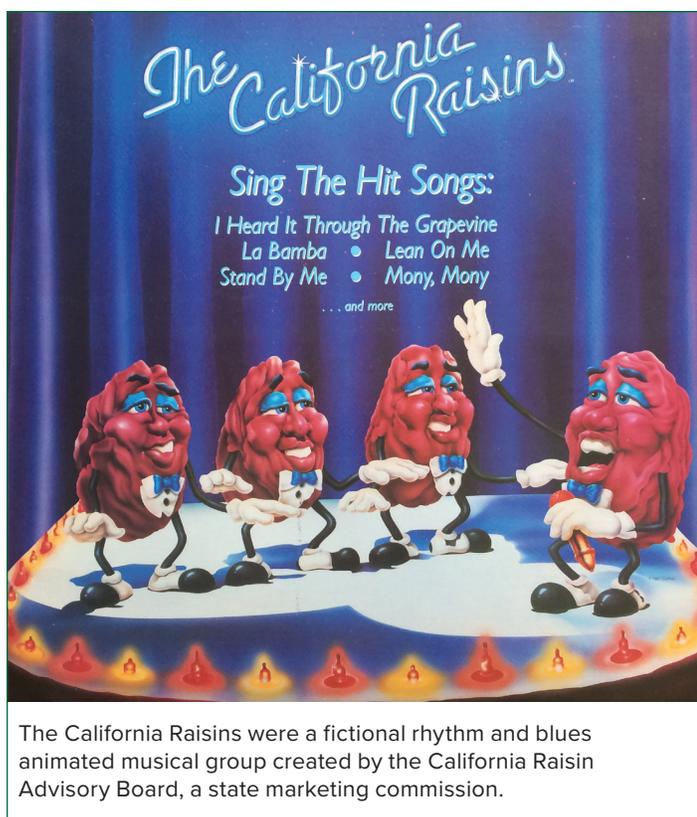
Marketing

Agricultural marketing involves the movement of commodities from farm to consumer, including packing and processing, transportation, financing, and sales at retail. Most commodities have several “owners” as they move from farm to fork. Farmers may sell to brokers who transport them to supermarkets and other retailers. Farmers receive a relatively small share of retail food spending, less than a quarter of average retail spending for a market basket of commodities consumed at home. Farmers receive less than half of the retail price of fluid

Figure 8. Farm Share of Retail Fresh Fruit and Vegetables



Source: ERS, USDA



milk and meat, and only about 5 percent of the retail price of cereal and bakery products.

Most of California farm commodities are specialty crops such as fruits and nuts, vegetables, and nursery and flower products, and they often present special marketing challenges. Growers of some commodities formed cooperatives to market their products, and the coop share of sales in many commodities has declined as production expanded and retailers preferred to deal with suppliers able to provide several related commodities year-round.

California farmers have also relied on federal- and state-mandated marketing programs to sell their commodities, with provisions for quantity and quality controls and marketing support. Farmers vote to approve marketing orders and commodity commissions, and pay an assessment per unit produced to fund commission activities. The number of marketing programs has been increasing, but more are approved under California rather than federal law, and the number of commissions has increased relative to marketing orders. The primary purpose of producer cooperation today is to support research that deals with pest and other problems facing

growers, and to sponsor advertising to increase the demand for the commodity.

Do marketing orders and commissions increase grower returns? Volume controls have been most the contentious orders, since withholding some of the commodity from the market can increase grower prices and attract new entrants, so that an ever-larger share of the commodity must be diverted away from the inelastic or high-price fresh market in order to keep prices there high. The high prices received for fresh California-Arizona lemons and oranges encouraged new plantings, so that an increasing share of the crop had to be exported or processed at much lower grower prices, reducing grower revenues and prompting the termination of the federal citrus marketing orders in 1994.

Cooperative quality-control efforts are less controversial, aiming to increase demand for the commodity by keeping inferior products off the market. For example, keeping immature fruit off the market early in the season may act as a supply control to increase grower prices and revenues later because consumers are not deterred by their earlier bad experience. Quality control efforts also include cooperation to enhance food safety, as after consumers of leafy green vegetables and almonds were sickened by contaminated product.

Most mandatory assessments paid by growers are used for generic advertising and promotion of particular commodities, such as the Got Milk or Dancing Raisins campaigns. Requiring all producers to contribute to these ads reduces free-riding, as when some producers do not contribute to campaigns that benefit all producers. Several large growers with their own brand names have sued to avoid making contributions for generic advertising. However, the U.S. Supreme Court has upheld laws that require all growers to contribute to advertise their commodities. In some commodities marked by perishability and concentration of production, producers are voluntarily sharing volume and pricing data to minimize wide swings in prices.

Trade

The value of California's agricultural exports has been about \$20 billion a year, over 40 percent of the state's annual farm sales. The leading exports in 2015 were almonds with sales of \$5.1 billion; dairy products, \$1.6 billion; and walnuts and wine worth \$1.5 billion each; these four accounted for half of the state's farm exports. Tree nuts were a third of total California farm exports, and trail only corn and soybeans as the leading U.S. farm exports.

California accounts for one-third of U.S. dairy exports, all almond and walnut exports, and over 90 percent of wine exports. The European Union (\$3.9 billion), Canada (\$3.5 billion), China (\$1.7 billion), Japan (\$1.6 billion), and Mexico (\$1.1 billion) collectively took 60 percent of California's agricultural exports in 2015.

The state's leading farm commodities and exports are not subsidized as with Midwestern corn and grains, making most California farmers supporters of freer trade as they shift land into high-value crops that are exported such as almonds. Dependence on exports increases risks from fluctuations in the value of the dollar and economic conditions in key importing countries. However, California agriculture is more diverse than Midwestern agriculture, where cattle and hogs and corn and soybeans dominate farm sales.

California residents are consumers of imported commodities. The state's competitiveness in global markets is evident in U.S. strawberry imports, which peak during the winter months when there is little production in the state. These are the months of peak Florida strawberry production, helping to explain why Florida farmers often oppose freer trade while some California strawberry growers partner with producers in Mexico and Chile in order to supply fruits and vegetables to their buyers year-round.

Trade in fruits and nuts is growing rapidly, posing challenges and opportunities for California agriculture. On the one hand, growing incomes abroad increase the demand for fruits and nuts, but they also encourage farmers in other countries such as Spain to produce fruits and nuts to export. California and the Netherlands are examples of high-income areas able to compete in global markets despite high wages and extensive regulation.

Farmers are divided on the virtues of the North American Free Trade Agreement (NAFTA), with some producers seeing new opportunities while others fear increased competition. Avocados show the potential for win-win outcomes, as Mexico reduced restrictions on other California commodities and the U.S. market expanded with the availability of Mexican avocados. Japan has a variety of barriers to imported commodities that California could export, so U.S. withdrawal from the Trans-Pacific Partnership will not help California farmers.

China is the world's largest producer of most fruits and vegetables, and some fear that the world's factory could also become the world's farm as Chinese farmers increase exports of fruits and vegetables; China has been a net agricultural exporter since 2004. However, rising incomes mean that demand for fresh fruits and vegetables is increasing in China, as are the wages of farm workers. Chinese consumers may prefer the higher-quality and more attractive packaging of imported fruits and vegetables to local produce. California garlic farmers were able to block Chinese garlic imports only temporarily, suggesting that adapting to the global changes is better than fighting what proves to be a losing battle.

California agriculture has largely embraced globalization and freer trade, since the state's farmers have much more to gain via increased access to more affluent consumers abroad than they would lose with protectionism. California farmers successfully competed with other U.S. farmers to become the dominant producers of fruits, nuts, vegetables, and other specialty crops, and they are likely to hold their own against farmers abroad as well.

Climate and Technology

Climate Change

The drought of 2013–15 and enactment of AB 32, a state law to limit greenhouse emissions in 2020 to 1990 levels, have made climate change a central challenge for California agriculture. Rising temperatures could increase the gap between the relatively wetter and sparsely populated northern part of the state, and the drier, more populated southern part of the state.

If more of the state's precipitation falls as rain rather than snow, the state's water system, which depends on snowmelt to provide surface irrigation water in summer, would be less viable. In addition, climate change could increase weather variability, leading to more floods and droughts. There could be changes in pest and disease infestations, which could force cropping changes.

Rising temperatures affect crops and animals directly. The optimal number of degree days, defined as degrees between 8°C and 32°C (46°F to 90°F), for many California crops is 2,500, and farmland prices drop when there are

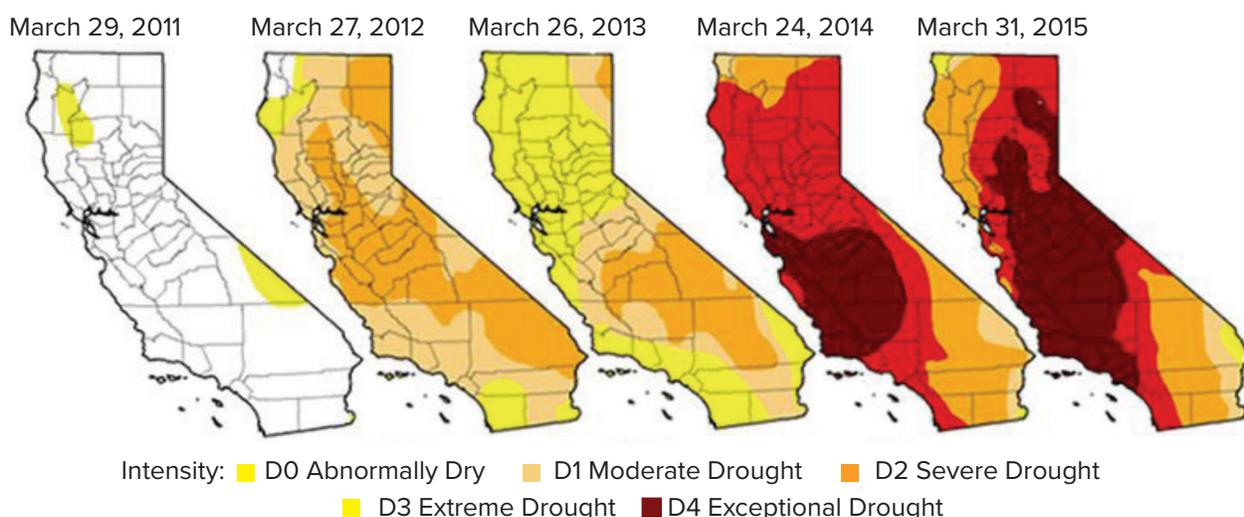
too many or too few degree days.³ Average degree days in the Central Valley are about 2,000, suggesting that global warming could lead to higher land prices and higher farm profits for some crops.

Climate change is expected to reduce yields of major field crops, including cotton and wheat, but have mixed effects on yields of fruit, nut, and vegetable crops. In some models, wine grape yields are less affected by rising temperatures than yields of nut crops and citrus, while other models that examine differences in temperature by month predict different impacts.

Animals will also be affected by rising temperatures, with milk yields likely declining due to heat stress. Workers tend to be less productive at low (under 55°F) and high (over 100°F) temperatures. Agriculture could adapt, moving dairy cows to higher elevations for cooler temperatures but increasing the cost of transporting feed. Farm workers could work at night, necessitating lighting systems and perhaps premium wages.

³ When the temperature is below 8°C or 46°F, there are no degree days. A temperature of 32°C or above contributes 24 degree days. Degree days are summed over the growing season.

Figure 9. California Drought Years, 2011–15



California experienced four years of progressively more severe drought until the rain and snow during the winter of 2015–16 filled the state's 154 reservoirs to capacity.

Source: <http://www.businessinsider.com/californias-drought-situation-is-worse-than-ever-2015-4>



The Agrobot has mechanical arms to pick strawberries trained to grow for machine picking.

Source: <https://www.cnbc.com/2018/03/08/wave-of-agriculture-robotics-holds-potential-to-ease-farm-labor-crunch.html>

Agriculture accounts for less than 10 percent of the state's greenhouse gas emissions, and agricultural emissions are dominated by methane from dairy cows and other animals, which has prompted efforts to better manage animal manure. State regulators are searching for carrots and sticks to reduce methane emissions.

Technology

California has high-tech agriculture supported by an educational-industrial complex that begins with the education of students, includes research supported by public and private funds, and involves transferring innovations and licensing technologies to commercial users. Cooperative Extension specialists are important intermediaries between farmers and researchers. Farmers get most of their information about farming from public sources, albeit sometimes transmitted via private consultants and associations.

Innovations are adopted by farmers when they increase profits. Early adopters are often the best-educated and best-capitalized farmers, although specific factors also play important roles, as with the high cost of water making San Diego avocado growers early adopters of drip irrigation. The rising price of water and technological improvements spread drip irrigation from 5 percent of California's irrigated cropland in 1985 to 40 percent by 2014.

California's arid climate reduces pest issues, and the relatively small yield penalty for organic farming encouraged organic production in the state; California's 1 million organic acres are about one-fifth of the U.S. total. Precision agriculture is another area where California is a leader, using technologies to modify water and other inputs to reflect the specific needs of particular plants and animals. Technology promises ever-lower costs of specific treatments, as when a drone can spray weeds only in the part of the field where they are present.

Precision agriculture depends on information and equipment to deal with particular crops. Harvesting fragile fruits and vegetables presents special challenges, since machines damage more of the crop than hand harvesters. Precision agriculture in animal agriculture includes robotic milking machines that entice cows to enter with feed and record detailed information on the cow.

Prepackaged salads were an innovation driven by a desire to reduce fluctuations in farm-level lettuce prices and increase convenience for consumers. With UC help, Fresh Express adapted controlled-atmosphere technologies that were developed to preserve fruit for leafy green vegetables, and soon learned that food service firms and consumers would pay premium prices for ready-to-eat salads. By 2016, there were over 400 types of prepackaged salads available, sales topped \$3.7 billion, and the farmers who supplied Fresh Express received contracts rather than fluctuating prices.

Some of the innovations in the food chain reflect the spread of technologies developed for other purposes and adapted for agricultural needs, including sensors in trucks hauling fresh produce that monitor temperature, and consumer apps that permit electronic ordering at grocery stores and restaurants.

California agriculture is well positioned to benefit from technologies developed in Silicon Valley and elsewhere. California has a high-cost and highly regulated business environment that is offset by affluent consumers, a desirable climate and soils for many crops, and a robust education and innovation system for developing, improving, and adapting innovations that keep the state's farmers on the cutting edge of productivity-increasing technologies.

Whither Giannini and Agriculture

The Giannini Foundation of Agricultural Economics was established with a 1928 gift to conduct research that improves the sustainability of California agriculture. On the eve of its centennial, what are the major contributions of the University of California agricultural economists who were and are the members of the Giannini Foundation?

The contributions of the Giannini Foundation are linked to the challenges and opportunities facing the state's agriculture, which has increasingly specialized in the production of high-value and high-risk commodities, most of which are sent out of state or to consumers abroad. During the Great Depression of the 1930s, there were 14 members of the Giannini Foundation, and most available funds were used to build Giannini Hall and support the Giannini Foundation Library at UC Berkeley (UCB).

Today, the Giannini Foundation has 70 members at UCB, UC Davis (UCD), and UC Riverside (UCR), and their research spans issues ranging from production and marketing to water, land, and climate change. The \$25 million endowment provides \$1 million dollars a year, almost half of which supports faculty research projects and a quarter for funding graduate students.

During its first 70 years, the Giannini Foundation published dozens of research reports and monographs dealing with issues that analyzed determinants of grower costs and prices, and mechanisms to increase the viability of the state's farmers. The shift to shorter articles that are distributed online led in 1997 to a new publication, [ARE Update](#), which has published over 400 shorter analyses of issues facing California agriculture and distributed to over 2,000 readers. Downloads of [ARE Update](#) articles suggest that China and other international issues affecting California agriculture are most popular.

Giannini Foundation members have organized conferences on a wide range of topics, from water to pests to climate change, and have made important contributions to public policy with their research papers, conferences, and advice. Many of the impacts of the Giannini Foundation are embedded in the 1,000 PhDs granted in agricultural economics at UCB, UCD, and UCR since 1930, many recipients of which became influential in research and policy.

Giannini Foundation faculty and graduate students are widely considered the best agricultural economists, winning awards and recognition for their contributions.

Agricultural economics is an applied branch of economics, often more interested in real-world issues than abstract models. Giannini Foundation members have been pioneers in developing many of the methods used to analyze agricultural issues, among the first to use econometric and other methods to analyze data to improve decision-making.

As California agriculture faces challenges from climate change to limited land and water, Foundation members are on the frontiers of efforts to develop solutions beneficial to the agricultural industry and all its residents. As the Foundation approaches the century mark, it is well positioned to continue achieving the goals laid out by its founder to conduct research beneficial to the state's agriculture.



The Giannini Foundation was created with a 1928 gift to University of California from A.P. Giannini (1870–1949), who founded the Bank of Italy (later Bank of America).

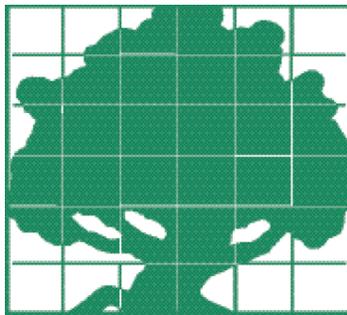
GIANNINI FOUNDATION INFORMATION SERIES

The Giannini Foundation Information Series is designed to communicate selected research results to a lay audience. The first Information Report was issued in 1963, and reports are numbered serially within years.

The Giannini Foundation of Agricultural Economics was founded in 1930 from a grant made by the Bancitaly Corporation to the University of California in tribute to its organizer and past president, Amadeo Peter Giannini of San Francisco. The broad mission of the foundation is to promote and support research and outreach activities in agricultural economics and rural development relevant to California. In line with those goals, the foundation encourages research in various areas of interest to agricultural and resource economists and supports dissemination of research findings to other researchers and to the public. Foundation membership includes agricultural economists (faculty and Cooperative Extension specialists) at the Department of Agricultural and Resource Economics, Davis, and at the Department of Agricultural and Resource Economics, Berkeley. Associate members include forestry economists in the College of Natural Resources, Berkeley, and economists in the Department of Environmental Sciences at Riverside.

This and other Giannini Foundation publications are available in PDF format online at:

<https://giannini.ucop.edu/publications>



Visit the Giannini Foundation website at

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